Chapter 4. Management Direction

USFWS

Flooding is a common occurrence on the refuge due to low elevation

Introduction

Our management direction is based on the tenets of conservation biology, and emphasizes biological diversity. It takes advantage of the emphasis in the NWRSIA on conserving biodiversity through sound science. The NWRSIA mandates change, and this plan will bring that change to the Refuge Complex by maintaining its biological diversity and environmental health, significantly improving its existing resource inventorying and monitoring program, and expanding it to include new areas: important, ecologically sensitive areas that require protection. Our plan also focuses on improving our ability to accommodate priority public uses, when they are compatible with refuge purposes and the mission of the Refuge System.

Conservation biology has been practiced for centuries. It derives from various fields, including population biology, genetics, forest and wildlife management, ecology, economics, anthropology, and philosophy. The science of conservation biology focuses on the protection of biological diversity at all levels, including genes, populations, species, habitats, ecosystems, and landscapes, as well as the maintenance of ecological processes, such as natural selection, natural disturbance, and hydrologic flow. Current thinking differs from traditional resource conservation. It is driven not by utilitarian, single-species issues, but by the desire to conserve the biological components and ecological processes of entire ecosystems.

Ecoregional planning (or reserve selection), a subset of the conservation biology field, involves working at large geographic scales to systematically determine areas of biodiversity significance and thus, conservation importance. In contrast, site planning (or reserve design) focuses on the best methods to achieve conservation success at a particular site or area.

Refuge Complex Vision Statement

> "The Chesapeake Marshlands National Wildlife Refuge Complex will provide the foundation for the creation of the most complete network of protected lands in our Nation's largest estuary. This assemblage of diverse island, wetland, upland, and aquatic habitats will represent all the biotic communities unique to the upper and middle Chesapeake Bay. The Refuge Complex will continue to be internationally and nationally renowned for its wetland habitats, which sustain significant populations of waterfowl and other Service trust resources. These refuges will expand their role in protecting, restoring, and managing the full range of natural processes, community types, and native plants and animals, making them anchors for biological diversity and ecosystem-level conservation locally, regionally, and within the National Wildlife Refuge System. The Refuge Complex will serve as a leader in the strategic acquisition or protection of important habitats within the watershed, and as a center to showcase the best science and technology used for wildlife conservation.
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> The Refuge Complex will demonstrate the importance of the natural world to the quality of human life; the value of, and need for, fish and wildlife management; and the human role in preserving and enhancing wildlife habitat. The Refuge Complex will forge partnerships to address the natural, historical, and cultural resource issues of the region. Local communities will recognize these refuges as national treasures, and actively participate in their stewardship. The Refuge Complex will raise public awareness and understanding of the Refuge System mission by providing clean, welcoming, safe, and accessible opportunities and facilities for compatible, high-quality, wildlife-oriented experiences. In collaboration with many partners, a wide range of innovative, stimulating, general public and environmental education programs and activities will be provided to diverse audiences.
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> By accomplishing this vision, these refuges will ensure healthy fish, wildlife, and plant resources for people to enjoy today and an enduring legacy for generations to come."

Refuge Complex Goals

The following broad goals of the Refuge Complex support the mission of the Refuge System, the purposes for which its refuges were established and other guiding laws and plans. Along with the vision statement for the Refuge Complex, they establish management direction.

Each goal is supported by measurable, achievable objectives and specific strategies and tasks needed to accomplish them. We intend to accomplish these goals in a 10- to 15-year time frame. The availability of funding may affect their actual implementation.

Goal 1. Protect and enhance Service trust resources and other species and habitats of special concern.

Goal 2. Maintain a healthy and diverse ecosystem with a full range of natural processes, natural community types, and the full spectrum of native plants and animals to pass on to future generations of Americans.

Goal 3. In collaboration with our conservation partners, create the most complete network of protected lands within the Chesapeake Bay Watershed.

Goal 4. Develop and implement quality scientific research, environmental education, and wildlife recreation programs that raise public awareness and are compatible with refuge purposes.

Goal 5. Ensure that staffing, facilities, resource protection, and infrastructure are developed commensurate with plan implementation.

Blackwater National Wildlife Refuge

Concepts Used in Developing Management Strategies

Land Protection.—On July 17, 1995, the Director approved a Preliminary Project Proposal to study protecting an additional 17,500 acres on Blackwater NWR, of which we acquired 2,186 acres by categorical exclusion. On July 25, 1995, the Director approved the study of an additional 16,000 acres on the Nanticoke River. See appendix B, "Land Protection Plan."

We will continue to pursue the protection of those lands and waters through a variety of actions, including fee title acquisitions, easements, and cooperative agreements. When we have assembled an adequate block of acreage along the Nanticoke River, we will manage that area as another division of the Refuge Complex.

We will also continue to identify within the focus area key private lands that will produce the greatest strategic gains in achieving our management goals and objectives outlined below. For example, we will prioritize the acquisition of forest lands in or near the core areas we have defined as providing optimal breeding habitat for forest birds. And, we will acquire inholdings from willing sellers as opportunities arise. [See chapter 1, figures 1.1 and 1.2.]

The private property rights of landowners to own, use, and manage their lands and natural resources will continue to be recognized and respected. A primary reason many of the Service's trust resources are concentrated in the Blackwater and Nanticoke focus areas is because of historical land management by private landowners. The Service recognizes that private lands can be well managed to maintain their current ecological and economical benefits. However, should private landowners within these focus areas subsequently decide to develop their properties and thus potentially adversely affect areas important to Service trust resources, conservation interests will be pursued. The acquisition of conservation interests in these lands will maintain current management programs and activities such as cropland and forest land management when these practices are compatible with refuge purposes and System mission, and done in accordance with approved management plans. Our management activities will be designed to complement the resources and rights of adjacent landowners.

Fish, Wildlife, and Habitat Management.—We will significantly expand the Complex-wide Resource Inventory and Monitoring Program, and will emphasize the tenets of conservation biology and ecosystem processes in designing and implementing our management programs. Also, we will implement programs for optimizing biological integrity and ecosystem health in the context of refuge purposes.

We will deploy a variety of active and passive management programs to accomplish habitat- and population-based goals and objectives, including intensively managed moist soil units (MSU) and croplands; development and implementation of a forest management program; active intervention to address exotic, invasive, and injurious

species; and landscape-level restoration.
Most of the fish, wildlife, and habitat management activities that we will implement under this CCP have routinely been implemented at Blackwater Refuge with the exception of active forest management. Therefore, a description of the forest management program is included as follows to clarify the general management principles and objectives.

The primary objective of forest management on refuges is to develop, manage, and perpetuate the diversity of indigenous wildlife populations needed to meet refuge objectives. The specific objectives of the NWRS forest management program, as defined in the Refuge Manual 6 RM 3, are to: 1) Provide habitat and protection for those species of plants and animals indigenous to the refuge that are officially listed by the Service or States as being threatened or endangered; 2) Provide habitat for waterfowl and other wildlife species; and 3) Provide compatible opportunities for wildlife-oriented recreation, environmental education, and interpretive/demonstration activities.

The diversity of forested habitats harboring many of our Trust Resources exists today as a result of past land management practices, including silviculture. Securing the conservation and restoration of Trust Resources will require actively fostering a mosaic of species composition and age-classes of forested habitats and seeking to improve the health of our existing forests. To provide Trust Resources with their needed habitats through time, the Refuge will embrace continued silvicultural activities consistent with the tenets of sustainable forestry (SFI and SCI) where compatible with Service mission and refuge purposes as mandated by the NWRSIA. In many cases, selected management strategies will also include reforestation of prior converted wetlands that were cleared, drained, and converted to agriculture.

Stewardship of forest habitats managed by the Refuge will be guided via the implementation of a written forest management plan providing for the conservation of desired habitat attributes. This will necessarily include provisions for the continuous production of suitable forest habitats utilizing sound silvicultural practices that help to achieve wildlife management objectives and refuge purposes, are ecologically responsible, respectful of cultural customs and uses, and economically contributory to the local communities.

The care and maintenance of many of our Trust Resources (particularly forest interior dwelling migratory birds and endangered species like the Delmarva fox squirrel and bald eagle) depend upon utilizing silvicultural prescriptions, which in turn require a cadre of professional forest and biological practitioners working collaboratively within both the public and private sectors to provide these services. Although not a primary objective, economics is recognized as an important part of every management program. Commercial harvest is an important tool for accomplishing forest habitat management because it reduces the funds and manpower needed to attain wildlife and habitat management objectives. Markets for forest products provide the economic incentives supporting the infrastructure of forestry practitioners; thus, the Service recognizes the importance of the forest industry in attaining desired habitat conditions on Refuge lands. As one of the largest forest landowners in the local community, the Refuge recognizes that actively participating in forest markets directly supports the infrastructure of forest practitioners, which are key partners in maintaining habitats for Trust Resources.

The Service also recognizes that private forest lands can be well managed to maintain their ecological and economic benefits. Future land protection efforts by the Refuge beyond the current boundaries will be cognizant of private landowner forest stewardship responsibilities and the importance of maintaining silvicultural practices and techniques defined in this CCP. When acquiring interests in private lands, such as implementing conservation agreements, we will initiate or continue forest management practices to conserve Trust Resources and enhance resource attributes, particularly in forests identified as having high conservation values in our identified focus areas.

The following management principles, as defined in 6 RM 3, will guide the planning and implementation of our forest management program:

1. Management operations will serve to meet wildlife habitat needs.
2. Provide a variety of successional stages, forest types, and seral stages within types.
3. Aesthetics will be considered and made part of forest management decisions.
4. Cultural resources will be protected and preserved.
5. Sufficient snags and den trees shall be made available.
6. Efforts will be taken to minimize the risk of wildfire ignitions.

7. Management practices will be consistent with available funds and manpower. Commercial harvest will be used as an available tool to accomplish management utilizing local industry resources.

We will write the forest management plan (FMP) in a collaborative inter-agency/interdisciplinary process. The goal of the forest management plan will be to meet NWRS mission and refuge purposes through accomplishing the objectives defined in this CCP and practicing the tenants of sustainable forestry and stewardship. We will routinely review the FMP to incorporate results of monitoring and scientific investigations, and respond as appropriate to changing environmental, social, and economic conditions as directed by NEPA.

All forest management activities will be strictly monitored to maintain compliance with best management practices and to conserve biological diversity and associated wildlife values, water resources, soils, and unique and fragile ecosystems and landscapes.

Public Use.—Outreach is two-way communication between us and the public to establish mutual understanding and promote public involvement in improving the joint stewardship of our natural resources. One concept that will guide our outreach is that public awareness of the Service, its mission, and its role in wildlife conservation is needed for the American public to appreciate and support our effective management of the Refuge Complex and its refuges. To improve that management, we must build a strong base of public understanding and support, by educating people about these refuges, their purposes and goals in a clear refuge message. The following concepts will guide our management of public use.

1. Promote the refuge message in providing visitors a more enjoyable experience and helping reduce visitor impacts on other wildlife areas.

2. Provide environmental education and training that incorporates the refuge message for teachers and students.

3. Increase opportunities to help the public to educate itself, such as printing an adequate quantity of brochures that incorporate the refuge message.

4. Provide compatible opportunities for wildlife observation, photography, hunting, and fishing.

5. Provide professionally produced interpretive information at appropriate locations.

6. Improve staff and volunteer training to enable them to provide the public quality interpretive experiences that convey the refuge message.

7. Maintain and improve visitor facilities to ensure that high quality, safe, enjoyable, and educational experiences of different levels and requiring different abilities are available.

8. Conduct effective outreach and work with State and local organizations to provide recreational facilities that enable visitors to enjoy the Refuge Complex without adversely affecting either wildlife or wildlife habitat.

9. Public uses will not interfere with important nesting or wintering seasons of listed species.

10. No public use activities will be permitted where public safety or trust resources are adversely affected.

We will improve existing public use opportunities and develop more environmental education and interpretation and wildlife-dependent recreation, in conformance with “Fulfilling the Promise” and the Refuge System Administration Act. We will develop an environmental education manual and teachers’ workshops; build an environmental education center; remodel and enlarge existing structures dedicated to public use; modernize exhibits; and build information kiosks, observation sites and decks, interpretive trails, photo blinds, and an accessible fishing pier. We also will expand hunting, fishing, and other wildlife-dependent recreational opportunities.

We will expand our outreach to build a stronger base of public understanding and support. We will develop better relationships with the media, local governments, and community organizations; participate in public events; work with the Friends of Blackwater; and install a travelers' information radio station.

Goals, Objectives, Strategies, and Monitoring Elements

Goal 1. Protect and enhance Service trust resources and other species and habitats of special concern.

Subgoal 1. Provide habitats to sustain 10 percent of each of Maryland's wintering waterfowl populations of Atlantic Population (AP) Canada geese, snow geese, and dabbling ducks (as measured by the Midwinter Waterfowl Inventory).

Objective 1.1.1. Monitor wintering waterfowl populations.

Basis of the objective.—Blackwater NWR is managed primarily for wintering waterfowl. Since 1955, 6 percent [SE = 0.6, n = 44] of Maryland's Canada goose, snow goose, and dabbling duck populations counted during the annual Midwinter Waterfowl Inventory have been on Blackwater NWR. To support the objectives of the NAWMP, the Chesapeake Bay Program Waterfowl Management Plan (2000), and Maryland's Canada Goose Management Program, the refuge must maintain a credible monitoring program to assess the efficacy of management actions and to determine the contribution of Blackwater NWR to Maryland's waterfowl populations.

Strategies to achieve the objective.—Blackwater NWR will continue to conduct three surveys of wintering waterfowl populations at three different spatial scales. The Midwinter Waterfowl Inventory (MWI) will be flown once annually, supplemented by bimonthly aerial surveys of the refuge and weekly ground counts of the impoundments, croplands, and adjacent river.

Monitoring element.—The percentage of AP Canada geese, snow geese, and dabbling ducks.

Objective 1.1.2. Restore emergent marsh on Blackwater NWR to 1933 coverage level by 2017

Basis of the objective.—Blackwater has lost more than 7,000 acres of emergent wetlands since its establishment as a national wildlife refuge in 1933. Most of that loss has occurred in the three-square (*Schoenoplectus americanus*) brackish marsh at the confluence of the Little Blackwater and Blackwater rivers, but is also now progressing upstream and downstream. That unusually high rate of wetland loss is likely the result of several confounding factors, including sea-level rise, land subsidence, saltwater intrusion, severely modified hydrology, and excessive herbivory.

This emergent marsh once provided significant breeding habitats for blue-winged teal and American black ducks, and foraging habitats for wintering populations of geese and dabbling ducks. The open water that has displaced the lost wetlands is now used primarily by waterfowl as a disturbance-free rest area during migration and winter and by resident populations of resident Canada geese as a safe place to molt during the summer. It has little value for diving ducks, presumably because its shallow, flocculent bottom precludes high densities of submerged aquatic vegetation (SAV) and invertebrates.

Strategies to achieve the objective.—We will develop a comprehensive Habitat Management Plan by 2008 that will detail options for maintaining, restoring, and enhancing marsh habitats. Restoration strategies to be assessed will include plugging Stewart's Canal to reduce saltwater intrusion, modifying Shorter's Wharf Road to allow sheet flow, implementing recommendations from the Nutria Pilot Study to reduce nutria herbivory, implementing the Integrated Wildlife Damage Management Plan for resident Canada geese, maintaining the muskrat trapping and nutria rebate program, riprapping the pine islands, reducing sediment load run-off into the upper watersheds, using thin-layer soil deposition, and evaluating more substantive spoil deposition. Strategies for maintaining and improving floral composition will include the use of prescribed fire to affect regrowth vigor and species composition, the use of pesticides to control invasive flora, and replanting in conjunction with techniques such as thin-layer soil deposition.

Monitoring element.—Acreage of emergent marsh restored.

Objective 1.1.3. Manage approximately of 420 acres in croplands on Blackwater NWR, thus reducing current cropland acreage by 25 percent by 2017.

Basis of the objective.—Due to wetland loss and degradation, natural food resources are inadequate to increase or even sustain the current levels of waterfowl use on Blackwater NWR. Furthermore, very few "hot foods" (e.g., corn and sorghum, which are high in carbohydrates and energy) are available off-refuge; those that are available are consumed early. When birds have to travel long distances to seek food off the refuge in severe winter weather, their energy reserves are quickly depleted. Consequently, the refuge plants row crops and cool-season grasses or forbs each year, presently as forced-account, to sustain wintering migratory waterfowl during critical periods of nutritional and physical stress. High-protein cover crops of Ladino clover and buckwheat, over-seeded with winter wheat, receive heavy waterfowl use the entire winter. Sorghum and corn provide high carbohydrates during midwinter and periods of extreme weather when food sources generally are unavailable. Japanese millet is planted in low elevation fields and in some MSUs, where early flooding in the autumn is likely. Small acreages also are planted in sunflowers for migrating waterfowl and granivorous passerines.

The forest management portion of the Habitat Management Plan recommends the restoration of selected, formerly converted wetlands from agricultural use to forested habitats (i.e., reforestation). We will convert some formerly converted wetlands from agricultural use to MSUs, due to soil types with poor drainage characteristics (see objective 1.1.4., below). Consequently, the acreage under cropland management will be reduced by 25 percent. Contractual planting of corn and sorghum crops with force account planting of the cool season grasses and forbs is recommended, because it minimizes labor and equipment on the part of the refuge while retaining the most nutritious composition of croplands to meet the seasonal needs of waterfowl. Should funding not be available for contractual planting and forced-account responsibilities, cooperative farming will be implemented.

Strategies to achieve the objective.—We will manage 420 acres of cropland by contractual planting of 100 to 120 acres in hot foods and forced-account planting, and maintaining 300 to 320 acres in cool season grasses and forbs. The croplands will be divided into one-quarter hot foods and three-quarters high-protein browse, consisting of Ladino clover, winter wheat, buckwheat, crimson clover, and annual rye. Small acreages of sunflowers will also be planted for granivorous passerines, particularly mourning doves. We will leave all crops unharvested for wintering waterfowl and other wildlife.

If funding is insufficient, we will implement cooperative farming on a 75- to 25-percent share of the crops produced. Additional strategies will include continuing to implement the Integrated Wildlife Damage Management Plan for resident Canada geese to reduce cropland damage; developing Farm Plans, including filter strips; controlling sediment erosion; using integrated pest management; using nutrient management planning; rotating crops; and using other best management practices. [Consult the Cropland Management Program for a more thorough description of the exact procedures and differences among cooperative farming programs and contractual or force account programs.] We will evaluate cropland management for newly acquired lands on a tract-by-tract basis, regarding the highest and best use consistent with the Habitat Management Plan.

Monitoring element.—Acres of crops, cool-season grasses, or forbs available for waterfowl at the onset of the fall migration (approximately 15 September).

Objective 1.1.4. Manage a minimum of 460 acres of impoundments on Blackwater NWR for moist soil management, thus increasing moist soil acreage by 25 percent by 2017.

Basis of the objective – Native herbaceous vegetation adapted to germination in hydric soils (i.e., moist-soil plants) provide waterfowl with nutritional resources, including essential amino acids, vitamins, and minerals that occur only in small amounts or are absent in other foods. These elements are essential for waterfowl to successfully complete aspects of the annual cycle such as molt and reproduction. Moist-soil vegetation also has the advantages of consistent production of foods across years with varying water availability, low management costs, high tolerance to diverse environmental conditions, and low deterioration rates of seeds after flooding.

MSU also promote invertebrate production. Invertebrates provide the critical protein-rich food resources required by pre-breeding and breeding female ducks, newly hatched waterfowl, and molting ducks and shorebirds. Due to the high value of MSU to waterfowl, shorebirds, and other water birds, additional MSU will be constructed on formerly converted wetlands with poor soil characteristics; i.e., poor drainage. Additionally, the existing MSU infrastructure will be improved to more effectively manage water levels.

Strategies to achieve the objective.—When implementing moist soil management, pool drawdowns typically would occur between mid-March and early June, depending on the wildlife objectives and moist soil plant or invertebrate response desired. Drawdown would begin in most pools first by gravity flow, but pumping often may be required in most of the impoundments to remove all the water. We would maintain several permanent and seasonal pumping stations, using gasoline, diesel, and electric pumps. Rates of drawdown can be critical and, depending on the pool bottom topography and soil type or organic content, can either occur rapidly or must be prolonged. We would complete all drawdowns by mid-June, and would keep pool bottoms as moist as weather conditions will allow, to facilitate the germination, growth, and production of a wide diversity of emergent moist soil plants, such as smartweed, beggartick, red-root Cyperus, Panicum, Walters' and barnyard millets, dwarf spike rush, and others.

We would monitor and record water levels, pH, conductivity, and salinity weekly during the growing season and biweekly during periods of flooding. We will describe exact water level management plans in our Annual Water Management Program, which we would use as an annual management guide (rainfall-dependent).

We will convert an additional 89 acres of PC wetlands to moist soil management. Electric pumps will be installed in pool 3 and pool 5 to facilitate flooding and drawdowns. Three water control structures will be installed between pools 3A–3B, 3B–3C, and 5A–5B. A water control structure will be installed to replace the 12" concrete pipe that now fills pool 4. Additional strategies include continued implementation of the Integrated Wildlife Damage Management Plan for resident Canada geese.

Future moist soil management units will be developed on newly acquired lands if they are appropriate for helping to achieve refuge purposes, goals, and objectives.

Monitoring element.—Acres of MSU that have >75-percent cover of vegetation that produces good waterfowl foods (see Martin and Uhler 1951) at the onset of migration (15 September).

Objective 1.1.5. By 2007, determine existing American black duck production and preferred habitat types.

Basis of the objective.—The American black duck is a National Species of Special Emphasis. It ranks on the Watch List in the Partners-in-Flight Mid-Atlantic Coastal Plain Bird Conservation Plan (1999) and is a species of emphasis in the Chesapeake Bay Program Waterfowl Management Plan (2000). American black ducks bred in high densities at Blackwater in the 1930s, but more recently, the perception is that both pair densities and brood production have been low. It is not apparent what proportion of the breeding population is nesting in emergent vs. palustrine forested wetlands. There is a clear need to develop an initiative with the explicit goal of implementing an integrated approach to the research and management of American black ducks on the Refuge Complex.

Strategies to achieve the objective.—The black duck initiative will seek collaborative efforts among these stake holders and others to develop funding for studies to assess black duck productivity, nest predation rates, and habitat use on the Refuge Complex. Strategies will likely involve nest monitoring, brood surveys, and a radio telemetry study of nesting females. Subsequent management to maintain and enhance black duck production will be based on recommendations from these studies and others identified in the Black Duck Atlantic Coast Joint Venture Plan and the Chesapeake Bay Program Waterfowl Management Plan 2000.

Monitoring element.—Partnership and funding for the initiative for American black ducks, and continued participation in the Midwinter Waterfowl Inventory.

Objective 1.1.6. Maintain natural nesting habitats for wood ducks by 2017

Basis of the objective.—The wood duck is a National Species of Special Emphasis. Blackwater has historically contributed to local and regional populations of wood ducks by maintaining 5,000 acres of palustrine wetlands.

Strategies to achieve the objective.—The refuge will continue to maintain 5,000 acres of palustrine forested wetlands; this acreage will increase as new lands are acquired. Silvicultural treatments (including contract sales and TSI) specifically will retain 2 to 5 snags of at least 12" DBH per acre to ensure a good distribution of natural cavities on the refuge. We will eliminate the existing wood duck nest boxes, except for 15 that we will maintain for environmental education along the Wildlife Drive. We will continue to conduct fall brood surveys and roost counts.
Monitoring element.—Acreage of palustrine forest maintained.

Objective 1.1.7. Determine the regional significance of the lesser snow goose population by 2010.

Basis of the objective.—The lesser snow goose (*Anser c. caerulescens*) is primarily a migrant in the mid-continental and Pacific flyways (Bellrose 1976). However, a relatively small proportion of the continental population migrates south in the fall to the Chesapeake Bay, Currituck Sound, and adjacent waters of the Atlantic Coast. An unusually high proportion of this regional population at Blackwater NWR is the blue phase, suggesting a genetically distinct population. Blackwater NWR has been a traditional wintering site for a significant portion of this population since 1934–35. Based on aerial surveys over the past decade, 2500–3500 lesser snow geese have routinely wintered on Blackwater NWR, with counts as high as 6,500 geese during peak migration. Other than the occasional vagrant, all other refuges on the mid-Atlantic coastal plain support greater snow geese (*Anser c. atlantica*). It is apparent that the population at Blackwater NWR is unique from both a continental and regional perspective, and may contribute to the genetic diversity of the continental lesser snow goose population.

Strategies to achieve the objective.—We will develop a study of the lesser snow goose population at Blackwater NWR with the two primary objectives of determining (via satellite telemetry) the migration corridor and breeding grounds, and determining the genetic uniqueness (by contrasting genetic markers) of this population. The importance of this study is that confirmation of a genetically distinct sub-population of lesser snow geese will clearly demonstrate the need to revise current USFWS plans to reduce snow goose (regardless of subspecific status) populations in Region 5.

Monitoring element.—Generate funding and complete the study identified above; implement subsequent recommendations.

Objective 1.1.8. By 2011, develop programs to prevent the loss or degradation of habitats and develop programs and actions to restore and enhance waterfowl habitats within the Nanticoke protection area.

Basis of the objective.—Although waterfowl habitats in the Nanticoke watershed are considered to be in relatively good ecological health, several factors are adversely affecting these wetlands' functions and values. With economies based in agriculture, forestry, fisheries, and tourism, the Nanticoke watershed has not yet experienced the adverse impacts from development in the intensity felt in other tributaries of the Chesapeake. However, due to poor land use practices, some habitat degradation has been documented, such as sedimentation, eutrophication, conversion, drainage, and channelization.

Strategies to achieve the objective.—We will restore wetland functions and values by restoring riparian systems, replanting degraded wetlands with native plant species, re-establishing SAV beds, controlling exotic or invasive species, and (where appropriate) using structural devices to restore natural hydrology and control salinity. We will assess the effects of hydrological and water quality changes by establishing a water quality monitoring program to evaluate the effects of upstream sources of pollutants on division resources.

Hydrological modeling may be considered for the Nanticoke River and its tributaries to determine the potential changes in habitat conditions over time from the compounding effects of land subsidence, sea-level rise, and saltwater intrusion. Eutrophication of the system is occurring, and any efforts to address the effects of excessive nutrients will require extensive coordination and planning with partners and stakeholders. Also, the effects of channeling and other hydrological modifications on the Nanticoke River's main stem and its tributaries need to be inventoried and mapped.

Another strategy is to determine the management options for formerly converted wetlands. Reforestation of prior converted (PC) forested wetlands and other drained wetlands will play a crucial role in establishing and restoring waterfowl habitats. However, some areas will be transformed into intensively managed moist soil systems, or

maintained in cropland. Our Resource Inventory and Monitoring Plan and Habitat Management Plan may identify other restoration and enhancement opportunities.

Monitoring element.—Seasonal acreage of each wetland habitat type; miles of restored riparian forests; acreage, number and type of restoration activities; acres of SAV beds planted.

Subgoal 2. Provide habitats that support Neotropical migratory songbirds, emphasizing forest interior dwelling (FID) species.

Objective 1.2.1. Establish, manage, and enhance a minimum of seven mature forest cores on Blackwater NWR that are 400 acres or more in size by 2017.

Basis of the objective.—Blackwater NWR now contains many of the large contiguous tracts of forested land remaining on the Delmarva Peninsula. Twenty-five species of FID birds potentially breed in the mid-Atlantic coastal plain (see "A Guide to the Conservation of Forest Interior Dwelling Birds in the Chesapeake Bay Critical Area," June 2000). Twenty of the 25 species are Neotropical migrants: species that nest in temperate North America and winter in Central and South America. The cerulean warbler, veery, and black-throated green warbler were eliminated from this list because they are unlikely to be breeding on Blackwater NWR (H. Armistead, D. Dawson, J. McCann, pers. comm). Consequently, 22 of these FIDs are potential breeders on Blackwater NWR, and 20 species have been documented during the breeding forestbird survey in the past 5 years (see chapter 3, table 3.8, "Twenty-two FIDs that potentially breed on Blackwater NWR").

Robbins, et al. (1989) suggest that, ideally, management should provide the highest probability of providing for the least common species in the forest ecosystem. Partners In Flight recognizes eight of the FID species as "globally significant" (PIF score >21). Eleven of the 22 FIDs are highly area-sensitive; that is, they seldom occur in small, heavily-disturbed or fragmented forests. These species are most vulnerable to forest loss, fragmentation, and overall habitat degradation and, consequently, the ones that the Refuge Complex has chosen to target. Most are rare or uncommon on the Maryland coastal plain and many have highly specialized breeding habitat requirements. In fact, two of these species (broad-winged hawk and brown creeper) only recently were recognized as breeders on the Maryland coastal plain (Robbins and Blom 1996). According to "A Guide to the Conservation of Forest Interior Dwelling Birds in the Chesapeake Bay Critical Area" (June 2000), a forest tract is considered to be at least marginal FIDS habitat if either of these two conditions is satisfied: (1) at least 4 of the 22 species are present with a probable or confirmed breeding status or, (2) at least 1 of the 11 area-sensitive species is present with probable or confirmed breeding status.

Based on Robbins, et al. (1989) and the literature reviewed in Bushman and Therres (1988), a minimum patch size of 400 acres of mature forest provides potential breeding habitat for at least 5 of the 11 highly area-sensitive FIDs identified in chapter 3, table 3.8: Kentucky warbler, worm-eating warbler, hooded warbler, American redstart, and barred owl. In addition to those five area-sensitive species, 400 acres will provide potential breeding habitat for 10 other FID species, or, 15 species. This minimum habitat objective ensures that forested habitat on Blackwater will exceed the definition of marginal FID habitat established in "A Guide to the Conservation of Forest Interior Dwelling Birds in the Chesapeake Bay Critical Area" (June 2000). Conversely, an ideal patch size of 865 acres will provide potential breeding habitat for all 11 area-sensitive species, and all but one (northern parula) of the more tolerant FID species.

The overarching goal of the forest management program at Blackwater NWR (to be expanded to include additional acquisitions) will be to maintain and increase the size of contiguous, mature forest cores from a minimum of 400 acres to as many as 865 acres. Management strategies will include reforestation, strategic land acquisition, regrowth of cut over areas, timber stand improvement of existing stands, and regeneration cuts. The latter will, in most cases, target forest stands that are exhibiting signs of declining health; to a lesser extent, regeneration cuts will also be used to influence species and age class diversity. Silvicultural prescriptions for different forest types will follow those outlined by the FIDS and Forestry Task Force (June 1999), unless they specifically conflict with habitat requirements of the DFS.

Strategies to achieve the objective.—Using digital ortho-photography, we will identify large contiguous forested or previously forested tracts of land within the approved LPP for Blackwater NWR. Acquiring the most recent and

technologically advanced aerial imagery of lands within and around Refuge Complex lands and maintaining and managing a state of the art Geographic Information System will prove invaluable in protecting and managing trust resources and their habitats.

The most effective strategy for establishing all seven mature forest cores by 2017 or earlier will be to continue to acquire land within the approved LPP for Blackwater NWR. The acquisition of large contiguous tracts of mature forest will be the highest priority, along with privately owned tracts of land, directly adjacent to or within established cores. Acquiring large contiguous tracts of cleared land or immature forest will remain vital to the establishment of additional cores.

Reforestation of a minimum of 120 acres of PC forested wetlands and other non-forested lands (based on current landownership) will play a crucial role in creating and eventually expanding cores. Many large contiguous forest patches which are not yet large enough to be considered cores can be enhanced or increased by restoring adjacent agricultural or timber harvested lands back to mature forested habitats. Natural regeneration of cut-over areas is preferred, however, areas lacking natural regeneration, will be planted with a mix of native tree species which once dominated the site. PC areas adjacent to or within large contiguous forest patches or potential cores will be the highest priority for reforestation.

Aside from the actual planting, additional techniques associated with reforestation may include site preparation, weed control and subsequent thinning. Site preparation for the purpose of improving seed germination or planting efficacy may consist of soil scarification, prescribed burning, herbicide application and bedding. The control of undesirable vegetation (weeds) prior to or following tree planting or natural regeneration may be accomplished through application of approved selective herbicides, prescribed fire, or a variety of mechanical and manual methods. The reforestation of abandoned or unnecessary roads or the partial closure of the canopy over essential refuge roads, where applicable, will also aid in the establishment and enhancement of core areas.

Following more detailed inventories, a wide array of forest management practices will be utilized to help maintain or improve the quality or condition of all forest habitats, with special emphasis on establishing or maintaining large contiguous patches of mature trees, as well as a diversity of species. In order to ensure the long term existence of core areas, stand replacement or regeneration must be an ongoing management objective. A common characteristic of mature and over mature forest stands on Blackwater is generally a closed canopy and, as a result, a sparse understory. Also due to the closed canopy and lack of sunlight, there exists little or no natural regeneration of preferred tree species such as oak.

Therefore, we will use a variety of regeneration harvests to stimulate the germination of stored seeds or sprouting of root stocks for the purpose of replacing over-mature and stagnant trees within a stand. Supplemental planting may also be required in some areas. Harvesting methods which are performed for the purpose of eventual stand replacement include, but are not limited to, single tree selection, group selection, shelterwood, and strip and patch clearcuts. The specifics on when and where these activities will be performed cannot fully be determined until more detailed forest inventories are performed on a stand by stand basis. We will develop annual work plans for detailed management prescriptions, such as timber harvesting, timber stand improvement techniques (TSI), and planting.

TSI techniques, such as release cuttings, thinning, and prescribed fire, will also be used to maintain or enhance the growth and vigor of trees within the cores. TSI aims at reducing competition for resources, and targets undesirable and suppressed individuals for removal, thus improving the overall growing conditions for more preferred species. The resulting enhanced growing conditions will ensure forest stands reach the prerequisites for becoming core habitats at a much earlier stage. TSI will also be utilized to establish and maintain desired vertical structure, age class diversity, stem density and species composition.

Protecting these core areas and all other forested habitats from natural and anthropogenic forces is of utmost importance. Insect pests and diseases can have devastating impacts on forest habitats and significantly diminish the integrity of core areas. Blackwater NWR will continue to cooperate with the USFS to monitor for and manage forest insect pest populations, specifically gypsy moths. Integrated pest management strategies, such as annual egg mass surveys and aerial defoliation detection surveys, will continue to be performed by the USFS, with supplemental surveying and monitoring conducted by the forestry staff.

We will maintain a GIS-based monitoring and tracking system jointly with the USFS. We will implement control measures, such as the aerial application of biological insecticides such as Bt (*Bacillus thuringiensis*) or Gypcheck, based on survey results, recommendations, and funding (see objective 2.1.3, below). Performing TSI will also help to improve the health of the forest by reducing stress, therefore reducing its susceptibility to insect pest and disease outbreaks. We will implement more periodic ground and aerial surveys to monitor for additional insect or disease outbreaks. Once detected, the refuge will seek additional assistance from the USFS.

Wildfire prevention will play a vital role in the long term viability of respective cores. All wildfires which occur on or near refuge lands will be promptly contained and extinguished. Prescribed burning will be conducted on a periodic basis in areas of hazardous fuel loadings and in areas which have a high probability of ignition; i.e., road shoulders.

Monitoring element.—The number of 400-acre mature forest cores established by 2017.

Objective 1.2.2. Increase the size of four of the seven cores to a minimum of 865 acres by the year 2027.

Basis of the objective.—Same as objective 1.2.1. Additionally, a minimum core size of 865 acres will encompass at least 9 of the 11 area-sensitive FIDs that potentially breed on Blackwater NWR. These species will serve as both indicator and umbrella species for a wide range of forest benefits. When sufficient habitat is protected to sustain a diversity of forest birds, other important components and microhabitats of the forest will be encompassed and be protected. These may include the small, forested streams and headwaters critical for fish populations and the vernal pools necessary for the survival of amphibians.

Strategies to achieve the objective.—After cores are identified and delineated, the primary management focus will be to increase the size of the core to the optimal minimum size of 865 acres, which will provide potential habitats for at least 9 of the 11 area-sensitive FIDs. Remote sensing and GIS will again be used to identify potential areas and methods for expanding the cores. The primary focus will be on lands which are directly adjacent to, or within, the established core. Many of these lands are privately owned and will require acquisition. Acquiring parcels which are already forested and meet the minimum core criteria of being dominated by mature trees is the fastest and most effective means of increasing core size.

Lands that are already part of the refuge, but do not meet certain minimum core criteria, consist of prior converted wetlands (agricultural), recently harvested timberlands, salt killed areas, and immature stands. Prior converted forested wetlands that are critical to the expansion and enhancement of a core will be reforested and managed for the purpose of becoming part of a core. Those forested areas, which are now salt-stressed or highly susceptible to salt water intrusion, were not considered as part of existing or future cores.

We have designated a minimum of 120 acres of PC wetlands we now own to be reforested as soon as we can acquire funding. We will assess and intensively manage recently harvested areas to promote the establishment of preferred species. We prefer to use natural regeneration; however, in areas where natural regeneration is inadequate, supplemental planting will be used. Subsequent weed control and thinning may be used on all reforested or regenerated areas. Any salt-killed areas which have an impact on the expansion of core areas will be assessed for their potential for restoration. Adjacent or interior immature forest stands will be managed to improve the growth, vigor, and mast production of desired tree species to ensure a high quality addition to the core. Such management may include release cuttings, thinning, prescribed fire, and integrated pest management.

Monitoring element.—The number of mature forest cores that are a minimum of 865 acres by the year 2027.

Objective 1.2.3. Improve the quality of all cores by increasing their effective area by 20 percent within 10 years after they are established.

Basis of the objective.—Eleven of the 22 Mid-Atlantic Coastal Plain FID species listed in chapter 3, table 3.8, are highly area-sensitive and, consequently, just as sensitive to edge effects. An edge is the area where a forest meets a clearing. The forest edge is home to a number of other birds which may compete with the FIDs for food or even feed upon the FIDs eggs. Therefore, a 100-meter buffer was delineated from the core edge towards the interior of the core to determine the actual area within the core which can be considered habitats for area-sensitive FIDs. This variable is known as the “effective area” or “functional habitat”.

Strategies to achieve the objective.—The effective area of a core can be enhanced in various ways. The most obvious method is to increase the overall size of the core. However, this is only true if the parcels added to the core are shaped so that "effective area", not just area, is being added to the core. For example, a linear-shaped tract which is 200 meters or less in width will provide no additional effective area to the core, regardless of its overall size due to the influence of the 100-meter buffer associated with the edge. Another method is to ensure that non-core inholdings within an established core are managed in a way that they will eventually become part of the core. Gaps within cores significantly decrease the effective area due to the additional edge habitat they create. Once again these gaps may exist in the form of agricultural fields, timber harvests, areas of mortality, young forest stands or oversized roadbeds.

The methods for reclaiming these lands are similar to those in the previous objectives, and include reforestation, regeneration, and timber stand improvements. The actual shape of the core area also significantly influences the effective area. The optimal shape for maximizing effective area is one with the lowest perimeter-to-area ratio (i.e., a circle). Strategically acquiring, reforesting, and managing adjacent parcels of land to decrease perimeter length by smoothing out the boundary and forcing the shape away from being linear will increase a core's effective area.

Monitoring element.—Percent increase of effective area in each core.

Objective 1.2.4. Maintain or improve mean species richness of desired tree species within cores by 10 percent within 15 years after they are established.

Basis of the objective.—Maintaining a diverse mix of native pine and hardwood tree species will ensure that the needs of a much wider variety of FIDs and other wildlife are met. A diversity of tree species provides a greater mix of canopy structures available to FID species. A mix of both hard and soft mast-producing trees can ensure a nearly year-round food source for many species of wildlife. Species diversity also reduces the potential for host specific insect pests or diseases to wipe out an entire core. Due to the existence of the DFS, we will focus primarily on promoting the growth and dominance of loblolly pine and hard mast-producing species, such as oaks and beech.

Strategies to achieve the objective.—Desired composition and diversity of tree species within forest stands will be accomplished primarily by implementing a wide variety of silvicultural techniques, including but not limited to, timber stand improvements, regeneration harvests, prescribed fire, and herbicide application. TSI incorporates all intermediate cutting operations that require financial investment and do not involve removal of useful material. Intermediate cuttings are treatments conducted to modify or improve the growth of an existing crop of trees, but not to replace it with a new one. They involve the selective removal of suppressed, undesirable, or overcrowded vegetation to allow for the expansion of the crowns and root systems of desired trees.

Specific examples of these treatments include crop tree release, thinning, and improvement cuttings. A variation of those methods consists of the selective killing of undesirable trees by girdling them, injecting them with systemic herbicides, or aerially applying broadleaf-specific herbicides such as Arsenal™. These methods not only free up growing space and resources, but also provide nesting and feeding habitats for a variety of wildlife, primarily birds. The girdling of selected trees and allowing the dead snags to persist directly supports the Refuge Complex objectives for providing quality wood duck habitats.

Timber harvesting techniques that are aimed at replacing the existing stand with a new one can prove extremely effective in managing for desired species composition and diversity. Those harvest methods include seed tree, single tree and group selection, shelterwood, and strip or patch harvests. Salvage and sanitation cuts may be performed in areas impacted, or potentially impacted, by devastating insect or disease outbreaks. Post-harvest management, such as site preparation and weed control, is essential for ensuring the regeneration and establishment of desired species.

Prescribed fire is also an effective means of altering or managing the species composition within a forest stand during the early stages of development. Prescribed burning will be performed in applicable stands at early stages of development, while most tree species are still susceptible to injury by fire.

Monitoring element.—Ratio of species richness of desired tree species 15 years following core establishment as compared to establishment date.

Objective 1.2.5. Develop forest management techniques for FIDS by 2008.

Basis of the objective.—Identifying forest management techniques which not only enhance the quality and health of the forest, but also provide more direct benefits to FIDs and other Neotropical migratory songbirds will compliment and provide additional justification for the objectives and strategies outlined in the step-down forest management plan.

Strategies to achieve the objective.—Implementing forest management practices and careful monitoring will identify management techniques and resulting conditions which are most beneficial to FIDs. By implementing the Resource Inventory and Monitoring Program and closely monitoring Neotropical migrant and FID populations each year, we will better understand their distribution and the main limiting factors for each species. Tying species occurrence to plant community type is essential for assessing species-specific habitat requirements and determining appropriate management needs.

The term "adaptive management" applies to assessing the impacts of all forest management activities to determine any positive or negative impacts to faunal populations with emphasis on FIDs and DFS. Since little information is available that addresses specific forest conditions and management strategies, the efficacy of forest management practices as it relates to FID and DFS populations will be assessed. Conflicts between management techniques will also be evaluated. In order to adequately achieve this objective, a research component, which measures the response of trust resources, should be applied to a variety of forest management practices. We will initiate the following research:

1. The effects of prescribed fire on DFS populations and avian communities in mid-Atlantic coastal plain forested habitats;

2. The effects of selective harvesting techniques on DFS and FIDS; and,

3. The effects of timber stand improvement techniques on DFS and FIDS.

Monitoring element.—The number of research studies implemented.

Subgoal 3. Provide habitats to support a diversity of migrating shorebirds and marsh and water birds.

Objective 1.3.1. Manage a minimum of 200 acres of MSU to provide foraging substrate for shorebirds during the spring migration by 2007.

Basis of the objective.—Blackwater NWR is too far inland to be an important stop-over site for migrating shorebirds. However, as many as 4,000 individuals and 26 species have been recorded in the freshwater impoundments and adjacent estuarine mudflats during peak spring migration. Several of the Calidris "peeps" (primarily semi-palmated and least sandpipers) and the yellowlegs (*Tringa spp.*) migrate through in the spring; dunlin are the most abundant wintering species; and spotted sandpiper, common snipe, and killdeer are the most common breeding shorebirds at Blackwater NWR. The U.S. Shorebird Conservation Plan (2000) and the draft Northern Atlantic Regional Shorebird Plan (2000) rank several of those shorebirds as species of at least moderate concern, due to declining populations at national and regional levels. Both plans recommend more intensive and coordinated manipulation of impoundments on public lands for the benefit of migrating shorebirds. Properly managed, MSU can provide high densities of benthic invertebrates for foraging shorebirds during the spring migration. When spring high tides in the marshes coincide with shorebird migration, the exposed bottoms and relatively shallow water in the MSU can attract large flocks of foraging shorebirds.

Strategies to achieve the objective.—We will expose 15 percent of pool bottoms weekly beginning on April 15 and continuing through May 31 (6 weeks). We will ensure that 50 percent of the bottoms of these pools will be exposed at peak shorebird migration, which generally occurs during the first week in May. Refuge staff will continue ground counts of shorebird populations at weekly intervals during the spring migration and at biweekly intervals during other times of the year. Data will be rolled up into the International Shorebird Survey maintained at the Manomet Center for Conservation Sciences.

Monitoring element.—Percentage of pool bottom exposed.

Objective 1.3.2. Maintain and enhance 15,000 acres of estuarine emergent marsh for nesting, foraging, and resting shorebirds by 2011.

Basis of the objective.—Blackwater NWR has lost nearly 7,000 acres of emergent wetlands since its establishment in 1933. Most of this loss has occurred in the three-square brackish marsh at the confluence of the Little Blackwater and Blackwater Rivers, but is also now progressing up and downstream. The unusually high rate of wetland loss is likely the result of several confounding factors, including sea-level rise, land subsidence, saltwater intrusion, severely modified hydrology, and excessive herbivory. Open water that has displaced the lost wetlands is now used primarily by waterfowl as a disturbance-free rest area during migration and winter, and by resident populations of Canada geese as a safe place to molt during the summer. Its depth precludes use by shorebirds other than phalaropes.

Restoring emergent marsh will enhance the significance of these wetlands to migrating shore, marsh, and water birds. Emergent marsh provides breeding habitat for several species, primarily spotted sandpiper, willet, and common snipe. At low tides, these habitats provide shallow pools and mudflats for a number of migrants, most commonly greater and lesser yellowlegs, semipalmated sandpipers, least sandpipers, white-rumped sandpipers, dunlins, semipalmated plovers, and killdeer.

Strategies to achieve the objective.—Strategies include restoring the marsh to its 1933 coverage level by implementing the current Refuge Complex Fire Management Plan and proposed Habitat Management Plan, minimizing human disturbance of wintering shorebird populations by prohibiting public entry and boating from October 1 through April 1, and evaluating the effect of the current prescribed fire program on nesting shorebirds. It will be necessary to identify large areas of mudflat and shoreline that are exposed at low tide, and to initiate a new boat survey to evaluate the significance of these sites to spring migrants. A study will need to be developed to estimate the breeding densities of shorebirds (and other marsh birds) by floral community type; this could be conducted in conjunction with the ongoing study of prescribed fire effects on marsh flora.

Monitoring element.—Acres of estuarine emergent marsh and tidal mudflats; boat survey of spring migrant populations at selected sites; nesting densities in marsh exposed to different fire regimes.

Objective 1.3.3. Manage pool 3C (22 acres) to provide roosting habitats for marsh and water birds by 2007.

Basis of the objective.—Impoundment systems support several species of marsh and water birds on the refuge. Properly managed, MSU can provide excellent habitats for anurans and fish, important prey items for marsh and water birds. At least 12 anuran species are known to occur in these impoundments during spring and summer. Fish can become a concentrated food source for egrets and herons during spring drawdown.

Strategies to achieve the objective.—We will continue to manage pool 3C for thermal cover and nocturnal roosting.
Monitoring element.—Surveys to determine acreage maintained in thermal cover.

Subgoal 4. Provide habitats to support a diversity of brackish marsh nesting birds, including rails, sparrows, and other species listed in marshbird species.

Objective 1.4.1. Maintain and enhance 15,000 acres of estuarine emergent marsh for nesting marsh birds.

Basis of the objective.—Blackwater NWR occupies the core of one of the largest contiguous areas of tidal marsh in the northeast United States. Only recently has the conservation value of this habitat for breeding birds been recognized. The Partners in Flight (PIF) Bird Conservation Plan for the Mid-Atlantic Coastal Plain (Watts 1999) ranks tidal marshes third (after pine savannah and barrier/bay islands) in regional priority for bird conservation action. Chesapeake Marshlands NWR bears a particularly high responsibility for the stewardship of brackish marshes within USFWS Region 5 due to the relatively high proportion of the region's high marsh habitat within the complex. The refuge complex's 50,000 acres of high marsh constitute one of only four significant areas of high marsh in the Mid-Atlantic coastal plain (Watts 1999).

Tidal brackish marsh and saltmarsh support a distinct community of breeding birds, several of which are endemic to this habitat type (table 4.1). Tidal marsh endemics at Blackwater include two species, saltmarsh sharp-tailed sparrow and seaside sparrow; and three subspecies, clapper rail (*Rallus longirostris crepitans*), eastern willet (*Catoptrophorus semipalmatus semipalmatus*) and coastal plain swamp sparrow (*Melospiza georgiana nigrescens* (Greenberg and Droege 1990). A number of other species have breeding populations in the Mid-Atlantic region largely confined to tidal marshes. Henslow's sparrow and sedge wren breed in the upper edges of tidal marshes in small numbers in the Mid-Atlantic, and, though not specialists of this habitat, require attention due to their priority conservation status nationally.

Several species breeding in tidal marshes at Blackwater are listed by USFWS as national Birds of Conservation Concern (USFWS 2002). Among factors contributing to this conservation status is the lack of information on population number and trends (Shriver et al. 2004). Two of these species, are also on Birdlife International's Red Data List: black rail (Near Threatened) and saltmarsh sharp-tailed sparrow (Vulnerable). Blackwater-Fishing Bay Marshes Important Bird Area derives its "globally important" status from these two species.

Table 4.1. Avian tidal marsh habitat specialists breeding at Chesapeake Marshlands NWR Complex.

Species	*Endemism category (breeding populations)*[b]	*Birds of Conservation Concern (USFWS 2002)*	*Principal marsh zone*
Blue-winged Teal[a]	4		High
Gadwall[a]	4		High
American Black Duck[a]	4		High
Clapper Rail[a]	2		Low
Black Rail[a]	3	x	High
Northern Harrier[a]	4	x	High
Willet[a]	2		High
Marsh Wren[a]	4		High & Low
Swamp Sparrow[a]	2		High
Seaside Sparrow[a]	1	x	Low
Saltmarsh Sharp-tailed Sparrow[a]	1	x	High

[a]Regularly occurring population at Chesapeake Marshlands NWR Complex.
[b] Category: 1 = species endemic to tidal marsh; 2 = subspecies endemic to tidal marsh; 3 = species with majority of populations in North America restricted to tidal marsh; 4 = species with majority of populations in Mid-Atlantic region restricted to tidal marsh (adapted from Greenberg and Maldonado, in press)

The majority of tidal marsh species nest predominantly in the irregularly flooded high marsh zone (table 4.1), probably because of the greater availability of nest sites safe from flooding. Saltmarsh sharp-tailed sparrows prefer areas dominated by saltmeadow hay (*Spartina patens*) and also occupy smooth cordgrass (*S. alterniflora*) near mean high tide level (Greenlaw and Rising 1994, Gjerdrum et al 2005). Black rails prefer saltmeadow hay marsh and are also found in black needlerush (*Juncus roemerianus*)(Watts 1999, Armistead 1999). Coastal plain swamp sparrows occupy the upper edges of the marsh, nesting in shrubs (*Iva fructesens, Baccharis hamifolia*) among saltmeadow hay (Greenberg and Droege 1990).

Two tidal marsh specialists, seaside sparrow and clapper rail, are most common in the regularly flooded low marsh. Both of these species require small areas of exposed mud for foraging (Watts 1999). Seaside sparrows nest mostly in smooth cordgrass, and build nests elevated on grass stems to avoid flooding (Gjerdrum et al 2005).

Management of tidal marshes for breeding marsh birds should focus on tidal marsh specialists with an emphasis on endemic taxa and species of conservation concern. Relative to most terrestrial habitats, little is known about the habitat requirements of tidal marsh birds and most work has been done in New England and the Gulf coast. Much research is needed in the Chesapeake region. However, available research suggests that they require large areas of marsh with natural tidal flow and abundant nest sites that are concealed from predators and safe from flooding.

Birds of tidal marsh show area-sensitivity in the Chesapeake Bay region and in New England. Clapper rail and seaside sparrow attain 100% incidence in marshes over 5 ha in size, and saltmarsh sharp-tailed sparrow, black rail,

Henslow's sparrow and sedge wren may require marshes of at least 100 ha (Watts 1999). In New England, willet, clapper rail, seaside sparrow, saltmarsh sharp-tailed sparrow and Nelson's sharp-tailed sparrow had a higher incidence on larger marshes in at least one of two regions studied (Shriver et al 2004).

Among the features contributing to Blackwater NWR's great value to tidal marsh nesting birds is the large area of marsh having relatively natural hydrology. In a review of impacts of marsh management on coastal marsh bird habitats Mitchell et al (in press) found that structural marsh management such as impoundments generally benefit wintering waterfowl and other waterbirds but are avoided by tidal marsh endemics. In New Jersey, clapper rails, seaside sparrows and saltmarsh sharp-tailed sparrows were found only in unimpounded marshes (Burger et al 1998).

Birds nesting in the high marsh zone require areas of dense vegetation for nest placement and thus management practices that allow a thatch of grass litter to accumulate across years will benefit tidal marsh species. Saltmarsh sharp-tailed sparrows select nest sites where grass vegetation is taller and more dense than random locations, with a denser layer of thatch from previous years (Greenlaw and Rising 1994, Gjerdrum et al. 2005). Although flooding is the greatest cause of nest failure in this species (Greenlaw and Rising 1994, Gjerdrum 2005), dense vegetation presumably plays an important role in concealing nests from predators. Nest placement in tidal marsh nesting sparrows may be a trade-off between avoiding flooding (by placing nests higher in grass vegetation) and avoiding predation (by placing nests in lower, concealed sites). In a review of nesting ecology of tidal marsh sparrows in North America Greenberg et al. (in press) found that nest mortality caused by flooding and predation are largely compensatory.

Strategies to achieve the objective. – Strategies include restoring the marsh to its 1933 coverage level, conducting research to investigate habitat and nest-site selection of marsh birds, and evaluating the effect of current prescribed fire program on nesting marsh birds. An extensive survey, employing recently adopted national marshbird monitoring protocols, and also specially adapted survey protocols for saltmarsh sharp-tailed sparrows (recently developed in New England), would be needed to investigate habitat relationships of marsh birds. The recent study of burning impacts on marsh-nesting sparrows would be continued and expanded to include other marsh birds. These would be conducted in conjunction with the ongoing study of prescribed fire effects.

Monitoring element. – Acres of estuarine emergent marsh, research results relating marsh bird densities to vegetation type, research results relating nesting densities and nest success to different fire regimes.

Subgoal 5. Provide habitats to support a diversity of raptors.

Objective 1.5.1. Provide habitat for forest interior dwelling raptors by 2007.

Basis of the objective.—Red-shouldered hawks (*Buteo lineatus*), broad-winged hawks (*Buteo platypterus*), and barred owls (*Strix varia*) are raptors that require large forest tracts (>250 acres) and are known to breed on the Maryland coastal plain (Robbins and Blom 1996). The draft "Guide to the Conservation of Forest Interior Dwelling Birds in the Chesapeake Bay Critical Area" considers these raptors to be highly area-sensitive species. The Partners in Flight draft "Mid-Atlantic Coastal Plain Bird Conservation Plan" specifically recommends that populations of these species and of Cooper's hawks be monitored. The forests that the refuge maintains are some of the most extensive and contiguous that remain on the Maryland coastal plain.

Strategies to achieve the objective.—We will maintain and enhance large stands of contiguous mature forest by implementing the draft Forest Management Plan; continue strategic land acquisition to reduce the patchiness of existing forest and increase total forest acreage; continue the annual breeding forest bird survey; and, consider designing a tape play-back survey for nocturnal raptors, especially barred owls.

Monitoring element.—The number of forested tracts >250 acres.

Objective 1.5.2. Provide marsh habitat for raptors by 2007.

Basis of the objective.—Blackwater NWR provides almost 7,000 acres of estuarine emergent marsh. Ospreys, northern harriers, and peregrine falcons are dependent on this habitat for at least part of their life needs, and all are considered priority species in the Partners in Flight draft "Mid-Atlantic Coastal Plain Bird Conservation Plan" (1999).

Strategies to achieve the objective.—Strategies include minimizing disturbance in the marsh by prohibiting public entry and boating from October 1 through March 31, implementing restoration tasks in the proposed Marsh Management Plan, and continuing strategic land acquisition to mitigate for marsh loss.

Monitoring element.—Acreage of marsh.

Objective 1.5.3. Provide artificial nest structures and evaluate their importance by 2007.

Basis of the objective.—Blackwater NWR has provided artificial nesting structures for a number of bird species of concern, including 10 nest boxes for barn owls (*Tyto alba*) and 30 nest platforms for 30 ospreys. Now that populations of these species recently have recovered, the need for continuing this program is questionable. These artificial structures require annual maintenance, periodic monitoring, and control of exotic species (house sparrows, European starlings) that displace targeted native species.

However, the deployment of artificial nests or nest substrates still may prove beneficial to some species. The hacking towers on Smith, South Marsh, and Spring Islands have fledged many peregrine falcons since their construction. Similarly, artificial nest platforms may increase the productivity of American black ducks nesting in the frequently inundated black needlerush marsh on Martin NWR (M. Haramis, USGS, pers. comm.). Artificial nesting structures also have value as a medium for public education.

Strategies to achieve the objective.—The reproductive contribution of the existing osprey platforms to local and regional populations needs to be evaluated. We will need to contrast the annual estimates of platform occupancy and subsequent production with state and regional estimates of osprey populations. We will maintain the existing osprey platforms on the refuge until we have completed that evaluation. Also, a study to evaluate the efficacy of using artificial structures to enhance black duck nesting on the Refuge Complex will be developed under the proposed American Black Duck Initiative.

Monitoring element.—Occupancy rates; fledgling rates; wood duck fall brood survey; completion of the American Black Duck Initiative.

Subgoal 6. Accomplish applicable recovery plan objectives and other management activities for Federal-listed species.

Objective 1.6.1. Accomplish all recovery tasks that are delegated to the refuge for DFS by 2017.

Basis of the objective.—The main thrust of the recovery program for DFS is protecting occupied habitats and re-establishing populations in previously occupied areas. Comprehensive DFS population or habitat surveys on Blackwater NWR have been limited to two benchmark sites. The refuge has significantly more forest habitat that is known to be occupied by DFS.

Strategies to achieve the objective.—The first strategy will be to complete a more detailed assessment of potential DFS habitats and conduct, at a minimum, presence or absence surveys to ascertain the percentage of occupied versus potentially occupied habitats. Preferably, more extensive 'mark recapture' studies will be conducted in all forested habitats, in order to determine current population status and possible trends. We will accomplish this as part of the Complex-wide Resource Inventory and Monitoring Program.

We will also evaluate these recovery tasks.

1. Describe habitat use and requirements of populations within their current natural ranges;

2. Develop an integrated habitat protection strategy using remote-sensing procedures and geographic information systems;

3. Define and field test applications for the Habitat Suitability Index model; map available habitat;

4. Protect DFS and its habitats;

5. Monitor current and potential threats to the DFS or its habitat;

6. Devise and implement a habitat management scheme;
7. Determine the effects of timber management and other land use practices on DFS;

8. Develop and refine prescriptive habitat management for DFS;

9. Develop and implement guidelines for habitat management on public lands occupied by DFS; and

10. Monitor the outcome of prescriptive habitat management.

Objective 1.6.2. Establish, manage, and enhance seven mature forest cores of 400 acres or more for DFS by 2017.

Basis of the objective.—The primary basis is to significantly improve the likelihood of down-listing or delisting the species. For the reclassification of the DFS from endangered to threatened, ecological requirements and distribution within the natural range must be fully understood, the seven benchmark populations must be stable or expanding for at least 5 years, and 10 new colonies must be established within the historical range.

The DFS will be considered for delisting when, besides having met the reclassification criteria, the following elements have been achieved.

1. Five post-1990 colonies are established outside the remaining natural range.

2. Periodic monitoring shows that 80 percent of translocated populations have persisted over the full period of recovery, and at least 75 percent of these populations are not declining.

3. Mechanisms that ensure perpetuation of suitable habitat at a level sufficient to allow desired distribution are in place within all counties in which the species occurs.

4. Mechanisms are in place to ensure protection and monitoring of new populations, to allow for expansion, and to provide interpopulation corridors to permit gene flow among populations (USFWS 1993).

By protecting occupied and potentially occupied habitat within the DFS historical range and providing additional distribution data, the refuge will significantly contribute to this effort. Although beliefs vary on the preferred forest cover types, age, and tree species composition, it is widely agreed that DFS appear to persist in larger densities in "mature" forests with a sparse understory. In combination with objective 1.5.3, below, the refuge's forested lands should accelerate de-listing by assuring the long-term availability of habitats needed to maintain natural populations and to assure the long-term continuance of a stable or expanding population throughout a significant portion of the DFS historic range.

Strategies to achieve the objective.—One main thrust of the recovery program for DFS is to protect occupied habitats. Blackwater NWR continues to maintain or enhance habitats that support the largest naturally occurring remnant populations of DFS. Strategies include acquiring land; remote sensing to identify areas of mature forest; establishing mature forest cores, as in Goal 1, Subgoal 2, Objective 1; reforesting PC wetlands and recently cleared timber lands; implementing silvicultural prescriptions; and, integrated pest management. Since the habitat requirements for FIDs are much more restrictive than those of DFS, we are assuming that any land protection or management strategies to enhance FID populations will also, directly or indirectly, benefit DFS.

Monitoring element.—The number of 400-acre mature forest cores established by 2017.

Objective 1.6.3. For DFS, maintain an average stand diameter of 15 inches (38.1 cm) DBH, or greater, of upper canopy trees within all core areas, as well as on an additional 10 percent of the remaining forested habitat, by 2022.

Basis of the objective.—Forest stands characterized by an average tree diameter of 15 inches, or greater, will exceed the currently accepted theory articulated in the recovery plan (USFWS 1993) and more recent activities by the DFS Recovery Team, on what constitutes "optimal habitat." Forest stands with an average overstory tree diameter of 15 inches (38.1 cm), or more, will provide adequate cover and reproductive habitats. The optimum tree canopy closure for DFS is from 20 to 60 percent. Optimal understory closure occurs when the shrub-crown closure is 30 percent or less (Allen 1982, and Tesky 1993). Habitat Suitability Index models indicate that sites where DFS were present contained a higher percentage of large [12-inch (>30-cm) DBH] trees (DFS Recovery Plan 1993).

Strategies to achieve the objective.—Acquiring tracts of forest land adjacent to existing cores or large enough to become cores will be instrumental in achieving this objective. As additional lands containing large trees are added to cores, portions of the cores which are exhibiting signs of declining health and vigor may be harvested to make room for new vigorous trees, while still maintaining an average DBH of 15 inches (38.1 cm) for upper canopy trees. All harvest and regeneration methods, excluding clearcutting, may be implemented within the core areas at any time, as long as those methods do not result in the creation of gaps in the forest canopy greater than 30 feet (10 m) (Draft Guidance: a Guide to the Conservation of Forest Interior Dwelling Birds in the Chesapeake Bay Critical Area, Oct 1999). If removing forest products results in gaps greater than 30 feet (10 m), the acreage on which the harvest occurred will be excised from the core until the canopy had sufficiently closed.

Within established core areas, applying silvicultural prescriptions will be required in order to achieve this objective. These prescriptions will primarily consist of the various types of timber stand improvement techniques and several harvest methods. Timber stand improvements will focus on improving growing conditions for the preferred tree species assemblage (specifically, nut and seed-producing species, such as oaks and pines).

Timber stand improvements include, but are not limited to, release cuttings, mechanical thinning, chemical thinning, crown thinning, low thinning, and improvement cuts. The various harvest methods employed will focus on regenerating the stand while at the same time retaining a significant percentage of large healthy hard and soft mast-producing trees. Growth rates of the remaining trees will ultimately be enhanced by the reduction in stand density and competition. The various harvesting methods to be employed within the cores may consist of single tree and group selection, shelterwood, and strip and patch clearcuts.

Protection of these core areas from insect pests and diseases will be essential for achieving this objective. Poor and declining health is the cause of most insect and disease outbreaks, and can result in large-scale tree mortality, cover-type conversions, invasions of exotic species, or loss of habitats. Continued coordination with USFS will be required to monitor and manage forest pest populations, specifically, gypsy moths. We will implement integrated pest management strategies as needed.

Monitoring element.—Average DBH of upper canopy trees for each core in 2022.

Objective 1.6.4. For DFS, improve the quality of an additional 1,500 acres of forested habitats outside the core areas by 2017.

Basis of the objective.—An additional 1,500 acres of existing forested habitats, which do not meet the minimum requirements to be included in a core due to juxtaposition or age structure, will be managed more exclusively for DFS and forest health. Management of these areas for FIDs will not be pursued until they become or are included within core lands. Most of these lands are in need of forest management to improve overall forest health, species diversity, age class diversity, and mast production. Proper management will also reduce the susceptibility of these habitats to insect and disease outbreaks.

Strategies to achieve the objective.—Where applicable, an extensive list of silvicultural techniques will be utilized to improve the health and quality of these forested habitats. In order to most effectively improve the health and quality

of forest habitats, management strategies will consist of performing a wide array of timber stand improvements, regeneration techniques, or harvest methods. Timber stand improvements will consist of all previously described release cuttings, thinning, and also, prescribed fire.

Timber harvesting methods may include clearcutting, seed tree harvests, single tree and group selection, strip and patch clear-cut, shelterwood cuts, salvage cuts, sanitation cuts, and other forest management practices that focus on improving site conditions for natural regeneration or establishing planted trees. These methods may include various types of regeneration harvests, site preparation and the control of undesirable vegetation through the use of prescribed fire, as well as mechanical and chemical methods. Integrated pest management strategies will be employed to monitor and control forest pest populations.

Monitoring element.—The overall health of the forest as it relates to tree growth and wildlife benefits. Some post-management variables which may be measured include growth rates and mast production of preferred tree species, understory density, regeneration and presence or absence of disease or insect pest populations.

Objective 1.6.5. Establish an additional 2 miles of 50-foot-wide forest corridors to connect disjunct forested patches by 2017.

Basis of the objective.—Forested corridors are necessary to aid DFS in traveling from one forest patch to another, and provide safe access to additional breeding and feeding habitat. This connectivity will reduce forest fragmentation and its associated detriments to wildlife populations on the refuge.

Strategies to achieve the objective.—Reforestation of PC wetlands will be the initial strategy implemented to create forest corridors between disjunct forest patches. We will assess all our currently owned and newly acquired PC wetlands to determine their suitability for establishing additional corridors. Reforestation of cut-over areas and abandoned or unnecessary roadbeds will also be targeted. We will continue to strategically acquire land, focusing primarily on land that contributes to combating the fragmentation of refuge forested habitats.

Monitoring element.—Miles of additional forest corridors, as compared to the present.

Objective 1.6.6. Maintain the 1996–2003 average of nesting and wintering bald eagles on Blackwater NWR by 2007.

Basis of the objective.—The Chesapeake Bay population of American bald eagles is Federal-listed as threatened. As the most significant nesting area north of Florida on the Atlantic Coast, Blackwater NWR has played a major role in recovering this species. Nesting pairs on the refuge have increased from 3 in 1978 to as many as 14 in 1997, and almost 300 eaglets have been produced in the past 15 years. Nests on Blackwater NWR have been the source for several translocation efforts in New Jersey and elsewhere. Also, Midwinter Bald Eagle Surveys during the past 5 years indicate that at least 150 bald eagles now winter on Blackwater NWR.

Strategies to achieve the objective.—Winter roost sites and nest sites will continue to be monitored and protected from human disturbance following the guidelines in the recovery plan (USFWS 1990) and "Bald Eagles in the Chesapeake: A Management Guide for Landowners" (National Wildlife Federation 1985). We will maintain an inviolate sanctuary encompassing 11,270 acres of water and marsh, by prohibiting public entry and boating from October 1 through April 1. Refuge biological staff will continue to support two annual surveys sponsored by the Maryland DNR: the Midwinter Bald Eagle Survey in January; and aerial nest surveys December–March. Staff will continue to conduct periodic roost counts, and investigate the status of suspected new roost sites. Blackwater NWR will also continue to be a translocation source for other states as needed. Management recommendations in the delisting package will be implemented as applicable.

Monitoring element.—The numbers of nesting and wintering bald eagles as determined by aerial surveys and the Midwinter Bald Eagle Survey.

Objective 1.6.7. Determine the occurrence of the Federal-listed swamp pink, sandplain gerardia, and sensitive joint-vetch on Blackwater NWR by 2008.

Basis of the objective.—Swamp pink (*Helonias bullata L.*; G3/S2), Federal-listed as threatened in 1988, is an obligate wetland perennial that occurs along streams and seepage areas in freshwater swamps and other wetland habitats. Swamp pink is known to exist in areas of Dorchester and Wicomico Counties and, possibly, may exist on Blackwater NWR.

The sensitive joint-vetch (*Aeschynomene virginica*; G2/S1) is an annual legume that occurs in fresh to slightly brackish tidal river systems. We need to discover whether sensitive joint-vetch occurs on Blackwater NWR. It was Federal-listed as threatened in 1992, due to its limited distribution. On the Eastern Shore, extant populations of *A. virginica* occur on Manokin Creek in Somerset County, and historic populations (before 1910) have occurred on the Nanticoke River in Wicomico County. Where *A. virginica* has been found in Maryland, it has been associated with *Echinochloa sp.*, *Spartina cynosuroides*, *Polygonum sp.*, *Juncus sp.*, and *Hibiscus moscheutus*, although the substrates have been sparsely vegetated; "e.g., muskrat "eat-outs" (USFWS 1995). These habitat conditions certainly exist on riparian areas of Blackwater NWR.

The sandplain gerardia (*Agalinis acuta*) was listed as endangered in 1991. In Maryland, one population on protected state lands occurs on the western shore. The Nature Conservancy identifies this species as potentially occurring in the focus areas (Nanticoke River Bioreserve Strategic Plan, 1998), but no comprehensive surveys for this species have been conducted.

Strategies to achieve the objective.—As part of the Complex-wide Resource Inventory and Monitoring Program, we will aggressively search for Federal- and State-listed flora, particularly swamp pink and sensitive joint-vetch, within the boundaries of Blackwater NWR. We will contract experts from the State Heritage Program or from universities to conduct botanical surveys. The conservation and management of any listed species that are identified will follow applicable tasks identified in USFWS recovery plans (USFWS 1991, 1995), and will be closely coordinated with the State Heritage Program.

Monitoring element.—Completion of the baseline inventory or botanical surveys.

Subgoal 7. Restore, protect and enhance habitats for anadromous and interjurisdictional fish species.

Objective 1.7.1. Inventory anadromous and estuarine or inland interjurisdictional fisheries on the Blackwater River and tributaries by 2008.

Basis of the objective.—The Blackwater River watershed historically provided nursery and spawning habitat for striped bass (*Morone saxatilis*), white perch (*Morone americana*), river herring (*Alosa pseudoharengus*, *A. aestivalis*), American eel (*Anguilla rostrata*), hickory shad (*Alosa mediocris*), American shad (*Alosa sapidissima*), and gizzard shad (*Corosoma cepedianum*). Other species of concern likely to occur in the Blackwater River watershed include mud sunfish (*Acantharchus pomotis*; G5/S2) and black-banded sunfish (*Enneacanthus chaetodon*; G4/S1). Turbid waters, due to marsh loss and frequent saltwater intrusion in recent years, have greatly reduced the quality of aquatic habitats. A fishery resource inventory is required to determine current status and abundance of species.

Strategies to achieve the objective.—We will conduct an initial survey to determine the occurrence and relative abundance of these species in the Little Blackwater and Blackwater Rivers. This survey will be conducted in cooperation with USFWS Fisheries Resource Office and other partners. The focus will be anadromous species, coastal migratory fishes identified in the Atlantic Coastal Fisheries Cooperative Management Act of 1993, and those species for which the Fisheries Management Workgroup of the Chesapeake Bay Program has developed fishery conservation plans. Based on the outcome of this inventory, monitoring of selected populations may be warranted.

Monitoring element.—Completion of survey.

Objective 1.7.2. Restore natural hydrology of the Upper Blackwater to pre-1980 conditions by 2007.

Basis of the objective.—The Blackwater River historically was more typical of tidal rivers on the Eastern Shore, with cattail (*Typha sp.*) marshes in the upper watershed changing to *Spartina alterniflora*-dominated saltmarsh at the mouth. Salinity levels varied from 0 ppt at the headwaters to 20 ppt near the mouth at Fishing Bay. However, in recent years, salinity in the upper reaches of the Blackwater River has exceeded 20 ppt, due to saltwater intrusion from Stewart's Canal. Loggers built this canal in the 1840s to allow barge access from Slaughter Creek to forests on Parson's Creek Neck and Piney Swamp. In the past two decades, salt water has more frequently breached the marsh that separates Stewart's Canal and Goose Dam from Moneystump Swamp at the headwaters of the Blackwater River. Increasing salinity and subsequent wetland loss have severely degraded freshwater fisheries and the value of the Blackwater River as spawning habitat for anadromous species.

Strategies to achieve the objective.—A marsh management plan will be developed to restore the freshwater system to the upper reaches of the Blackwater River. Strategies will include using clean dredged material to restore marsh between Blackwater River and Parsons Creek, the construction of a flap gate on the Slaughter Creek drainage, continued control of nutria, and other tasks identified in subgoal 1, objective 2. We may consider restocking the freshwater and anadromous fisheries, pending the outcome of post-restoration fisheries surveys. Similarly, it may be necessary to replant or reseed freshwater wetland plants after natural hydrology has been restored.

Monitoring element.—Survey fisheries (see objective 1) and salinity or water quality (see objective 3) before and after restoration.

Objective 1.7.3. Establish a long-term program to monitor salinity and other water quality parameters at selected sites in the Blackwater and Little Blackwater Rivers by 2007.

Basis of the objective.—Since 1996, the refuge routinely has monitored salinity and other parameters to document the water quality degradation that may be contributing to marsh loss on Blackwater NWR. The current protocol involves discrete sampling of salinity, temperature, pH, dissolved oxygen, and hydrogen sulfide at ten sites on the Blackwater and Little Blackwater Rivers every 2 weeks. However, because many factors such as tidal variation and storm events confound the interpretation of these data, this monitoring regime poorly describes long-term trends and fails to accurately quantify the magnitude and extent of saltwater intrusion.

Also, it is critical that the refuge have a reasonable data base from which to assess the effects of implementing restoration tasks identified for marsh management. A more rigorous monitoring program is needed that will not only provide more meaningful background levels of water quality parameters, but also allow continuous sampling to capture extreme saltwater intrusion events.

Strategies to achieve the objective.—Real-time monitoring equipment, capable of sampling diel variation in salinity and other water quality parameters (salinity, temperature, pH, DO, H_2S, conductivity, light penetration and turbidity), will be deployed at four permanent water quality sites: on Blackwater River below Stewart's Canal or Goose Dam; at the confluence of the Little Blackwater and Blackwater Rivers; at the mouth of the Blackwater River near Fishing Bay; and on the Little Blackwater River adjacent to the boathouse. Monitoring of these sites will provide adequate background data from which to assess changes in salinity (and other parameters) after implementing restoration tasks identified in the Marsh Management Plan. Additionally, a permanent tide gauge on the Little Blackwater River adjacent to the Blackwater Field Station will be established.

Monitoring element.—The number of monitoring stations established.

Objective 1.7.4. By 2011, initiate water and sediment quality and contaminant assessments on the Nanticoke River and its tributaries.

Basis of the objective.— According to the Maryland Department of Natural Resources, nitrogen levels in the Nanticoke River are among the worst of all tidal tributaries in Maryland. A recent report by the State of Delaware adds that the most significant water quality problems in the Nanticoke River include bacterial contamination and eutrophic conditions (e.g., nutrient over-enrichment). The possible sources of this nitrogen are many: both natural and human-generated. Septic systems, agricultural crops, lightning, livestock or poultry operations, and decaying

plant materials have all been documented as releasing or contributing factors to eutrophication. The future health of the Nanticoke watershed and its wildlife is largely related to the amount of nutrients entering the ground and surface water.

Strategies to achieve the objective.—We will establish a series of permanent real-time water quality stations throughout the division. We will periodically monitor benthos, physical, and chemical parameters at fixed stations in the river and its tributaries. We will collect data to document and assess nutrient loading and other potential adverse impacts from land use changes and practices. To the extent possible, we will use water quality data and monitoring results from other agencies. If warranted, we will collect samples for pesticide or herbicide analyses, and periodically monitor selected sites for trace element concentrations in water sediment or biological tissues.

The Service will collect additional data on bacteria contamination. If nutrients continue to be of concern, we will pursue source identification and work with appropriate entities to identify measures to reduce concerns with nutrient or bacteria transport into or through division habitats. The Service will monitor contaminant concentrations in sediment and biological tissues to evaluate contaminant risk in wetland and aquatic systems and associated fish, wildlife and plants. Measures to reduce or manage risks will be developed if warranted.
Refuge staff will cooperate to the extent possible in the broader Chesapeake Bay Program initiatives addressing water quality issues, including participation in the Lower Shore Tributary Strategy Team. Equipment will be acquired and partnerships will be established with other agencies to more effectively assess water quality impacts to species and their habitats.

Monitoring element.—Establishment of water quality stations, water quality monitoring protocols, and development of hydrological models, if appropriate; extent of mapping and assessments of hydrological modifications; analysis of solids, ions, nutrients, trace elements, and bacteria.

Objective 1.7.5. Implement recommendations of Little Blackwater River contaminants monitoring study by 2010.

Basis of the objective.—Animal feed operations (AFOs), particularly poultry farms, and the application of their wastes as fertilizer are known to contribute excessive nutrients, trace metals, and estrogenic compounds to surface and ground waters of the Blackwater watershed. Although fewer than a dozen commercial poultry operations and only one large hog farm exist within the Little Blackwater River, Buttons Creek, and Transquaking River watersheds, the amount of manure produced from these livestock is staggering: 1,000 chickens produce one ton of manure. Excessive nutrient loading from leachate and runoff from fields on which the manure is applied can contribute significantly to algal blooms, decreased water clarity, anoxia, and reduced SAV.

Eutrophication from AFO activities has also been linked to outbreaks of *Pfiesteria piscicida*, a dinoflagellate that has caused fish kills on the nearby Chicomicomico River. Our Chesapeake Bay Field Office is now studying the contribution of commercial poultry and swine operations to phosphate, nitrate, trace metal, and estrogenic compound levels in the Little Blackwater River. Their final report will address the need for long-term contaminants monitoring and specific management recommendations.

Strategies to achieve the objective.—We will need to pursue implementing the recommendations at the conclusion of this study.

Monitoring element.—Contingent on study recommendations.

Goal 2. Maintain a healthy and diverse ecosystem with a full range of natural processes, natural community types, and the full spectrum of native plants and animals to pass on to future generations of Americans.

Subgoal 1. Control, eradicate, or manage injurious, invasive, and exotic species

Objective 2.1.1. Eradicate nutria populations on Blackwater NWR by 2017.

Basis of the objective.—Executive Order No.13112 (Feb. 1999) directs all Federal agencies to prevent and control introductions of invasive species in a cost-effective and environmentally sound manner. Blackwater NWR has lost more than 7,000 acres of estuarine marshes since the 1940s. Several factors compound that loss, including sea-level rise, land subsidence, saltwater intrusion, modified hydrology, and excessive herbivory by the introduced nutria (*Myocastor coypus*).

Nutria, indigenous to southern South America, were introduced in Maryland in 1943. High population densities (over 50,000), high reproductive rates, and unique behavioral attributes make herbivory by this rodent species problematic. A 3-year study (Mike Haramis, USGS–BRD Patuxent Wildlife Research Center) of 342 fixed vegetative plots within 57 quarter-acre experimental units clearly demonstrates that nutria "eat-outs" into the root mat are degrading the marsh's ability to maintain itself.

Strategies to achieve the objective.—In January 2003, we implemented the National Strategy and Standard Operating Procedures for Managing Invasive Species as contained in part 1, dated August 31, 2001. In 1997, 23 organizations formed the Nutria Partnership to deal with this problem. Partners include Blackwater NWR, Chesapeake Bay Field Office (USFWS), Patuxent Wildlife Research Center (USGS–BRD), MD Cooperative Fish and Wildlife Research Unit (USGS–BRD), MD Department of Natural Resources, MD Department of the Environment, UM–ES, UM–College Park, Tudor Farms, Ducks Unlimited, National Fish and Wildlife Foundation, Friends of Blackwater, the American Aquarium and Zoological Association, the MD Fur Trappers Association, the MD and DE Chapter of the Wildlife Society, and the Salisbury Zoo.

In FY 2000, the partnership implemented the "Marsh Restoration: Nutria Control Plan" in Maryland. That was a 3-year pilot project to develop control techniques, study population demographic and reproductive response, and develop marsh restoration techniques. The eradication program began in 2002, and will continue until eradication has been achieved. We will also continue the nutria trapper rebate program at Blackwater NWR; this program has removed almost 58,000 nutria from the refuge in the past 15 years.

Monitoring element.—Surveys to determine the success of the eradication program.

Objective 2.1.2. Reduce the resident Canada goose population to its 1989 level by 2008.

Basis of the objective.—The resident Canada goose population on Blackwater NWR increased from an estimated 350 in 1989 to more than 5,000 in 2000. During that same interval, the resident Canada goose population in Maryland increased from 25,000 to 90,000. The direct and indirect results of this population explosion are adversely affecting the primary purpose for which the refuge was established.

Exclosures constructed by refuge staff in the spring of 1999 clearly demonstrated that resident geese were seriously impacting the natural marsh vegetation at Blackwater NWR. Studies conducted by Haramis and Kearns in the Patuxent Marshes, Maryland; May and Kangas in Kenilworth Marsh, Washington, D.C., and Nichols on the Maurice River, New Jersey substantiated similar destruction of natural marsh vegetation by resident Canada geese. A study at Bombay Hook NWR also demonstrated that resident geese are significantly affecting natural vegetation in moist soil impoundments. These findings are consistent with observations at Blackwater NWR, which not only suggest that resident geese are impacting moist soil vegetation, but that they are causing significant damage to natural marshes and agricultural crops planted to provide forage for migrating and wintering waterfowl. Increasing damage has been documented by refuge staff during the past 10 years throughout the refuge.

Also, resident Canada geese concentrate around the remaining water in impoundments during summer drawdowns. The resulting concentrations of fecal droppings in these stagnant pools, when the temperatures are high, create excellent mediums for degraded water quality, and increase the potential for fecal-borne human and avian diseases. The National Wildlife Health Research Center (NWHRC) found that 16 percent of 37 resident geese sampled in 1998 and 32 percent of 90 resident geese sampled in 2000 from Blackwater NWR were DVE-positive (duck virus enteritis, or duck plague). There is also increased concern regarding the transmission of diseases, such as cryptosporidiosis, giardiasis, chlamydiosis, and West Nile virus. Because of these potential problems, Region 5 funded investigations by NWHRC and the New Jersey Division of Fish, Game, and Wildlife in 1999 to evaluate threats to human health posed by resident Canada geese in Rhode Island, New Jersey, and Virginia.

Strategies to achieve the objective.—The primary strategy will be to implement the approved Integrated Wildlife Damage Management Plan for reducing current refuge population levels and mitigating the impacts of resident geese. (Contact headquarters for a copy of the EA.) That plan includes using nonlethal scare techniques, such as pyrotechnics, propane cannons, eagle effigies, reflective tape, balloons, and flags; and using perimeter fencing to exclude geese from certain areas. Lethal components of the plan include nest and egg destruction, live capture with humane euthanasia by certified processors, and selectively killing individuals to reinforce nonlethal methods.

Another possible strategy is a late spring hunt after migrant populations have moved through the area. Conservation measures similar to those for late season snow goose hunting will have to be authorized by the USFWS and the Atlantic Flyway Council before spring hunting is allowed. The Migratory Bird Treaty Act does not permit hunting Canada geese after 15 March.

Monitoring element.—Summer ground surveys for waterfowl.

Objective 2.1.3. Eradicate the mute swan population on Blackwater NWR by 2012.

Basis of the objective.—Mute swans (*Cygnus olor*) are exotic birds that escaped into the Chesapeake Bay in 1962, and now number approximately 4,000. Mute swans destroy SAV beds and disrupt nesting colonial waterbirds. The island refuges harbor most of the mute swans on the Refuge Complex, but Blackwater NWR also sustains a few pairs. Maryland DNR began controlling mute swan populations in 1993, and requested refuge assistance in 1995.

The State initially authorized Blackwater NWR to take both eggs and swans. However, due to legal action and public outcry, all permits have been canceled. The Service and the State are developing legislation to allow swan control. Most waterfowl and wetland biologists in the Chesapeake Bay region advocate a return to a more aggressive method for controlling mute swan populations. This is consistent with a directive by the USFWS Directorate to all Regional Directors to support the recommendations of the Atlantic Flyway Council regarding mute swans (see below).

Strategies to achieve the objective.—In 2001, Blackwater NWR staff participated on an interagency Mute Swan Task Force to develop a management policy for the State of Maryland. The Service will continue to work with the State and USDA to develop legislation and permitting authority to authorize (sic) the refuge to take both eggs and swans to achieve the eradication goal. The refuge may or may not comply with recommendations made by the task force. Also, the refuge may or may not comply with the recommendations of the Atlantic Flyway Council, which endorses the following actions.

1. State wildlife agencies, if they do not already have the authority, should seek to gain authority over the sale and possession of mute swans and their eggs.

2. The sale of mute swan adults, young or their eggs should be prohibited.

3. States should seek to eliminate all importing and exporting of mute swans without a special purpose permit issued by the state wildlife agency.

4. Mute swans captured due to nuisance complaints, sickness, or injury should be removed from the wild or be euthanized.

5. Egg addling programs where feasible should be encouraged.

6. Both state and Federal wildlife agencies should institute programs to prevent the establishment of, or eliminate, mute swans.

7. States should seek to make the mute swan an unprotected species if this is not already the case.

8. States should strive to manage mute swan populations at levels that will have minimal impacts on native wildlife species or habitats.

Monitoring element.—Survey in summer to determine the success of the eradication program.

Objective 2.1.4. Control gypsy moth populations on Blackwater NWR by 2008.

Basis of the objective.—Control of gypsy moth populations is required to protect mixed hardwood and hardwood forests, which are essential for supporting endangered DFS, FIDS, and other wildlife. Epidemic gypsy moth populations have plagued Blackwater NWR since 1993, primarily due to the large number of host tree species, the lack of forest management, and declining forest health conditions. Acquiring lands that are already infested with gypsy moths or other forest pests adds to the problem. Many times, lands that are added to the refuge need immediate treatment to prevent the total loss of wildlife habitat. We may need to implement more detailed property assessments, in order to detect insect and disease infestations. Any such findings should reduce the price we pay for those lands.

Strategies to achieve the objective.—Since 1993, Blackwater NWR has participated in, and benefitted from, the USFS Forest Pest Management Program. This program alone is responsible for protecting thousands of acres of prime DFS habitat. Although the program provides funding and expertise to assist the refuge in controlling our gypsy moths, it may someday disappear. In that event, we will become responsible for providing funding to ensure the protection of these vital habitats from the many potential insect and disease outbreaks. The refuge will continue to coordinate with the USFS to monitor gypsy moth populations and provide recommendations for control. At a minimum, USFS will continue to conduct annual gypsy moth egg mass surveys to determine population densities, recommend control treatments, assist with the acquisition of forest pest management funding, conduct post treatment aerial defoliation surveys and prepare annual reports.

Refuge personnel will continue to provide USFS personnel with up-to-date GIS data to inform them of new land acquisitions and the location of additional forest lands to be surveyed. Refuge forestry personnel will assist with annual egg mass surveys, the preparation of funding proposals and pesticide use proposals, and the administration of control treatments. A method for controlling gypsy moth populations will continue to be aerial application of Bt (*Bacillus thuringiensis*) or Gypcheck, which are both viable biological insecticides. The susceptibility of forested habitats to gypsy moth and other forest pest infestations will be minimized by improving the overall health of forests on the refuge as outlined in previous objectives.

Monitoring element.—Gypsy moth population status as determined by USFS annual surveys and monitoring. Intensified monitoring to assess the effects of management on stands' susceptibility to gypsy moth infestations, and to assess the threats to non-target species.

Objective 2.1.5. Eradicate Phragmites in the MSU, and reduce Phragmites below 2000 levels elsewhere.

Basis of the objective.—Over the past several decades, populations of common reed (*Phragmites australis*) along the Atlantic Coast have dramatically increased in both freshwater and brackish wetlands. At present, convincing and decisive evidence for the status of *P. australis* as native, introduced, or both, is not available (Blossey and McCauley 2000). Phragmites seeds profusely, and spreads vegetatively, by a vigorous system of rhizomes and stolons. Its monotypic stands have replaced diverse wetland plant communities with, and have changed basic ecosystem processes.

Dense Phragmites stands decrease native biodiversity and impact the quality of wetland habitat, particularly for waterfowl. Phragmites, however, may serve to abate wave-induced shoreline erosion. Refuge staff have conducted

limited (<60 acres annually) aerial- and hand-spraying with the aquatic formulation of glyphosate along the edges of impoundments and the forest–marsh ecotone, but funding in the past has been inadequate to control Phragmites over more extensive reaches of the marsh.

Strategies to achieve the objective.—Phragmites control measures will include the use of herbicides, mowing, discing, dredging, and burning. Biological control agents specific for Phragmites are being investigated at Cornell University, and will be used if feasible. The most widespread and successful approach on refuges is the application of glyphosate late in the growing season, followed by prescribed burning or mechanical removal of dead stalks. One reason for the reliance of chemical control is that habitat management methods such as burning, cutting, mowing, and discing actually encourage the spread of Phragmites.

Holding water within managed impoundments for sufficient durations to kill Phragmites is not a viable option because these systems require annual drawdowns to encourage the growth of moist soil plants. Drawdowns in the absence of chemical control can also increase the spread of Phragmites. Specific strategies to control Phragmites will be developed as part of the proposed Marsh Management Program. Classified hyperspectral imagery data (collected in summer 2000) will be used to estimate the current coverage of Phragmites.

Monitoring elements.—The number of acres of Phragmites treated. Evaluate treated areas to determine the degree of control, the response of natural vegetation, and how the treatments affect the use of the treated areas by wildlife.

Objective 2.1.6. Control purple loosestrife, johnsongrass, and Canadian thistle wherever they appear on Blackwater NWR by 2008.

Basis of the objective.—Purple loosestrife (*Lythrum salicaria*), an exotic plant that was first observed on Blackwater in 1996, is a wetland invader that competes with beneficial native plants. Control on the refuge has involved digging up the plants and spot applications of glyphosate (Roundup®).

Johnsongrass (*Sorghum halepense*) is listed as a noxious weed by the State of Maryland. This species, a product of introgression with *S. bicolor*, forms weedy hybrids with cultivated sorghum and is poisonous to mammals. Refuge staff have spot-treated Johnsongrass with glyphosate in refuge fields as required by Maryland law.

The State of Maryland lists Canadian thistle (*Cirsium arvense*) as a noxious weed. This species is poisonous to mammals. Refuge staff have spot-treated Canadian thistle with glyphosate (Roundup®), as required by Maryland law.

Strategies to achieve the objective.—These three injurious species are associated primarily with the moist soil management units and croplands. All three can be successfully controlled with the spot application of glyphosate. However, constant vigilance is required on the part of refuge staff to maintain the advantage of early detection. It may be necessary to consider the use of biological control agents developed by the Plant Protection Section (Maryland Department of Agriculture). Of the three species, agents have been identified only for Canadian thistle; these include several insects (*Cassida rubiginosa*, *Ceutorhynchus litura*, *Cleonis piger*, *Rhinocyllus conicus*, *Urophora cardui*, *Larinus planus*), and two diseases (*Puccinia punctiformis*, *Pseudomonas syringae pv. tagetis*). The refuge will continue the current policy, established in 1989, of no insecticides in its farming program.

Monitoring element.—The occurrence of individual plants.

Subgoal 2. Protect , enhance, and restore natural diversity of communities, sensitive species, and associated ecosystem processes in the Blackwater and Nanticoke watersheds.

Objective 2.2.1. By 2012, develop specific inventory, assessment, and management programs for rare, sensitive, and declining species; species of special concern; and rare and unique community types.

Basis of the objective.—In the Nanticoke watershed, the Maryland and Delaware Natural Heritage Programs have documented more than 200 plant species and almost 70 animal species categorized as biologically significant: e.g., TNC designations G1 through G5, and S1 through S3. For a complete list, see appendix C, "Rare Species in the Nanticoke River Watershed." The Nature Conservancy has identified high quality examples of several globally and

nationally unique types of communities, including Xeric Dunes, Atlantic White Cedar Swamps, Coastal Plain Ponds, (e.g., Carolina Bays or Delmarva Bays), Rich Woods, Coastal Plain Bogs, and Wet Meadows.

The Maryland program has designated two Maryland Natural Heritage Area sites within Blackwater NWR: the Upper Blackwater River and Gum Swamp. Numerous rare, threatened or endangered plants or animals occur within the Blackwater River watershed. In addition to migratory birds, Blackwater NWR has a clear mandate to protect, manage, and restore habitats that support listed species.

Strategies to achieve the objective.—The most important need is development and implementation of the Resource Inventory and Monitoring Program, to help determine the occurrence and distribution of floral and fauna on the Refuge Complex. We will arrange contracts with experts at the Heritage Program, USGS–BRD, or universities, for surveys of listed species and species that are uniquely difficult to detect. We will implement the appropriate tasks identified in existing recovery plans for Federal- and State-listed species. The development of the Habitat Management Plan will provide opportunities to evaluate the effects of management practices (e.g., TSI, prescribed fire) on species of concern.

Monitoring element.—Species occurrence. The acres of habitat under Service protection and management; the approved Habitat Management Plan; the mapping and assessment of hydrological modifications within the watershed; and, the number of surveys, censuses, and inventories funded, underway, or completed.

Objective 2.2.2. Provide and manage habitats for State-listed resident and migrating butterflies by 2010.

Basis of the objective.—At least four State-listed lepidopteran species likely occur on Blackwater NWR; they are known to occur on the Delmarva peninsula, and their host plants grow on the refuge. Larvae of two endangered species, the frosted elfin (*Incisalia irus*; G3/G4/S1) and regal fritillary (*Speyeria idalia*; G3/S1) feed on wild indigo (*Baptisia tinctoria*) and violets (*Viola spp.*), respectively. Larvae of two threatened species, the rare skipper (*Problema bulenta*; G2/G3/S1) and king's hairstreak (*Satyrium kingi*; G3/G4/S1) feed on *Spartina cynosuroides* and horse-sugar (*Symplocos tinctoria*), respectively. The need to document the occurrence of lepidopterans on the refuge should be apparent.

Strategies to achieve the objective.—We will document the occurrence and distribution of lepidopterans as part of the Refuge Complex Resource Inventory and Monitoring Program, or, alternatively, contract it as a discrete survey to a university or the Heritage Program. Both the draft Forest Management Plan and the proposed Marsh Management Plan will consider strategies to improve the distribution and abundance of host species used by State-listed species.

We will need to evaluate the crops we now grow for use by waterfowl as host species for lepidopteran larval and adult forms. For example, clover (*Trifolium spp.*), which is a protein source for migrating geese, hosts alfalfa butterflies (*Colias eurytheme*). Black willow (*Salix nigra*), which provides thermal cover for wintering dabbling ducks, hosts mourning cloaks (*Nymphalis antiopa*). Similarly, hackberry (*Celtis occidentalis*), which may be planted on dredge spoil to create roost sites for colonial waterbirds, hosts hackberry butterflies (*Asterocampa celtis*). Clearly, opportunities exist to modify existing management activities to more fully benefit nontarget lepidopterans. Successfully implementing the resident Canada goose control program will minimize grazing on clover, and allow this host plant to flower. Establishing a demonstration butterfly garden at the Visitor Center will not only serve an educational purpose, but also permit incidental observations of visiting butterfly species to be used to supplement inventory data.

Monitoring element.—Inventory program, contracted survey.

Objective 2.2.3. Maintain and restore hydrology and water quality as appropriate by 2010.

Basis of the objective.—Blackwater NWR maintains one of the most extensive and intact estuarine systems remaining on the Eastern Shore. However, many are concerned about the loss of 7,000 acres of emergent wetlands since 1933, the effects of sea-level rise and salt water intrusion on palustrine forested wetlands, nutrient runoff from wastes produced by animal feed operations, and the degradation of water quality and freshwater or anadromous

fisheries on the upper reaches of the Blackwater River due to saltwater intrusion from Stewart's Canal. These are significant environmental quality issues that negatively affect ecosystem processes and associated biota.

Strategies to achieve the objective.—We will develop and implement restoration tasks to be identified in the Habitat Management Plan. Implement management recommendations stemming from the ongoing CBFO study to evaluate the contribution of commercial poultry and swine operations to phosphate, nitrate, trace metal, and estrogenic compound levels in the Little Blackwater River.

Monitoring element.—Measurement of salinity and other water quality parameters.

Objective 2.2.4. By 2008, develop a Habitat Management Plan to address the issues of marsh loss and marsh management.

Basis of the objective.—The need to develop an HMP is critical, because of the significant loss of marsh, the emphasis on marsh restoration, the need to preserve community diversity, the increasing numbers of invasive and exotic species, the large number of threatened and endangered species, and the contribution of the refuge estuarine wetlands to the Bay ecosystem. Blackwater NWR sustains the northernmost expanse of three-square bulrush. Blackwater NWR also continues to maintain tremendous wetland diversity; more than 30 percent of its land is within two Maryland Natural Heritage Area sites, the Upper Blackwater and Gum Swamp. Federal-listed sensitive joint-vetch (*Aeschynomene virginica*; G2/S1) and State-listed rare skippers (*Problema bulenta*; G2/G3/S1) almost certainly occur within the estuarine marshes of Blackwater. To protect, restore, and enhance this diversity, a comprehensive Habitat Management Plan must be developed.

Strategies to achieve the objective.—Restoration strategies will include plugging Stewart's Canal to reduce saltwater intrusion, modifying Shorter's Wharf Road to allow sheet flow, implementing recommendations from the Nutria Pilot Study to reduce nutria herbivory, implementing the “Integrated Wildlife Damage Management Plan” for resident Canada geese, maintaining the muskrat trapping and nutria rebate program, riprapping the pine islands, reducing sediment load run-off into the upper watersheds, and thin-layer placement of dredged material. Strategies for maintaining and improving floral composition will include the use of prescribed fire to affect regrowth vigor and species composition, the use of pesticides to control invasive flora (in particular, purple loosestrife and Phragmites), and replanting in conjunction with techniques such as thin-layer dredged material placement. The development of the Habitat Management Plan must be superseded by implementation of the Complex-wide Resource Inventory and Monitoring Program, and by vegetation classification of hyperspectral imagery to the community level.

The HMP also must include a significant monitoring component due to the dynamic history of the marsh and the planned restoration strategies. LIDAR technology could be used to create fine-resolution Digital Elevation Models (DEMs); this will be the basis for an accurate elevation base map of the refuge, critical for making predictions and assessments of various restoration strategies. Relative Elevation Modeling (REM) will allow the refuge to predict the ability of wetlands to build vertically at a pace equal to sea-level rise. Landscape modeling of habitat change will link the refuge GIS data and wetland ecosystem process models; this will help to predict the impacts of restoration efforts at specific places on the refuge and to target critical areas for intensive management. The current rates of wetland elevation change and sedimentation need to be monitored; this is essential if the refuge is to understand current accretionary dynamics and the impact of different management practices.

Monitoring element.—Completion of a baseline flora inventory, classification of hyperspectral imagery, and approval of the Habitat Management Plan. Although not a prerequisite for completion of a Habitat Management Plan, the funding and completion of a DEM and REM for the Refuge Complex will contribute significantly to the technical merit and prioritization of restoration strategies outlined in the Habitat Management Plan.

Objective 2.2.5. By 2017, protect, restore, and conserve riparian habitat as lands are protected.

Basis of the objective.—The functions of riparian areas include water quality improvement, aquatic habitat, stream shading, flood attenuation, shoreline stabilization, and groundwater exchange. Loss of these systems allows for a more direct contribution of non-point source pollutants to receiving waters. The pollutant removal functions associated with wetlands and riparian area vegetation and soils combine the physical process of filtering and the biological processes of nutrient uptake and denitrification (Lowrance, et al., 1983; Peterjohn and Correll, 1984).

Riparian forests, for example, have been found to contribute to the quality of aquatic habitat by providing cover, bank stability, and a source of organic carbon for microbial processes such as denitrification (James, et al., 1990; Pinay and Decamps, 1988). Riparian forests have also been found to be effective at reducing instream pollution during flood flows (Karr and Gorman, 1975; Kleiss, et al., 1989). As importantly, restoration of the riparian areas will minimize disturbances to wildlife and provide additional breeding, feeding and sheltering areas.

Strategies to achieve the objective.—We will seek all opportunities to restore, conserve, manage, and protect riparian systems through a combination of land acquisition, forging partnerships, using existing resource management and related plans, and a significant inventorying or monitoring effort to initially assess status and trends.

Management strategies in this plan will involve restoration, manipulation to achieve desired future conditions, or protecting existing habitat functions and values. Invasive species management, primarily *Phragmites australis*, will be incorporated.

Monitoring element.—Amount (acres) and quality (composition, structure) of available habitat and wildlife responses; number of miles of riparian habitat acquired or restored; implementation of the division Resource Inventory and Monitoring Plan; acquisition and maintenance of current remote sensing and GIS layers; approval of Forest Management Plan.

Objective 2.2.6. By 2022, protect, enhance and restore current and historical Coastal Plain Atlantic white cedar swamps along the Nanticoke River.

Basis of the objective.—Atlantic white cedar has been classified as globally rare or threatened throughout its historic range and given a G-3 ranking by The Nature Conservancy. Therefore restoration and management of this vegetative alliance are high priorities within the Fish and Wildlife Service and other Federal land management agencies.

Strategies to achieve the objective.—We will determine the historic distribution of Atlantic white cedar within the Nanticoke River watershed with particular emphasis on distribution on division lands. We will assess alterations in land use patterns to determine effects if any on the current distribution of Atlantic white cedar. We will assess alterations in hydrology which may have impacted site conditions and soil properties to the point which they no longer support this vegetation community. We will join forces with the Atlantic White Cedar Alliance, TNC, other Federal, state and local agencies, academia and NGOs to develop and implement restoration and management strategies. Specific restoration and management strategies may include but are not limited to restoring the hydrology on a site by site basis to mimic natural conditions, harvesting hardwoods and pines from lands which were historically dominated by cedar and regenerating these sites through planting or natural seed sources where mature cedars are present and controlling competing vegetation in regenerating cedar stands.

Monitoring element.—A detailed GIS that displays the historical and present-day distribution of Atlantic white cedar within the Nanticoke River watershed. A data set that includes information on the current status of existing cedar stands and incorporates restoration needs into the Forest Management Plan for the Nanticoke protection area.

Goal 3. Create the most complete network of protected lands within the Chesapeake Bay watershed.

Subgoal 1. Strategic growth and protection of Blackwater NWR

Objective 3.1.1. By 2022, protect an additional 31,314 acres described in our approved LPPs.

Basis of the objective.—Protecting that land will contribute to the resource conservation goals of a variety of international, national, and regional initiatives, including RAMSAR, IBA, NAWMP, and the National Wetlands Priority Conservation Plan. Protection supports objectives of the Management Plan for Canada Geese in MD, the Chesapeake Bay Waterfowl Policy and Management Plan, and workgroup recommendations by the Chesapeake Bay Program Living Resources Subcommittee. The protection and improvement of habitats in this area are seen to be critical steps in the North American Waterfowl Management Plan, which specifically recommends protection of

53,500 acres and the improvement of an additional 5,000 acres in the Blackwater–Nanticoke protection area by the year 2000.

The Nanticoke River is listed in the Emergency Wetlands Resource Act Regional Concept Plan, and is a landscape project supported by The Chesapeake Bay Estuary Program. The Nature Conservancy has recognized the lands within our Nanticoke protection LPPs as a bioreserve and a Last Great Place; the State has designated the Nanticoke River as a Wild and Scenic River. The Nature Conservancy has developed the "Nanticoke River Bioreserve Strategic Plan" (1998) which outlines the biological significance of the watershed and its threats. More than 23 Natural Heritage sites lie within the project, which also contains the largest contiguous forest remaining on the Delmarva Peninsula.

Strategies to achieve the objective.—We will seek opportunities to conserve, manage, and protect lands through a combination of land acquisition; easements; forging partnerships with State agencies, land trusts, and other landowners; and, developing agreements with other entities holding title or other rights or interests in land in targeted areas of the watershed. The use of hyperspectral imagery to remotely identify significant habitats and the use of LIDAR to evaluate the potential effects of sea-level rise will help greatly in prioritizing our land protection. The use of GIS to delineate the effective areas of forest cores will also help in strategic protection. We will develop an MOU with National Park Trust to facilitate and accelerate Complex-wide land protection.

Appendix B, "Land Protection Plan," describes the concepts of the Service land acquisition program and its acquisition priorities, the relationship of land protection to achieving goals and objectives in national and regional habitat plans for trust resource species, collaborative science-based conservation planning, alternative approaches to land acquisition, the role of landscape-level biological planning in developing priorities, the benefits to specific conservation targets (species and ecosystem types), how proposals promote biological integrity, the review of Comprehensive Environmental Response Cleanup Liability Act responsibilities and issues, recreational guidelines and improved access issues for additional wildlife dependent recreational activities, and operational and maintenance costs.

Monitoring element.—Annual acres protected; acquisition and analyses of remote sensing or GIS layers.

Objective 3.1.2. By 2007, continue to assist partners in developing a landscape protection plan.

Basis of the objective.—Population growth, fragmentation, and other, related land use changes must serve as an important backdrop in our CCP. These forces ultimately result in fundamental changes to fish, wildlife, and plant populations and to ecosystem processes; they affect land acquisition efforts; they create logistical problems in land management, maintenance, and law enforcement; and, they produce significant recreational demands and pressures on the Refuge Complex. The collective efforts of many different agencies, entities, and non-governmental organizations already are protecting and conserving many unique and important habitats, communities, and species in the watershed.

The salient issue is what role the Refuge Complex (and each refuge) should play as part of the emerging, larger, interconnected system of protected lands within the watershed. The Service alone cannot acquire or otherwise conserve the resources within the Blackwater River watershed. The success of management and conservation of biological diversity and efforts to maintain or restore the integrity and health of ecosystems and communities will rely upon partnerships.

Strategies to achieve the objective.—We will assist in developing Maryland's GreenPrint Program; participate in implementing the Chesapeake 2000 Agreement; work with local, state, and regional government acquisition or easement initiatives on strategic partnerships to maximize and coordinate land protection; acquire, restore, or otherwise protect forested corridors to connect refuge land with other protected land; participate in the Chesapeake Bay and Susquehanna River Ecosystem Land Protection Plan; and, develop an MOU with National Park Trust to facilitate and accelerate Complex-wide land protection. We will assist the Maryland Wildlife and Heritage Service with the development of its comprehensive Wildlife Diversity Conservation Plan, whose purpose is to identify the important places on the Maryland landscape where conservation is needed to sustain wildlife diversity and the actions necessary to conserve this diversity, focusing on fish and wildlife species of greatest conservation need.

Monitoring element.—The number of acres and the quality (composition, structure) of available habitat protected and managed; and, the number of partnerships and initiatives created.

Goal 4. Develop and implement quality scientific research, environmental education, and wildlife-dependent recreation programs that raise public awareness and are compatible with refuge purposes.

Subgoal 1. Encourage and provide opportunities for research by other agencies, universities, and other institutions, especially, research that relates to the mission, management, and objectives of Blackwater NWR.

Objective 4.1.1. Foster relationships with government entities, conservation groups, and institutions, communicate the most critical research and management needs of the refuge, and provide at least five research opportunities by 2012.

Basis of the objective.—One of the important purposes of Blackwater NWR is priority scientific research, which we define as studies that contribute to the enhancement, protection, uses, preservation, and management of native wildlife populations and their habitats in their natural diversity (4 RM 6). The Service encourages and supports research that provides additional data upon which to base decisions on managing units of the Refuge System (4 RM 6). We need to provide opportunities for research and management-applied studies, which are crucial to sound resource management.

One of our objectives is to provide students and others with the opportunity to learn the concepts of field research (4 RM 6). Providing research opportunities to universities, colleges, and other institutions will enhance the education of students pursuing wildlife, archaeological, or other degrees (see subgoal 2, below). The information they provide the refuge on wildlife-habitat relationships and other topics will further environmental education and interpretation and wildlife conservation.

Strategies to achieve the objective.—We will actively seek partnership opportunities, and consider unsolicited proposals for research in a variety of disciplines, including flora and fauna, public use, and cultural resources. All reports, surveys, and scientific papers generated will be made available to refuge staff and cataloged for future needs.

We will communicate to the institutions above, the priority information gaps we seek to fill, e.g., the effects of human activities on wildlife and habitats, and habitat needs of species of special concern, with priority given to studies that contribute to the enhancement, protection, use, preservation, and management of native wildlife populations and their habitats in their natural diversity (4 RM 6). We will also permit the refuge to be used for other investigatory scientific purposes, when such use is compatible with the purposes, goals, and objectives of the refuge. Priority will be given to research studies that contribute to the enhancement, protection, uses, preservation, and management of native wildlife populations and their habitats in their natural diversity (4RM 6).

We will specifically create new and innovative partnerships with U.S. Geological Survey and the Fish and Wildlife Cooperative Research Units (University of Maryland Eastern Shore and others) to achieve information needs and to evaluate management actions. Refuge staff will identify research needs, collaborate with researchers where and when appropriate and feasible, provide facilities and support as defined in objective 4.1.2., and routinely author and co-author publications.

Monitoring element.—The number of published research projects supporting refuge objectives.

Objective 4.1.2. Maintain refuge facilities, equipment, and lands for potential use by researchers, interns, students, and other conservation partners by 2008.

Basis of the objective.—Providing facilities and equipment facilitates research, as housing and travel costs can be significant components of research budgets.

Strategies to achieve the objective.—Housing, equipment storage, and use of Service equipment will be provided at the discretion of the Project Leader, with priority given to research that furthers the goals and purposes of the refuge. We will seek partnerships with the Friends of Blackwater to purchase new facilities or renovate existing ones.

Monitoring element.—Inventory of facilities available for researchers, listing of habitats used during research.

Subgoal 2. Provide opportunities for environmental education and interpretation that meet the needs of users.

Basis of the subgoal.—The Refuge System Administration Act and the NWRSIA direct us to provide opportunities for the priority general public uses of the Refuge System. Environmental education and interpretation are two of the six priority public uses. These uses advance public awareness, understanding, and appreciation of the functioning of ecosystems and the benefits of their conservation to fish, wildlife, and people. This ultimately contributes to the mission of the Refuge System.

Objective 4.2.1. Complete and distribute an environmental education manual by October 2009.

Basis of the objective.—Only one environmental education program is now available at the refuge. The refuge cannot meet the requests by school groups and scout, church, and 4–H groups. An environmental education manual will provide programs and activities for schools and other groups while increasing public understanding of wildlife needs, ecosystems, conservation, and habitat management for wildlife and, ultimately, the public use goal of the refuge.

Strategies to achieve the objective.—Refuge staff will edit and print section 1 of an environmental education manual by October 2008, section 2 by October 2010, and section 3 by October 2012. The manual will be distributed to schools and feedback gathered 1 year after each section is published.

Monitoring element.—The number of schools, teachers, and students that visit the refuge; assessment of how the manual meets their needs and expectations.

Objective 4.2.2. Annually provide two on-refuge teacher training programs.

Basis of the objective.—Many teachers do not have the background in environmental education and wildlife to teach the activities in the manual. Teacher workshops will enable them to learn how the activities should be conducted, what to expect to find at the refuge, and will provide background information for preparing the students for the various activities. A well-trained teacher will provide the necessary background for refuge environmental education, and focus on the importance of the refuge in wildlife habitat management, enhancing the refuge's ability to meet its environmental education goals.

Strategies to achieve the objective.—We will conduct two teacher workshops each year.

Monitoring element.—The number of teachers attending workshops; teacher assessment of the education manual; effectiveness of the training.

Objective 4.2.3. By 2012, develop specialized programs and provide the 15 types of environmental education programs identified in the environmental education manual for 150 groups of students.

Basis of the objective.—Refuges are learning laboratories, and Service programs are designed to show students and teachers the value of fish and wildlife resources. There is now only one refuge-specific environmental education program available for teachers, 4–H clubs, scouts, home schoolers, college students, and others. The refuge has not been able to meet the requests for special programs for all these groups. With 15 environmental education programs geared toward each of the different types of groups and their needs, the refuge will provide the programs requested.

Strategies to achieve the objective.—We will develop environmental education programs that can meet requirements of boy scouts, girl scouts, 4–H clubs, home school groups, college programs, programs for adults, and special event programs to be available when needed by 2012.

We will implement the environmental education manual and refuge activities for elementary-age visiting groups by October 2008; for middle school groups by October 2010; and high school groups by October 2009.

We will develop three changeable environmental education activities for the refuge web page by January 2010, and alternate programs every 6 months.

Monitoring element.—The number of environmental education programs and students per year, and assessment of how well the environmental education program and manual meet their needs and expectations.

Objective 4.2.4. Develop adequate facilities and equipment for environmental education study compatible with wildlife management purposes of the refuge by 2014.

Basis of the objective.—No facilities are adequate for providing environmental education programs year-round. Building such a facility will greatly enhance the capability of the Refuge Complex to administer its environmental education program, and, ultimately, achieve the public use goal of the refuge.

Strategies to achieve the objective.—We will purchase the Robbins property to construct an environmental education outdoor classroom, and purchase equipment and materials to use for environmental education. We will build a contact station for the Nanticoke protection area along Route 50 on a site yet to be determined; and by 2017, we will build an outdoor classroom facility.

Monitoring element.—Completed construction of the facilities and purchase of equipment; and the number of visitors or groups using each facility or location.

Objective 4.2.5. Increase interface with the education community, non-government organizations, universities, and other state and Federal agencies by 2010.

Basis of the objective.—No staff are available for coordinating volunteer services, even though we recognize the crucial link between public awareness and effective management of the Refuge System. The Volunteer and Community Partnership Act requires us to develop guidance for refuge education programs to further the mission of the Refuge System and the purposes of individual refuges. The Act encourages cooperative efforts with state and local education authorities and partners to develop and implement these programs.

Strategies to achieve the objective.—We will develop five shared education programs and activities with other environmental education centers (Horn Point EE Center, Karen Noonan EE Center, Pickering Creek EE Center, and universities) by October 2014; foster opportunities for the participation of students, co-ops, SCEPS, interns, and SCAs; participate in community and other government-agency-sponsored events; expand our participation in the envirothon for high schools; develop an MOU with Henson Scout Camp and the 4-H Camp Thendera to work together on environmental education and interpretive programs and events; and, develop an envirothon for middle and elementary schools.

We will improve communications by planning and conducting workshops and meetings with other environmental education interests (the education community, non-government organizations, and other agencies); share information and ideas; and, assist with environmental education activities. We will continue to work with the Nanticoke Watershed Alliance on special programs involving environmental education and outreach; and expand our volunteer network and friends groups.

Monitoring element.—The number and types of partnerships developed, number of programs established, and number of participants in these programs.

Objective 4.2.6. Provide qualified educators and volunteers to conduct environmental education and interpretation programs by 2010.

Basis of the objective.—The System must have professional public use planners and specialists in recreation, interpretation, and education to provide the American people with more and better opportunities to enjoy compatible wildlife-dependent experiences on refuges. Trained professionals will be able to educate the public in a manner that visitors of all ages can enjoy while learning about wildlife, their environment, conservation, and refuge management.

Strategies to achieve the objective.—In addition to the supervisory ORP and the permanent full-time Recreation Aid or Park Ranger (position vacant since 1989), we will hire a permanent full-time ORP to recruit and train interns and at least 30 volunteers a year, and assist with the environmental education program. We will hire two additional permanent full-time ORPs and one additional ORP for the Nanticoke protection area. We will provide trained professionals and volunteers the opportunity to attend appropriate environmental education training.

Monitoring element.—The number of trained professionals, volunteers, and students providing environmental education.

Objective 4.2.7. Provide 100,000 hours of interpretation to enhance visitors' knowledge of wildlife and refuge management, while providing an enjoyable refuge experience by 2017.

Basis of the objective.—Refuges are the front yards of the Refuge System, and provide people the opportunity to experience its diverse environmental education and interpretation activities at first hand. Refuges provide visitors with an understanding and appreciation of fish and wildlife ecology and help people understand their role in the environment through interpretation programs and facilities. The refuge now provides 26,000 hours of interpretation annually. The refuge Visitor Center, self-guided Wildlife Drive, and associated interpretation trails (one self-guided) provide visitors some knowledge of wildlife and refuge management and an enjoyable refuge experience. However, the Visitor Center is in poor condition, short of space, understaffed, and its exhibits are outdated. We cannot meet the increasing number of requests for more activities, programs, demonstrations, and special events. Programs will need to be created to specifically target the Nanticoke protection area resources. Improving facilities, staffing, and programs will greatly enhance our capability to administer interpretation programs, and ultimately achieve the wildlife-dependent education and recreation goals of the refuge.

Strategies to achieve the objective.—By 2008, we will remodel and expand the Visitor Center to include a larger multipurpose room for 150 people; a second-floor observation area with observation telescopes; an environmental education area; new office space for four ORPs or Park Rangers, seasonal or temporary staff, interns, and the volunteer program; sales outlet space for FOB; fire-safe storage for historical items; and, a larger exhibit area.

We will update present kiosk information panels and provide two more kiosks by 2010: one at the entrance to the new Wildlife Drive location, and one at the Nanticoke River contact station to provide interpretive information on Nanticoke protection area resources. We will provide a panel in the Woods Trail kiosk explaining the history of the steam engine; construct trailheads with kiosks at new hiking, canoeing, and biking trails by October 2007; install interpretive signs in new hiking, biking, and canoeing areas and other areas as needed; and, catalog and store all slides, photos, and historical items.

The refuge will serve as an NPS Gateways Site. We will install an indoor interactive computer console in the Visitor Center by October 2008; install an outdoor interactive computer console by 2014; install a live action monitor of eagle and osprey nests with educational exhibits by 2009; produce a new refuge film in 2012; a Nanticoke film by 2014; and, purchase new videos applicable to the refuge for use in the Visitor Center and Nanticoke Contact Station.

We will develop new, updated exhibits for the Visitor Center and Nanticoke Contact Station, which will be open every day but Christmas Day and Thanksgiving Day; revise the Mammals and Wildlife Drive Guide leaflets to FWS standard format; produce a self-guided Woods Trail leaflet, Nanticoke leaflet, volunteer leaflet, and exotic species leaflet by October 2012; produce an endangered species leaflet and entrance fee leaflet by October 2014; and, produce other leaflets as needed.

We will construct a ¼–mile bicycle trail from the Wildlife Drive to Key Wallace Drive. In partnership with the highway department, we will build a 3-mile bike path from the Wildlife Drive to Hip Roof Road. We will build a butterfly garden by October 2008; establish a habitat demonstration area by October 2009; and, provide bat housing in silos at Hog Range.

Monitoring element.—The number, type, and location of facilities or activity, and the response by refuge visitors (the number of hours, number and type of visitors or groups using each facility, location, or activity).

Subgoal 3. Provide opportunities for compatible wildlife-dependent recreation.

Basis of the subgoal.—The NWRSIA directs us to provide six priority wildlife-dependent recreational uses in the Refuge System: hunting, fishing, wildlife observation and photography, and environmental education and interpretation. By providing the public with opportunities for those uses, we will increase public awareness, understanding, and appreciation of ecosystem functions and the benefits of ecosystem conservation to fish, wildlife, and people. Ultimately, these will contribute to the mission of the Refuge System.

Objective 4.3.1. By 2012, increase the opportunities for wildlife observation and photography.

Basis of the objective.—During scoping meetings, the public requested that we increase wildlife observation and photography opportunities. Achieving this objective will provide the public with the opportunity to view the relationships among resource management, wildlife and habitat, and people.

Strategies to achieve the objective.—By October 2008, we will redesign the Wildlife Drive to start from the Visitor Center and finish at its present entrance, to give visitors a better wildlife observation experience, and enable them to get information and assistance from staff and volunteers at the Center before entering the drive. We will convert the Pool 5 section of the drive to non-motorized use, to allow a separate area for pedestrians and bicyclists that will not conflict with motorists, thereby improving visitor safety. We will also build a new parking area for visitors who wish to bike or hike.

By October 2017, we will build a wildlife observation trail from Route 335 to Smithfield Road (Gum Swamp Trail), with parking facilities. We will install benches along all wildlife observation trails to allow visitors to rest and enjoy wildlife.

By January 2012, we will replace the observation tower with an accessible deck over wetlands and an elevated observation platform at water's edge at the junction of the Little Blackwater River and Blackwater River, to be used for environmental education programs and by visitors to view the wetlands.

By January 2012, we will install six observation and photo blinds and provide a photography program for the public for each season of the year.

By 2009, we will build a second-floor observation deck and install observation telescopes at the Visitor Center.

By 2017, we will build a wildlife observation trail and observation tower on the Nanticoke.

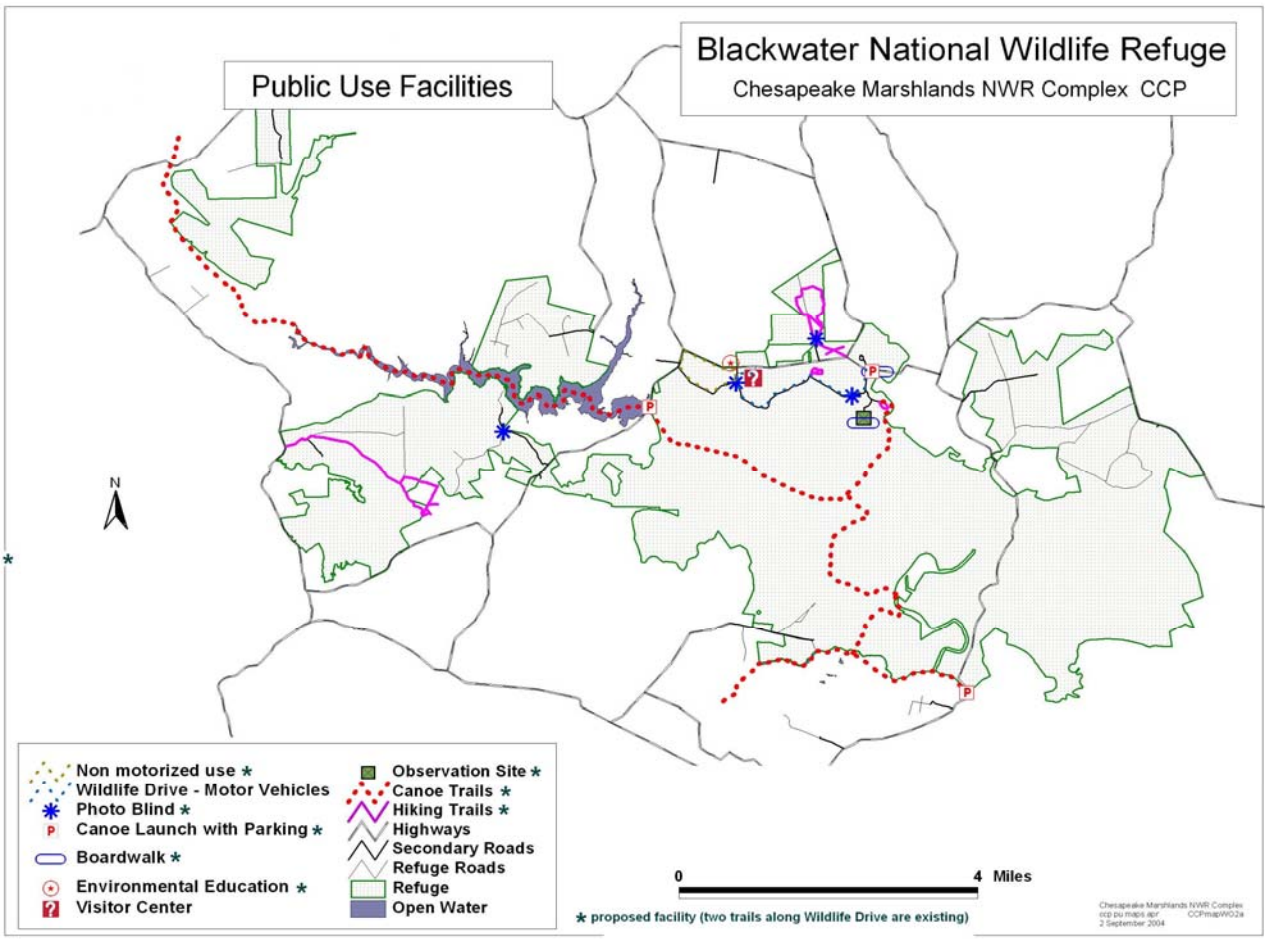

Figure 4.1. Public Use Facilities

Objective 4.3.2. Provide increased fishing opportunities by 2017.

Basis of the objective.—The demand for safe, adequate fishing opportunities is increasing.

Strategies to achieve the objective.—By January 2007, expand areas closed to boating, using State regulations. By 2008, in partnership with the State of Maryland, we will build a canoe access ramp and controlled parking area at the Route 335 bridge, and encourage the Friends of Blackwater or a concessionaire to provide canoe and kayak rentals.

By January 2009, we will mark river channels on Blackwater River, and, by January 2014, we will build an accessible boardwalk or pier, kiosk, designated fishing and crabbing area, and parking area on the Little Blackwater near Key Wallace Bridge.

By 2017, we will construct a canoe access ramp with controlled parking area, and build an accessible boardwalk or pier near the Nanticoke River.

By January 2017, we will map waterways for public safety, monitor canoeing and boating activities, provide interpretive fishing, crabbing, and boat safety programs, develop National Fishing and Boating Week activities for the public, and develop signs and printed materials explaining Blackwater NWR rules and regulations to visitors.

Monitoring element.—The number, type, and location of facilities constructed, and response of refuge visitors, by season (number of visitors using each of the facilities—pier, canoe ramp, parking).

Objective 4.3.3. Provide additional opportunities for high quality hunting experiences.

Basis of the objective.—The need to provide hunting opportunities compatible with the resource is increasing. At our scoping meetings, the public recognized hunting as a traditional, family-oriented form of recreation, important in developing an appreciation for fish and wildlife, and recommended more opportunities for big game, small game, and waterfowl hunting.

Strategies to achieve the objective.

Big game hunting.—We will open 10,430 acres of existing refuge land to big game hunting, and open additional acreage as we acquire it.

Beginning the last Saturday in September and ending the third Saturday in January, we will permit big game hunting for sika and white-tailed deer for a minimum of 51 days: 43 days of archery hunting; 2 days of muzzleloading rifle or shotgun hunting; 2 days of youth-only shotgun hunting; and 4 days of shotgun hunting; all within State seasons and in conformance to State weapons and bag limits.

During the archery seasons, hunters will walk in from existing, designated parking areas, and all vehicle access will be prohibited. During firearms seasons, vehicles will be restricted to designated roadways. There will be no off-road vehicles or ATV use allowed during any hunting season. There will be no access allowed by boat during any of the big game hunting seasons. The first section of the Wildlife Drive will be closed the first 2 days of the shotgun hunt, leaving the second part open for public use.

We will provide hunting opportunities to a minimum of 3,000 hunters annually, on a first-come, first-served, mail-in system (non-quota for the archery season, but "with quotas" for the firearm hunts). Hunters will be restricted to zoned areas for safe distribution, with a ratio of no more than 1 hunter per 20 acres, although some areas may have only 1 hunter per 40 acres. Staff and volunteers will operate check stations during muzzleloader and shotgun hunts to obtain deer age, sex, species, and weight data. We will require hunters who kill deer during the archery season to have them checked at a Maryland DNR-certified checking station.

Before July 1, we will prepare and submit for review an annual hunt plan. We will publish summaries of the biological information in the refuge Annual Narrative Report. Administrative fees will be charged for the permits. Senior citizens will receive a 50-percent discount on those fees. We will use those fees to hire a hunt coordinator and maintain parking areas and signs.

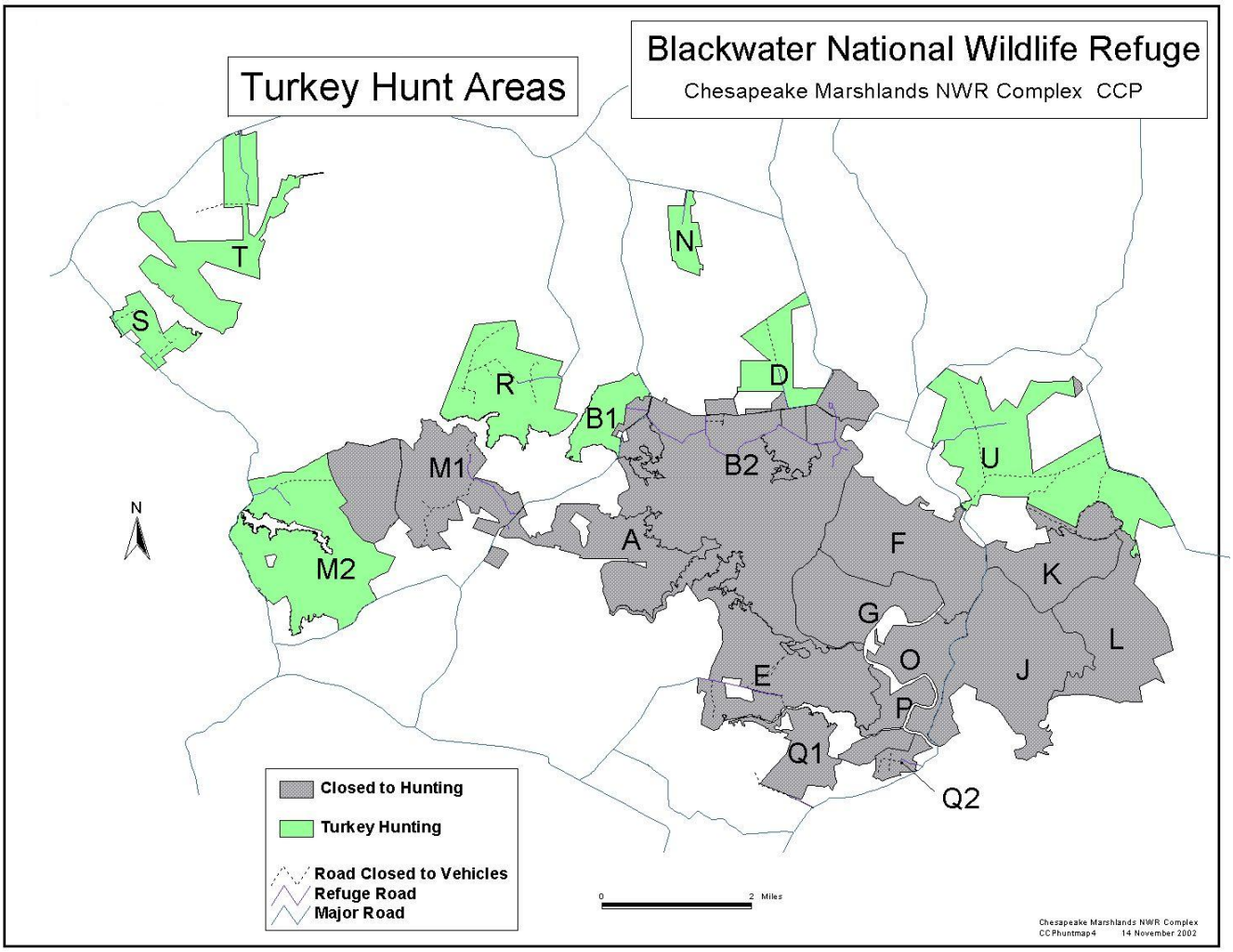

Figure 4.2. Turkey Hunting Areas

One area of the refuge will be designated for certified wheelchair-bound big game hunters. Hunt leaflets, regulations, and maps will be prepared and published annually, and distributed to hunters. Refuge-specific regulations will be published annually in the Federal Register and codified in Title 50, Part 32. We will maintain a hunter data base to facilitate mailing and distributing information. Blackwater NWR will

continue the same precautions for threatened and endangered species and migratory waterfowl as proposed under alternative A of our draft CCP. Hunting will be regulated in time and space to eliminate conflicts with endangered species and other public uses, and to ensure compatibility with refuge purposes. Annual spotlight surveys, harvest data, herd health conditions, and available habitat will continue to ensure that the deer hunt program remains biologically sound.

Deer hunting to maintain herd numbers within acceptable levels will continue to provide opportunities to utilize a renewable resource. We will adjust refuge hunting seasons each year to take into consideration changes indicated in herd quality by biological monitoring (APCs, antler size, reproductive rates, etc.).

Forest game hunting.—By April 2008, we will open the refuge to turkey hunting in accordance with State regulations (see figure 4.2, turkey hunt areas). The refuge will be open to hunting on Tuesdays and Saturdays for 5 weeks during the State season (April 18 to May 23) on a quota basis. Turkey hunting will require a permit issued to 14 hunters per day (112 hunters), determined by a lottery system. We will also participate in the state junior turkey hunting program. The junior hunt is designated for hunters age 16 or younger only, who must be accompanied by a licensed (or exempt from license requirement) unarmed adult age 21 or older.

The hunt will take place on approximately 7,485 acres in 10 areas (Areas B1, D, M2, N, R. S. T, U1, U2, and U3), located where public use will not occur, as specified in the Annual Hunt Plan. Scout days will be authorized the day before each hunt day. We will open new areas as they are acquired whenever hunting will not conflict with public use or endangered or threatened species (bald eagle), and will not have a negative impact on other wildlife and habitat resources or public safety. Hunting on newly acquired lands will conform to existing regulations. We will complete a compatibility determination before the hunt begins.

Waterfowl hunting.—By 2009, we will open Blackwater NWR to spring hunting of resident Canada geese (March 15 through April 15), according to the Annual Hunt Plan based on the "Integrated Wildlife Damage

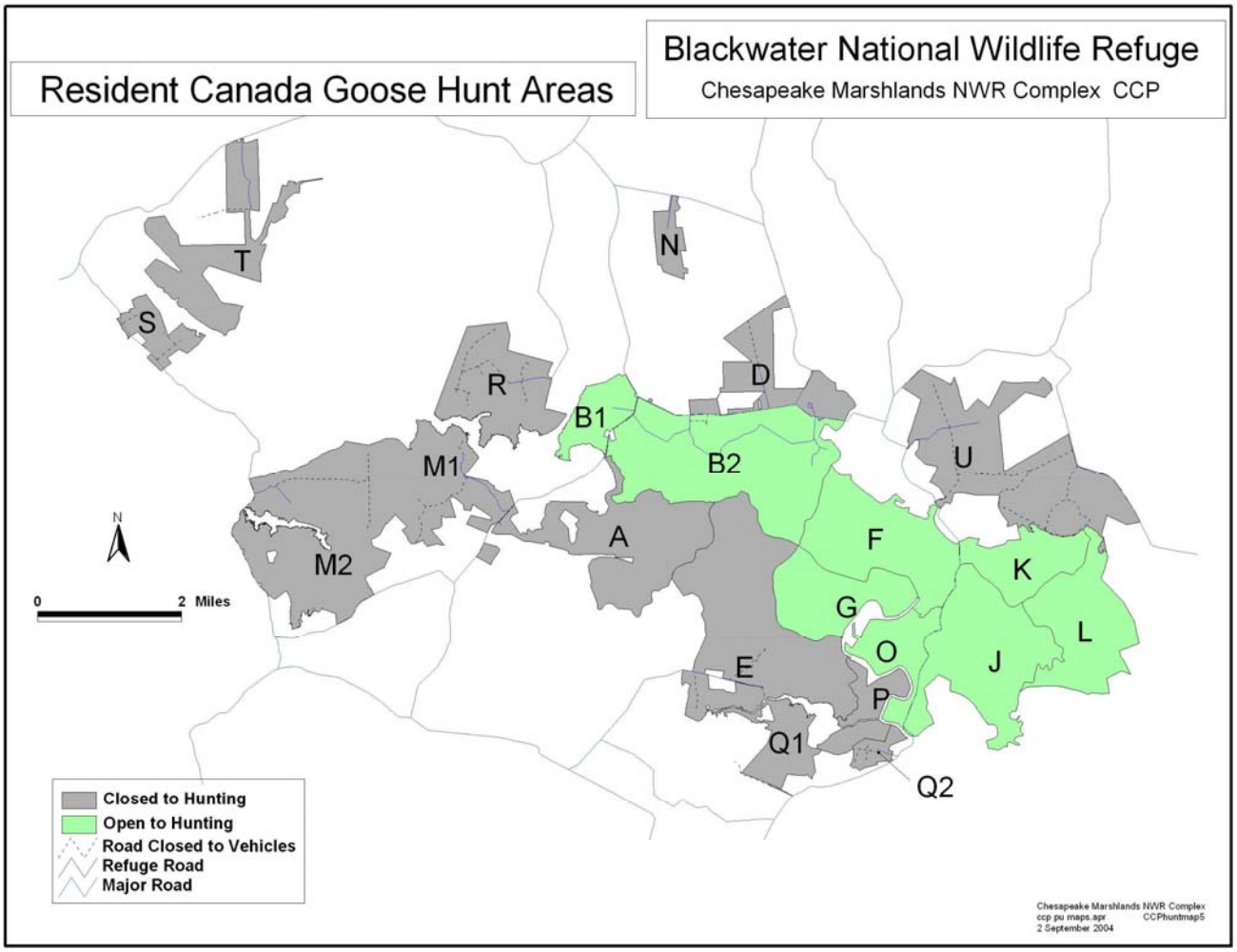

Figure 4.3. Resident Canada goose hunting areas

Management Plan for Control of Resident Canada Geese," if consistent with the Service EIS on managing these injurious resident waterfowl. Hunting will occur in areas that will not conflict with public use or endangered and threatened species (bald eagle), and will not have a negative impact on other wildlife and habitat resources or public safety (see figure 4.3, Resident Canada goose hunt areas). We will close the hunt areas to boating access by non-hunters during the hunting season.

Resident goose hunting will require a permit determined by a lottery system issued for 30 blind sites constructed by the hunter within 100 yards of a numbered post. The blind sites will be located in areas B1, B2, G, F, J, K, L, and O, on approximately 8,300 acres of marsh (3,731 acres), fields (70 acres), and open water (4,500 acres). Thirty permits per day (27 days) will be issued providing 810 recreational waterfowl hunting opportunities. New areas will be evaluated and considered as they are acquired whenever hunting will not conflict with public use areas or endangered and threatened species (bald eagle), will not have a negative impact on other wildlife and habitat resources, or adversely affect public safety. Retrievers will be permitted.

By 2012, waterfowl hunting in accordance with State seasons, species, bag limits, and hunting methods, will be permitted on 40 percent of all new acquisitions. This hunting opportunity will continue to maintain approximately 23,000 acres as an inviolate sanctuary for wintering and migrating waterfowl.

We will hire a full-time Refuge Law Enforcement Officer to enforce hunting regulations, in addition to other duties. The Friends of Blackwater will hire a full-time Hunt Coordinator to prepare updated mailing lists, regulations, maps and applications; mail out information, process applications, collect and record money; and, maintain the hunt areas, conduct the hunts, and collect and prepare records of hunt statistics.

Monitoring element.—The number and type of hunting experiences, and response of refuge visitors (number and type of visitors or groups participating in each hunt).

Subgoal 4. Enhance and increase outreach activities.

Basis of the subgoal.—In recognizing the crucial link between public awareness and effective management of the Refuge System, and in order to build a stronger base of public understanding, support, and activism beyond that portion of the American public who visit refuges, the Service has supported nationwide strategies, including the 100-On-100 Outreach Campaign, the National Outreach Strategy: A Master Plan for Communicating in the U.S. Fish and Wildlife Service, the NWRSIA, the Cooperative Alliance for Refuge Enhancement (CARE), the Volunteer and Community Partnership Act, and the Challenge Cost-Share Program. Enhancing and increasing outreach activities support this subgoal.

Objective 4.4.1. Increase public knowledge of the Refuge Complex and each refuge's existence, location, and activities. (See "Strategies," below, for completion dates.)

Basis of the objective.—Many people, including numerous local residents, are unaware of the refuge, its mission, and what it does. Increasing public knowledge of the refuge's existence, location, and activities will encourage more people to visit the refuge and become aware of the importance of refuge habitat management, wildlife, and conservation, to supporting the mission of the Service.

Strategies to achieve the objective.—We will install two travelers' information radio stations on Route 5: one near Cambridge by January 2007, and one near the Nanticoke River in Vienna by 2012. We will participate in local events, such as the Bay Country Festival, 4-H Fairs, Waterfowl Festival, Shad Festival, and other events as they develop; work with Dorchester County Tourism, South Dorchester Folk Museum, Harriet Tubman Organization, and other community organizations in events and activities as they are developed, and develop ecotourism programs at the Hyatt Regency conference center by October 2012.

We will develop better personal relationships with the media, develop a refuge monthly or weekly activity report for local newspapers and radio stations, and continue to work with Friends of Blackwater to seek funding, develop programs, produce projects, expand the cooperative sales outlet, plan and conduct public events, promote national projects and other activities as they develop, and respond to all public inquiries.

We will involve more people from the community in the Volunteer Program, participate in the development of watershed-wide cooperative outreach groups of Dorchester, Caroline, Somerset, and Wicomico Counties; continue to participate in the Nanticoke Watershed Alliance and Lower Shore Tributary Strategies Team; and develop an envirothon for middle and elementary schools by 2017.

Monitoring element.—The number of types of activities involving the communities, and the number of participants in each.

Subgoal 5. Ensure the compatibility of all public use.

Basis of the subgoal.—The Service is responsible for ensuring the compatibility of all public uses, in conformance with the Refuge Recreation Act of 1962 and the Refuge Administration Act of 1966, which place into law the concept that all refuges will be closed to all recreation uses, until we have determined that the uses are compatible with a refuge's establishing purpose(s), and that sufficient funds are available to administer those uses.

Objective 4.5.1. Provide public use opportunities that are compatible with the wildlife, resources, and purposes of Blackwater NWR by 2007.

Basis of the objective.—The NWRSIA calls for the Refuge System to provide increased opportunities for families to experience compatible, wildlife-dependent recreation.

Strategies to achieve the objective.—We will determine the compatibility of all new recreational uses.

Monitoring element.—The number of compatible determinations.

Objective 4.5.2. Provide adequate housing for interns and students (researchers and public use) by 2009.

Strategies to achieve the objective.—By 2007, we will set up and renovate a mobile home purchased by the Friends of Blackwater for intern and researcher residence.

By 2009, we will renovate and convert the old headquarters building to intern housing.

Objective 4.5.3. Develop adequate facilities and equipment. (See "Strategies," below, for completion dates.)

Strategies to achieve the objective.—By 2008, we will remodel and expand the Visitor Center to include a larger multipurpose room for 150 people; a second-floor observation area; and environmental education area; new office space for five ORPs or Park Rangers, temporary staff, interns, and volunteers; sales outlet space for FOB; and a larger exhibit area. We will construct a contact station on the Nanticoke River.

We will build two outdoor classrooms: one near the Wildlife Drive by 2009, and one at the Nanticoke River by 2017; and, purchase equipment and materials to use in environmental education.

By October 2009, we will build an improved loop hiking trail from Route 335 to Smithfield Road, with a parking area for visitors who wish to hike, and a parking area for visitors who wish to bike.

By January 2012, we will replace the observation tower that was removed in 1990 with an accessible deck and elevated observation platform over wetlands to water's edge at the junction of the Little Blackwater River and Blackwater River, and build three observation and photo blinds.

By January 2009, we will redesign the Wildlife Drive to start from the Visitor Center and finish at its present entrance, and convert the second part of the Wildlife Drive to a bike trail, which will connect with a bike trail to be built along Route 335 to Hip Roof Road by the MD Highway Department and Dorchester County.

Subgoal 6. Protect human health and safety.

Objective 4.6.1. Ensure that human health and safety are primary considerations in implementing refuge management activities.

Strategies to achieve the objective - Allowed public uses and many refuge management activities have undergone a compatibility determination that considers human health and safety prior to implementation.

One refuge management activity affecting public health and safety that relates to both our wildlife habitat and public use programs is mosquito control. In rare circumstances mosquitoes can serve as disease vectors presenting a threat to human health. West Nile virus and encephalitis are two examples of mosquito borne diseases that are a

public health concern. It is the policy of the National Wildlife Refuge System that we will allow native mosquito populations to function unimpeded and we may allow mosquito populations to be controlled only in the following circumstances:

There is a need to manage a public or wildlife health threat from a specific mosquito-borne disease that mosquito and disease monitoring data, collected by either the Service or state/local public health or mosquito control agencies, have documented as enumerated in Service policy.

There are tires, tanks, or other similar debris/containers that may serve as artificial breeding sites for native or non-native species of mosquitoes. We may remove these or treat them with pesticides.

We are enhancing, restoring, or managing habitat for other wildlife species to achieve refuge purposes. This may be in the form of habitat restoration or water level manipulations where there is a definable benefit to other wildlife over not undertaking such actions. We prohibit habitat modifications or management actions designed specifically for mosquito control that impact other wildlife species or habitats and are detrimental to refuge purposes or System goals. These modifications or actions include, but not limited to, inappropriate draining, maintaining high water levels that are inappropriate for wildlife, and the importing or enhancing of non-native predators.

There is a need to manage a threat to public health and safety from extreme numbers of biting mosquitoes when advised to do so by the Centers for Disease Control and Prevention (CDC) and/or the Federal Emergency Management Agency (FEMA). Such mosquito control may be necessary following natural or human-caused disasters when biting mosquitoes may hamper recovery efforts.

In cases of officially determined health emergencies, any method we use to manage mosquito populations within the refuge will conform to applicable Federal laws such as the Endangered Species Act. Habitat management and pesticide uses for mosquito control will give full consideration to the integrity of non-target populations and communities. They will also be consistent with integrated pest management strategies and with existing pest management policies of the Department of the Interior and the Service.

Goal 5. Ensure that the staffing, facilities, resource protection, and infrastructure necessary for implementing this CCP are developed.

Objective 5.1. By 2008, obtain base funding necessary to maintain minimum staffing and operational support of the refuge.

Basis for the objective.—The Refuge Complex staffing chart (see appendix D) identifies this refuge's minimal staffing level for basic resource inventory and monitoring to ensure the use of the best science in management decisions. Additional biological and maintenance staff are needed to maintain intact and diverse ecosystems, recover endangered species, and monitor populations status and trends. Law enforcement officers are necessary to ensure the safety of visitors and for resource protection.

Critical needs exist in the public use programs to respond to expected high levels of visitation and demands for opportunities for visitors to experience and appreciate wildlife. Existing equipment inventories are insufficient to effectively support existing or additional staff. Clearly, implementing this plan will require staff to effectively perform all identified public use, management, inventory, and maintenance programs identified in this plan.

Strategies to achieve the objective.—We will obtain congressional, national, and regional support for base funding for approved refuge projects; obtain local community support for implementing programs during the transition period, including expanding the use of volunteers and interns to accomplish programs and projects; and, seek opportunities for collaborative funding projects with partners. We have identified under goal 4, subgoal 5, objective 3 the public use infrastructure needed to accomplish our goals.

Monitoring element.—Achieve base funding level necessary to maintain minimum staffing and operations.

Chesapeake Island Refuges

Concepts Used in Developing Management Strategies

Land Protection.—This plan will expand potential management responsibilities at the island refuges through Cooperative Management Agreements and Memorandums of Understanding. We will welcome management agreements with the State of Maryland and the U.S. Navy for Bloodsworth, Adams, and Northeast Islands (U.S. Naval Reservation lands), and South Marsh Island (the MD DNR Wildlife Management Area).

Fish, Wildlife, and Habitat Management.—This plan will expand the Complex-wide Resource Inventory and Monitoring Program, and will place special emphasis on the tenets of conservation biology and ecosystem processes in the design and implementation of our management programs. Programs will also be in place for optimizing not only Federal trust species, but also biological integrity and ecosystem health in the context of refuge purposes. A variety of active and passive management programs will be deployed to accomplish habitat-based and population-based goals and objectives, including the continued extensive use of artificial nest structures, habitat creation, predator controls, active intervention to address exotic, invasive, and injurious species, and landscape-level habitat restoration.

Public Use.—Our management of public use on the island refuges will be guided by the following concepts. As with our approach at Blackwater NWR, the island refuges' public use program will promote the refuges, Refuge Complex, and Refuge System conservation messages, to help reduce the impacts on other wildlife areas and inform visitors about the importance of closed areas for wildlife. The island refuges will provide environmental education for the visiting public and training for teachers and students; develop compatible opportunities for wildlife observation, photography, hunting, and fishing; develop a friends group and volunteer program; develop extensive environmental education and interpretation facilities, programs, and activities and wildlife-dependent recreational facilities, programs, and activities to conform with "Fulfilling the Promise" and the Refuge System Administration Act. Public uses will not interfere with important nesting or wintering seasons of listed species. No public use activities will be permitted where public safety or trust resources are adversely affected.

Goals, Objectives, Strategies, and Monitoring Elements

Goal 1. Protect and enhance Service trust resources and other species and habitats of special concern.

Subgoal 1. Provide habitats to sustain 5 percent of each of Maryland's wintering waterfowl, as follows: Atlantic Population (AP) Canada goose, and dabbling duck population, as measured by the Midwinter Waterfowl Inventory.

Objective 1.1.1. On a broad scale, protect, restore, and enhance a mix of wetland habitat types throughout the island marshes by 2022.

Basis of the objective.—This objective supports the goals of the Atlantic Coast Joint Venture (ACJV), the North American Waterfowl Management Plan, 1989 Chesapeake Bay Program Waterfowl Populations Objective (as updated in 2000). The ACJV project has specifically identified Martin NWR. Under NAWMP, four priority waterfowl species associated with the island refuges benefit from the important estuarine emergent and submergent habitats: black duck, mallard, northern pintail, and blue-winged teal. Other than the midwinter waterfowl survey, standard protocols and surveys are lacking throughout the island refuges. Waterfowl law enforcement activities have been restricted to Martin NWR, and little is known about possible illegal hunting on the remaining satellites. Emergent wetland and SAV habitats are being impacted by erosion and poor water quality.

Strategies to achieve the objective.—We will initiate standard protocols and annual winter surveys throughout the island refuges by the year 2007; record habitat types for waterfowl concentration areas; incorporate them into a GIS data base; note signs of hunting and assess illegal hunting; and, determine and implement specific actions through an operational plan.

We will implement a summer water quality monitoring program following the protocols established by the "Chesapeake Bay Program Submerged Aquatic Vegetation Management Plan," and use the data collected to target SAV restoration sites and delineate areas where erosion- induced turbidity is limiting SAV resurgence. Mute swan feeding impacts to SAV beds can be assessed during water quality sampling, and specific actions determined. Mute swan control will follow the recommendations of the Mute Swan Task Force.

Management strategies in this plan include wetland creation or restoration, SAV restoration, erosion control, mute swan management, invasive plant species management (primarily *Phragmites australis*), and law enforcement. Significance of boat traffic, disturbance, and the need for a sea duck sanctuary will be assessed. Management activities for the island refuges will be more specifically addressed in the island refuges Habitat Management Plan.

Monitoring element.—Amount (number of acres) and quality (composition, structure) of available habitat and present wintering waterfowl populations. Annual water quality sampling related to suitability for SAV. Existing and planned management prescriptions will be monitored to determine vegetation and waterfowl response.

Subgoal 2. Restore, protect and enhance habitats for black duck production.

Objective 1.2.1. Create an American Black Duck Initiative for the island refuges that will include a determination of existing black duck production, the factors affecting production, and the preferred nesting and brood habitat types by 2012.

Basis of the objective.—This objective also supports the goals of the Atlantic Coast Joint Venture, the North American Waterfowl Management Plan and the 1989 Chesapeake Bay Waterfowl Management Plan (updated 2000). Although many of the islands are thought to be locally important as black duck production areas, little quantitative data is available. Predator effects at both tree hammock and emergent marsh sites requires evaluation. Predation may be causing black ducks to nest in less than optimal habitats (e.g., black needlerush) which are prone to flooding. Habitat use during brood rearing, fall migration, and winter is presently unknown.

Strategies to achieve the objective.—We will create an integrated approach to black duck research and management (Black Duck Initiative) for the island refuges. The initiative will focus research on questions regarding black duck production management. An initial strategy will be to determine black duck predator occurrence on the island refuges. Additional surveys will be conducted to determine present black duck nesting habitat use. An experimental predator removal program will be initiated to assess black duck productivity both before and after removal, and to document any changes in nesting habitat use.

Black duck habitat use during brood rearing, fall migration, and winter will be evaluated through a telemetry study. Nesting black duck females will be fitted with radio transmitters and tracked through the Summer, Fall, and Winter to determine habitat use and dispersal. In addition, experimentation with providing artificial nesting substrates in black needlerush and black duck nesting response will be undertaken.

Management strategies in this plan could involve habitat restoration or manipulation. We will evaluate converting former dredged material disposal sites dominated by Phragmites to more desirable vegetative communities to promote black duck nesting, as well as creating nesting hammocks in needlerush dominated wetlands as a management alternative. We will protect breeding habitat through erosion control.

Monitoring element.—Amount (acres) and quality (composition, structure) of preferred nesting habitat and present breeding black duck population. Management prescriptions (habitat manipulation, predator control) will be monitored to determine breeding black duck response.

Objective 1.2.2. Determine to what extent predators are limiting production of ground-nesting waterbirds by 2012.

Basis of the objective.—Preferred nesting habitat on the island refuges for ground-nesting waterbirds (e.g., black ducks, rails, and terns) occurs on the comparatively few upland hammocks scattered throughout predominately emergent wetland habitats (primarily on Martin NWR and Spring Island Satellite). Because hammocks can be easily targeted by mammalian predators such as red foxes and Norway rats, ground-nesting species may be driven into less desirable nesting habitats (e.g., black needlerush marsh). Birds forced into emergent marsh nesting then

become susceptible to egg predation by fish crows and gulls. At present little is known as to the extent of predation, significance relative to production, or which predator species are the main culprits.

Strategies to achieve the objective.—A study will be designed by 2012 to assess gull, crow, Norway rat, and red fox populations and associated predation problems. The study will use black duck and clapper rails as the study species and compare control areas vs. areas where potential predators are removed. Effects on nest site selection and nest success will be compared between control and predator removal treatment sites. The study will also employ telemetry to assess bird movements during brood rearing, fall migration, and winter. Funding for a biotechnician and graduate students is included in this plan.

Monitoring element.—Predator populations, and water bird nest site selection, production, and seasonal movements.

Subgoal 3. Restore, protect, and enhance habitats for designated species of Neotropical migrants identified for protection in the Partners In Flight Plan.

Objective 1.3.1. Determine suitable breeding habitat and population status for Henslow's sparrow, seaside sparrow, and sharptail sparrow by 2009.

Basis of the objective.—This objective generally contributes to the goals and objectives of the Region 5 priority list for the Partners In Flight Plan. Island and headland wetland habitats, particularly those occurring on Martin NWR and the Bishops Head Division, which includes Spring Island, have been identified as potential key areas for breeding Henslow's sparrow, seaside sparrow, and sharptail sparrow. Although suitable habitat occurs, present breeding use is unknown.

Strategies to achieve the objective.—The initial strategy will be to determine breeding bird distribution and habitat use on the three targeted refuge units. A baseline breeding bird survey, and subsequent annual survey will be established by the year 2009. Vegetation and hydrology data will be collected to determine preferred nesting habitat types. Data collected will be incorporated into a GIS breeding habitat mapping product. Based on data collected and a GIS assessment of existing conditions, objectives and more specific actions will be determined, and an operational plan prepared.

Management strategies in this plan could involve habitat restoration, habitat manipulation, and protecting existing habitat values. Significance of human disturbance and predation on bird production will be assessed. Protection of breeding habitat will be provided through erosion control and invasive species management (primarily *Phragmites australis*).

Monitoring element.—Amount (number of acres) and quality (composition, structure) of available habitat and present breeding bird populations. Existing and planned management prescriptions will be monitored to determine breeding bird response.

Objective 1.3.2. Provide suitable stop-over and resting habitat for Neotropical migrants and raptors on the forested islands by 2007.

Basis of the objective.—This objective also contributes to the goals and objectives of the Region 5 priority list for the Partners In Flight Plan. Martin NWR and the Watts Island and Barren Island Divisions have been identified as potential key migration and stop-over areas for migratory passerines, and raptors. In addition, large numbers of monarch butterflies are purported to use these offshore forested and shrub habitats. Although the islands are known to be used during migration, to what extent they are used is unknown.

Strategies to achieve the objective.—The initial strategy will be to determine Neotropical migrant distribution and habitat use on the three targeted refuge units. A baseline Spring and Fall Neotropical migrant survey and subsequent annual surveys will be established by the year 2009. Vegetation data will be collected to determine preferred habitat types and use by various species. Data collected will be incorporated into a GIS Neotropical migrant habitat mapping product. Based on data collected and a GIS assessment of existing conditions, objectives and more specific actions will be determined, and an operational plan prepared.

Management strategies in this plan could involve habitat restoration, habitat manipulation, and protecting existing habitat values. Significance of human disturbance will be assessed. Protection of Neotropical migrant habitat will be provided through erosion control and forest pest management.

Monitoring element.—Amount (acres) and quality (composition, structure) of available habitat and present Neotropical migrant populations. Existing and planned management prescriptions will be monitored.

Subgoal 4. Protect, enhance and create island habitats for colonial waterbirds.

Objective 1.4.1. Create 25 acres of colonial waterbird nesting habitat by 2012.

Basis of the objective.—With the exception of great blue heron and least tern, all heron and larid colonies occur on island sites. Most of the islands composing the island refuges have limited amounts of upland topography which can support vegetation suitable for shrub and tree nesting wading birds. Former dredged material disposal areas on Martin NWR exhibit elevations suitable for shrub and tree species growth, however Phragmites colonization precludes such species establishment. Many existing rookeries on Martin NWR occur on former dredged material disposal sites, which were naturally vegetated by desirable tree and shrub species before the expansion of Phragmites. More recent dredged material disposal sites have been colonized by monotypic stands of Phragmites, and do not represent nesting habitat.

Strategies to achieve the objective.—Through the use of aerial photography and interpretation, existing stands of Phragmites will be delineated and then ground-surveyed to determine suitability for tree and shrub establishment (e.g., elevations > highmarsh zone). We will use glyophosphate or another herbicide approved for estuarine applications to control Phragmites, with subsequent burning to remove dead, standing vegetation. After that, we will plant native shrub and tree species, such as hackberry, bayberry, and eastern red cedar.

Management will include preventive herbicide treatment and control around existing rookeries where Phragmites has invaded, but has not yet taken over the plant community. In addition, opportunities for creating additional tree and shrub hammocks through the beneficial use and placement of clean dredged material will be assessed. Wetland restoration and erosion control opportunities will prioritize sites where existing rookeries are in jeopardy from erosion.

Monitoring element.—Acreage and quality of shrub and hammock habitat suitable for colonial waterbird nesting.

Objective 1.4.2. Determine to what extent predators are limiting production of ground-nesting waterbirds by 2012.

Basis of the objective.—Preferred nesting habitat on the island refuges for ground-nesting waterbirds (e.g., black ducks, rails, and terns) occurs on the comparatively few upland hammocks scattered throughout predominately emergent wetland habitats (primarily on Martin NWR and Spring Island Satellite). Because hammocks can be easily targeted by mammalian predators, such as red foxes and Norway rats, ground-nesting species may be driven into less desirable nesting habitats (e.g., black needlerush marsh). Birds forced into emergent marsh nesting then become susceptible to egg predation by fish crows and gulls. At present, little is known about the extent of predation, its significance to production, or which species are the main predators.

Strategies to achieve the objective.—A study will be designed by 2012 to assess gull, crow, Norway rat, and red fox populations and associated predation problems. The study will use black duck and clapper rails as the study species and compare control areas to areas where potential predators have been removed. The effects on nest site selection and nest success will be compared between control and predator removal treatment sites. The study will also employ telemetry to assess bird movements during brood rearing, fall migration, and winter. This plan includes funding for a biotechnician and graduate students.

Monitoring element.—Predator populations, and water bird nest site selection, production, and seasonal movements.

Subgoal 5. Provide habitats to support a diversity of migrating and nesting shorebirds, gulls, terns and allied species.

Objective 1.5.1. Protect, enhance and create foraging and nesting habitat for a diversity of migrating shorebirds, gulls, terns and allied species by 2014.

Basis of the objective.—The island refuges' habitats primarily comprise emergent estuarine wetlands, SAV beds, and upland shrubs and forest. Shorebird use, either for nesting or foraging, is concentrated in the less prevalent intertidal flats, beach, and bay dune habitats that fringe the islands. Many of these shorebird areas are being impacted by erosion, and as much as 50 feet a year of beach habitat is being lost.

Maryland DNR has an existing shorebird banding and brown pelican color marking program which includes colonies on the island refuges. This program needs to be expanded, with the Service taking a more active role.

Strategies to achieve the objective.—The USACOE maintains boating channels close to the island refuges. Maintenance dredging for navigation purposes often generates sandy dredged material suitable for intertidal flat, dune, and beach creation. Given the lack of suitable upland disposal sites in this portion of Chesapeake Bay, there is an opportunity to provide placement sites for purposes of shorebird habitat restoration.

The management strategy in this plan will be to designate sites for beneficial uses of dredged material aimed at shorebird habitat creation or restoration. This can be done in conjunction with sites that are prioritized for erosion control. Habitat restoration will be funded through the USACOE, in consultation with the refuge. Habitats to be created will benefit other species such as nesting diamondback terrapins.

In addition to habitat restoration, this plan includes generating funding to hire a biologist to work with the Maryland DNR banding and color marking program. Additional responsibilities of this position will include monitoring of these and other restoration programs on the refuge.

Monitoring element.—Shorebird population dynamics and distribution, fish and wildlife use, vegetation response, dredged material movement and topography changes over time, and invasive plant management.

Subgoal 6. Provide habitats to support estuarine habitat associated raptors.

Objective 1.6.1. Evaluate the efficacy of the artificial nesting program for raptors by 2010.

Basis of the objective.—Martin NWR, Spring Island, and Watts Island have played a pivotal role in the recovery of the formerly listed peregrine falcon (endangered), delisted in 1999. Four artificial nesting structures have fledged 56 peregrine falcons since 1986. Scientists involved in peregrine recovery have questioned the continued construction of peregrine nesting structures anywhere on the Delmarva peninsula. Translocations now are restricted to the Maryland and Virginia Piedmont, which, unlike Delmarva, are considered the species' former range.

Osprey populations plummeted in the 1950s due to eggshell thinning associated with the uptake of the pesticide DDT. Following the ban on DDT, osprey populations throughout Chesapeake Bay dramatically rebounded. Although natural nesting sites are limited on some of the refuges and divisions of the Refuge Complex and on Spring Island, this is not the case for most of the refuge or the watershed.

The installation and maintenance of osprey nesting platforms at Martin NWR has created the region's largest concentration of nesting osprey. Since 1980, the osprey have produced 850 fledglings. Ospreys readily use other structures: for example, channel marks or towers. Barn owls are another species of concern in Maryland that readily uses artificial nesting structures.

Strategies to achieve the objective.—We will maintain the existing peregrine falcon and osprey nesting structures on Martin NWR, Spring Island, and Watts Island; evaluate the existing natural nesting habitat on the other islands and determine whether an expansion of the artificial nesting structure program is justified in view of expanding osprey

populations; evaluate whether to expand or simply maintain the peregrine falcon nesting structure program; and, evaluate the need for artificial structures for barn owls.

Monitoring element.—The population trends of ospreys, peregrine falcons, and owls within the range of the island refuges.

Subgoal 7. Accomplish applicable recovery objectives for Federal-listed species as outlined in recovery plans.

Objective 1.7.1. Conduct surveys and evaluate the feasibility of reestablishing a northeastern beach tiger beetle population by 2012.

Basis of the objective.—The northeastern beach tiger beetle (*Cicindela dorsalis dorsalis*) occurred historically in great swarms on beaches along the Atlantic Coast, from Cape Cod to central New Jersey, and along Chesapeake Bay beaches in Maryland and Virginia. Only two small populations remain on the Atlantic Coast. The subspecies occurs at more than 50 sites in the Chesapeake Bay region.

The tiger beetle is most vulnerable to disturbance in the larval stage, which lasts 2 years. Larvae live in vertical burrows, generally in the beach intertidal zone, where they are sensitive to destruction by high levels of pedestrian traffic, ORVs, and erosion control projects that allow the beach to become vegetated. Population recruitment seems to be hampered by a lack of both undisturbed beaches and of nearby populations as a colonizing source. Although suitable habitat appears to be available on Martin NWR and Watts Island, the occurrence of tiger beetles is unknown.

Strategies to achieve the objective.—The initial strategy will be to have all the islands with suitable habitat surveyed for tiger beetles; contracting university experts to conduct the survey will be necessary. If tiger beetles are found, we will implement management actions under the guidelines of the "Northeastern Beach Tiger Beetle Recovery Plan" (USFWS 1994), working with the Tiger Beetle Recovery Team. An opportunity may arise to create new tiger beetle habitat using sand generated by USACOE dredging projects in the vicinity of the islands. We will also assess the potential for translocating tiger beetles to natural and created beaches.

Monitoring element.—Monitor known populations and any additional populations that are discovered; evaluate human impacts.

Objective 1.7.2. Protect, manage, and conserve the existing bald eagle population by 2007.

Basis of the objective.—The bald eagle population in Chesapeake Bay has been Federal-listed as endangered since 1978. Eagle nesting occurs on Smith, Watts, and Barren Islands, and has been continuous on the islands in recent years. This success has been the result of protecting nests from human disturbance during the nesting season.

Strategies to achieve the objective.—We will continue to implement the guidelines in the "Bald Eagle Recovery Plan" (USFWS 1990). Regardless of the proposed delisting of the bald eagle, management at the island refuges will continue to focus on maintaining the existing eagle nesting sites and protecting them from disturbance.

Monitoring element.—The number of nesting bald eagles as determined by aerial surveys.

Subgoal 8. Restore, protect and enhance habitats for anadromous and interjurisdictional fish species.

Objective 1.8.1. Inventory anadromous and estuarine and inland interjurisdictional fisheries on the island refuges by 2012.

Basis of the objective.—The marshes of the islands are permeated with tidal creeks, which provide spawning, or feeding habitat for an abundance of finfish. The adjacent shallow and deeper waters support an extensive fishery stock, and commercial fishing industry. This productivity, in large part, is related to the extensive SAV beds associated with the island refuges. However, many colonial waterbirds nesting on the islands travel daily to the mainland for feeding. Why the birds elect to travel to the mainland, or whether forage fish stocks are less plentiful on and around the islands, is unknown.

Strategies to achieve the objective.—Our initial strategy will be to design jointly with our Fisheries Resources Office an inventory or study that will compare the waterbird forage base on mainland sites with island sites, in conformance with the Complex-wide Resource Inventory and Monitoring Plan. Using the study's findings, we will define more specific actions regarding fish habitat management on and around the island refuges; and, implement the recommendations of the "Submerged Aquatic Vegetation Policy for the Chesapeake Bay and Tidal Tributaries" (Chesapeake Bay Program). Goal 2, below, covers SAV policy recommendations in more detail.

Monitoring element.—Approval of inventory plan.

Subgoal 9. Restore, protect, and enhance habitats for blue crab.

Objective 1.9.1. Where applicable, implement recommendations of the 1997 Chesapeake Bay Blue Crab Fisheries Management Plan by 2007.

Basis of the objective.—Tangier Sound is one of the most important soft-crab- and peeler-crab-producing areas in the Chesapeake Bay. The brackish waters associated with the island refuges exhibit this high production because of the extensive SAV beds within the interior tidal guts and surrounding shallow waters. Blue crabs (*Callinectes sapidius*) use the SAV beds during postlarval settlement, juvenile development, overwintering, and for protection during molting and soft shell phases of all size classes. In Tangier Sound SAV beds are composed of eel grass (*Zostera marina*) and widgeon grass (*Ruppia maritima*), and fall within the salinity range of invading postlarvae. Juvenile crab density is approximately 30 crabs per square meter in SAV, as compared to only one crab per square meter in unvegetated habitat.

Strategies to achieve the objective.—The SAV Workgroup of the Chesapeake Bay Program Living Resources Subcommittee recommended strategies for SAV protection and restoration to benefit blue crab postlarval settlement. The recommendations apply to the segment of the Chesapeake Bay that includes Tangier Sound. The island refuges will implement recommendations of the Chesapeake Bay Program Submerged Aquatic Vegetation Policy for the Chesapeake Bay and Tidal Tributaries. Goal 2, below, covers specific recommendations included in this policy.

Monitoring element.—Water quality parameters that will result in the restoration of SAV.

Goal 2. Maintain a healthy and diverse ecosystem with a full range of natural processes, natural community types, and the full spectrum of native plants and animals to pass on to future generations of Americans.

Subgoal 1. Control, eradicate, or manage injurious, invasive, and exotic species.

Objective 2.1.1. Eradicate the mute swan population on the island refuges by 2007.

Basis of the objective.—Mute swans are exotic, non-migratory birds that escaped into the Chesapeake Bay in 1962, and have reached an estimated population of 4,000. They are protected under Federal and State laws. On the island refuges, they are injurious to SAV and, because of their aggressive territorial behavior, displace nesting native colonial waterbirds. In 1993, mute swans destroyed the only black skimmer colony in the Chesapeake Bay and the State-listed least tern colony on Barren Island.

Strategies to achieve the objective.—The refuge will continue to participate on the Maryland Governor's Task Force on Mute Swan Management, and will support the mute swan management actions endorsed by the Atlantic Flyway Council, including:

1. State and provincial wildlife agencies, if they do not already have authority, should seek to gain authority over the sale and possession of mute swans and their eggs.

2. The sale of mute swan adults, young, or their eggs should be prohibited.

3. States should seek to eliminate all importing or exporting of mute swans without a special purpose permit issued by the state wildlife agency.

4. Mute swans captured due to nuisance complaints, sickness, or injury should be removed from the wild or be euthanized.

5. Egg addling programs, where feasible, should be encouraged.

6. Both state and Federal wildlife agencies should institute programs to prevent the establishment of or eliminate mute swans.

7. States and provinces should seek to make the mute swan an unprotected species if this is not already the case.

8. States should strive to manage mute swan populations at levels that will have minimal impacts on native wildlife species or habitats.

The island refuges have zero tolerance for mute swans, and will take appropriate actions to keep swans from becoming established on refuge lands. However, refuge staff do not control swans on State-owned waters.

Monitoring element.—Aerial surveys to determine overall and nesting distribution.

Objective 2.1.2. Reduce Phragmites below year 2000 levels by 2012.

Basis of the objective.—Phragmites (*Phragmites australis*) is a large, coarse perennial grass 1.5–4 m in height. While primarily found in brackish and freshwater wetlands where it grows at and above mean high water, the plant is also common in moist uplands and the dune systems of Atlantic coast barrier islands. Phragmites seeds profusely and spreads vegetatively by a vigorous system of rhizomes and stolons. Once established, the plant forms dense stands and may invade adjacent areas, crowding out more desirable wetland species and reducing the overall species diversity of the affected system. Some question whether phragmites is native, or whether a native and a more invasive exotic genotype exists. Phragmites often establishes itself in areas modified by human activity. A particular problem is its colonizing dredged spoil disposal areas.

Strategies to achieve the objective.—The primary strategy will follow management prescriptions recommended for creating colonial waterbird nesting habitat (goal 1, subgoal 4, objective 1). Where funding allows, we will also delineate, target, and control other areas where Phragmites occurs.
Monitoring element.—Phragmites distribution and trends

Subgoal 2. Protect, enhance, and restore natural diversity of communities and associated ecosystem processes on the island refuges.

Objective 2.2.1. By 2012, develop specific inventory, assessment, and management programs for species and community types identified as rare, sensitive, declining, or of special concern.

Basis of the objective.—The island refuges have a clear mandate to protect, manage, and restore habitats that support Federal- and State-listed rare or threatened species, and species of special concern. At present, we know very little about the occurrence of such species on the island refuges.

Strategies to achieve the objective.—Our most important need is to develop and implement the Complex-wide Resource Inventory and Monitoring Program. We will contract with experts at the Heritage Program, USGS–BRD, or universities for surveys for listed species and species which are uniquely difficult to detect. We will implement appropriate tasks identified in existing recovery plans for Federal- and State-listed species. With the development of the Forest Management Plan and the Marshland Management Plan, opportunities will exist to evaluate the effects of management practices (e.g., TSI, prescribed fire) on species of concern.

Monitoring element.—Species diversity indices; species richness

Objective 2.2.2. Control erosion, and create and restore habitat, through the beneficial use of clean dredged material by 2007.

Basis of the objective.—The islands of the Chesapeake Bay constitute a unique ecosystem component that is rapidly being lost to erosion. New islands are not being formed due to the armoring of mainland shorelines, and the sediment loads generated are negatively affecting SAV. Shallow waters that formerly were island marsh and forest are characterized by a hard, laminar, mud clay bottom. Such bottom types do not support SAV, and support a comparatively depauparate benthic community. Targeting former fastland areas converted to shallow water minimizes resource tradeoffs associated with filling for wetland, beach, and upland restoration. Restored habitats can be constructed in such a fashion that benefits erosion control, while reducing sediment loads and turbidity.

Strategies to achieve the objective.—Using GIS, we will delineate and prioritize the most severely eroding shorelines. Then, we will assess boating channels near the island refuges for the feasibility or desirability of dredging and using the clean dredged material in other erosion control projects. Factors will include baseline conditions, habitat tradeoffs, grain size analysis, contaminants assessment, and distance from priority erosion control sites. In this plan, we will keep the Susquehanna NWR within the Refuge System, and target it for habitat restoration using clean dredged material.

Throughout project planning, we will coordinate closely with the Baltimore and Norfolk Districts, USACOE, to ensure this approach to the beneficial use of dredged material meets the dual objectives of habitat restoration and navigability. We will specifically refer to the USACOE's May 2005 Baltimore Harbor and Channels, Dredged Material Management Plan and Draft Tiered Environmental Impact Statement, which documents the regional benefits of using dredged material from the mainstem channels for marsh restoration in Dorchester County (USACOE 2005). Habitat restoration project types (e.g., wetland, upland, or beach) will be determined by existing site conditions, fetch, habitat tradeoffs, and resource priority. For example, if restoring the northeastern beach tiger beetle were the priority, erosion control will be minimal, in order to maintain or create an unvegetated beach to benefit the beetle. Where erosion control is the highest priority, we will focus on wetland restoration, in conjunction with offshore, segmented stone breakwaters.

In addition to restoring habitat, this plan includes generating funding to hire a biologist, who will work in close coordination with the Corps, and to hire a biotechnician for monitoring plant, animal, and water quality responses. SAV restoration targeting will be a closely related priority.

Monitoring element.—Habitat response, topography (vertical and horizontal), fish and wildlife use, water quality improvements, SAV distributional changes, and acres restored.

Subgoal 3. Protect, restore, and enhance SAV habitats.

Objective 2.3.1. Restore SAV coverage to 1970s levels by 2022.

Basis of the objective.—Waters within and surrounding the island refuges support 16 percent of all SAV within the tidal portion of the Chesapeake. Although 13 principal species are distributed around the Bay, two are prevalent in the "Crabbing Capitol of the World": eel grass (*Zostera marine*) and widgeon grass (*Ruppia maritima*). Widgeon grass grows in the shallowest water zone (< 3' MLW) and eel grass grows in the deeper shallow zone (3–6" MLW). Both species' water depth tolerances have been reduced by declines in water quality and subsequent reduction in the photic zone.

The Chesapeake Bay Program has targeted SAV as one of its highest priority living resources, because of the many ecological functions it serves: It provides shelter and nursery area for fish, crabs, invertebrates, and epiphytes; it has long been recognized as an essential food for certain waterfowl species; it removes nutrients and heavy metals from the water and sediment, removes suspended sediment and binds substrates; and, in dense beds, it dissipates wave energy and protects shorelines from erosion. SAV is also a barometer on the health of the Chesapeake Bay because its environmental requirements include good water quality that is low in suspended sediments, dissolved nutrients, and phytoplankton. For these reasons, the recent decline in SAV throughout the island refuges is alarming.

Strategies to achieve the objective.—We will implement the recommendations of the Chesapeake Bay Program Submerged Aquatic Vegetation Policy for the Chesapeake Bay and Tidal Tributaries (1989). These include

- Protecting existing SAV beds from further losses due to increased degradation of water quality, physical damage to the plants, or negative disruption to the local sedimentary environment
- Setting and achieving regional water and habitat quality objectives that will result in the restoration of SAV through natural revegetation;
- Setting regional SAV restoration goals in terms of acreage, abundance, and species diversity considering historical distribution records and estimates of potential habitat.

Island refuges strategies can support these recommendations through erosion control and habitat restoration aimed at biodiversity (see goal 2, subgoal 2, objective 2, "Erosion Control and Beneficial Use of Dredged Material"). These strategies will decrease sediment loadings associated with island erosion. Maintaining adequate depths in boating channels decreases the likelihood of resuspension of channel bottom material by boat wakes and propellor wash. We will provide the USACOE with placement locations (presently in short supply) so channels can be dredged on schedule.

In other areas around the island refuges, fetch and wave energy may be the limiting factor for SAV recolonization. Again, working with the COE in looking at historical land mass and SAV records, we will delineate formerly quiescent shallow waters now exposed to higher wave energies. Those sites will not have a wetland, upland, or beach habitat restoration component, and could be prioritized for offshore breakwater construction by the COE. Breakwaters will be constructed to recreate quiescent shallow waters where they historically occurred. We will monitor wave energies, sediment changes, and SAV response before and after construction.

This plan also includes a water quality and SAV monitoring initiative to characterize baseline conditions and future SAV response to all management actions, and includes funding to hire a biotechnician for data collection and analysis. Water quality and SAV monitoring will follow the protocols of the Chesapeake Bay Program SAV Workgroup.

Monitoring element.—Water quality, sediment types, wave energy, bathymetry, and SAV distribution.

Goal 3. Create the most complete network of protected lands within the Chesapeake Bay watershed.

Objective 3.1. Implement strategies for the protection of the island refuges by 2022.

Basis of the objective.—Federal management of additional land on the islands will contribute to the resource conservation goals of a variety of international, national, and regional initiatives, including RAMSAR, IBA, NAWMP, and the "National Wetlands Priority Conservation Plan." Management also supports objectives of the Chesapeake Bay Program Living Resources Subcommittee under specific workgroup recommendations for SAV, wetlands, waterfowl, and blue crab. Protecting land on the islands will also benefit private landowners on the mainland by preserving the barrier function of offshore islands.

Strategies to achieve the objective.—We will seek all opportunities to conserve, manage, and protect lands through a combination of easements, forging partnerships with landowners, and developing agreements with other entities having title and other land rights or interests in targeted areas of the watershed by 2022.

- Amend the 2005 appropriations bill for the Department of Defense to include wording that transfers Bloodsworth Island to the Service, should the Navy declare it excess real property.
- Secure management authority of South Marsh Island through a Cooperative Agreement or Memorandum of Understanding with the MD Department of Natural Resources, if amenable.
- Assist partners, including the states and the Chesapeake Bay Foundation, Inc., in developing an island protection plan as part of an ecosystem component.

- Acquire inholdings as they become available from willing sellers.

Monitoring element.—The implementation of the Resource Inventory and Monitoring Plan; and, the acquisition and maintenance of remote sensing or GIS layers.

Goal 4. Develop and implement quality scientific research, environmental education, and wildlife-dependent recreation programs that raise public awareness and are compatible with refuge purposes.

Subgoal 1. Encourage and provide opportunities for research by other agencies, universities, and other institutions, especially as they relate to the mission, management, and objectives of the island refuges.

Objective 4.1.1. Foster relationships with governmental entities, conservation groups, universities, and institutions and communicate the most critical research and management needs of the island refuges by 2009.

Basis of the objective.—Service policy encourages and supports research and management studies that provide data for making decisions on managing the island refuges. Research and monitoring are crucial to sound resource decisions and adaptive management.

Strategies to achieve the objective.—We will actively seek partnership opportunities, and will consider proposals for research in a variety of disciplines, including flora and fauna, public use, and cultural resources. All reports, surveys, and scientific papers generated will be made available to refuge staff and cataloged for future needs. The refuge will communicate and prioritize information gaps we seek to fill. Priority will be given to studies that contribute to the enhancement protection, use, preservation, and management of native fish and wildlife populations and their habitats and natural diversity. In addition to fish- and wildlife-oriented research, we will permit the use of island refuges lands for other investigatory scientific purposes when such use is compatible with the purposes, goals, and objectives of the refuges.

Monitoring element.—The number of partnership initiatives; the number of research projects; and the number of participants in each.

Objective 4.1.2. Provide adequate facilities and equipment and assess the need for building new facilities for use by researchers and refuge staff.

Basis of the objective.—The Middleton House on Martin NWR is the only facility now available to house researchers or as a base of operation for refuge staff. The existing structure is cramped, outdated, poorly insulated, and in need of new plumbing. The house also serves as a small visitor center. Better facilities and equipment will improve research, housing, and headquarters for the island refuges. Given the isolated location of Martin NWR, a self-sufficient research facility and base of operations is required for Service research and management activities.

Strategies to achieve the objective.—Renovate and enlarge the Middleton House and purchase new equipment to accommodate researchers, students, and refuge staff.

Monitoring element.—Adequacy of facilities and equipment.

Subgoal 2. Provide opportunities for environmental education and interpretation to meet the needs of refuge users.

Objective 4.2.1. By 2012, develop adequate facilities and equipment for environmental study and interpretation for the island refuges.

Basis of the objective.—The Middleton House, the current facility on Martin NWR, is woefully inadequate. No staff are available for environmental interpretation, and the few existing displays fail to capitalize on the human inhabitants' unique island culture, fishing and crabbing industry, or the islands' crucial role in Chesapeake Bay

ecology. An opportunity exists for the refuge to become a major destination for tourists visiting Smith Island. With an adequate facility, the refuge potentially could attract 60,000 refuge visitors per year. Siting a facility in the town of Ewell will ensure compatible use, and provide habitat restoration education possibilities.

Strategies to achieve the objective.—We will upgrade the visitor contact station at the Middleton House on Smith Island to provide new displays and material on the island refuges; provide office space with telephone, fax machine, computer, and copy machine; provide suitable furniture for second-floor lodging of interns and researchers; and upgrade plumbing and electrical systems. We will also increase environmental education and interpretation activities.

In the town of Ewell, we will purchase suitable land near the Middleton House to build and manage an environmental education center that highlights island refuges ecology in partnership with the Chesapeake Bay Foundation, Inc. We will also build a kiosk at the Ewell ferry dock to provide directions and interpretive information, and develop exhibits and habitat restoration projects for the Middleton House and environmental education center.

Monitoring element.—The number, type, and location of facilities and programs; the response by refuge visitors (the number and types of visitors or groups).

Objective 4.2.2. By 2007, provide interpretation programs to enhance visitors' knowledge of the island refuges and refuge management, while providing an enjoyable refuge experience.

Basis of the objective.—Refuges provide opportunities for people to acquaint themselves with the Service and its range of activities at first hand. More importantly, through interpretation programs, facilities, and guided public use strategies, the Refuge System helps people understand their place in the environment. No staffing or programs currently exist for the island refuges to provide interpretation programs. Although staff from the Refuge Complex or Blackwater NWR could implement some of these programs, we need to create specific programs targeting the island refuges if the refuges are to achieve their education and recreation goals.

Strategies to achieve the objective.—We will develop a professional video on the island refuges and purchase other videos that apply to the refuges for use in the visitor center; develop a general leaflet and other self-guided leaflets and brochures; install signs where needed; develop additional new outdoor displays; develop at least one special event for the islands, and participate in Crisfield events; create a website and interactive computer information station..

We will hire an Outdoor Recreation Planner to provide the increased public use program activities, supervise interns, and conduct public education, interpretation, and outreach programs for the island refuges. We will develop a volunteer program for monitoring, education and interpretation programs, outreach, and maintenance at the island refuges; develop a friends group to create a small cooperative sales outlet for Federal passes, educational books and other items; seek funding, develop programs; and produce projects.

We will expand our outreach programs to reach an additional 15,000 visitors by incorporating summer programs that coincide with tour boats visiting the island refuges; develop an MOU with the Chesapeake Bay Foundation, Inc., to work together on environmental education and interpretation programs and events; develop an interpretive sea kayak trail among the islands, if compatible with refuge purposes. Upon completing a compatibility determination, we will develop an interpretive canoe or kayak trail on Martin NWR; and, provide guided interpretive estuarine tours for education groups during the spring and fall.

Monitoring element.—The number, type, and location of facilities or activities, and response by refuge visitors (the number and type of visitors or groups using each facility, location, or activity).

Subgoal 3. Provide opportunities for compatible wildlife-dependent recreation.

Basis of the subgoal.—The NWRSIA identifies six priority wildlife-dependent recreational uses the Service must facilitate in the Refuge System: hunting, fishing, wildlife observation and photography, and environmental education and interpretation. By providing the public with opportunities for those uses, we will increase public

awareness, understanding, and appreciation of ecosystem functions and the benefits of ecosystem conservation to fish, wildlife, and people. Ultimately, these will contribute to the mission of the Refuge System.

Objective 4.3.1. By 2009 provide opportunities for wildlife observation and photography

Basis of the objective.—During our scoping meetings, the public indicated its interest in having opportunities and facilities for wildlife observation and photography. Achieving this objective will provide the public an opportunity to view the relationships among resource management, living resources, and people.

Strategies to achieve the objective.—We will construct a wildlife observation trail or boardwalk on Martin NWR associated with the new environmental education center. The resources profiled will include waterfowl, water birds, and saltmarsh ecology. We will also build an observation tower and observation and photography blinds in suitable locations, and install a spotting scope. In cooperation with partners, we will conduct a needs assessment to determine the scope, extent, and compatibility of additional facilities and programs.

Monitoring element.—The number, type, location, and response of refuge visitors user hours.

Objective 4.3.2. Provide safe and adequate fishing facilities and opportunities.

Basis of the objective.—The island refuges do not have jurisdiction over the shallow water interior to the islands, or shallow and deep waters surrounding the islands. The Service is not authorized to regulate fishing or other waterborne activities within the navigable waters of the State, or within areas where water bottoms are State-owned. Public access to fishing is by boat only, and people can fish anywhere, provided they have a boat. Given the vastness and complexity of the wetlands and waterways around Martin NWR, we consider boat rentals a safety concern for the inexperienced boating public. Therefore, we propose no additional measures.

Objective 4.3.3. By 2008, provide opportunities for a high quality hunting program.

Basis of the objective.—Recognizing hunting as a traditional family-oriented form of recreation important in developing an appreciation of fish and wildlife, the public requested expanded hunting opportunities during our scoping meetings. Hunting currently is not allowed on any of the refuge islands, nor are we proposing to open any existing Service-owned island lands to hunting. However, should the Maryland DNR enter into an MOU with the Service for its management on South Marsh Island, existing state hunting opportunities and access will be maintained. The MOU will not require a compatibility determination for an existing state use.

Monitoring element.—The number and type of hunting experiences, and response of refuge visitors (number and type of visitors or groups participating in each hunt).

Subgoal 4. Protect human health and safety.

Objective 4.4.1. Ensure that human health and safety are primary considerations in implementing refuge management activities.

Strategies to achieve the objective - Allowed public uses and many refuge management activities have undergone a compatibility determination that considers human health and safety prior to implementation.
One refuge management activity affecting public health and safety that relates to both our wildlife habitat and public use programs is mosquito control. In rare circumstances mosquitoes can serve as disease vectors presenting a threat to human health. West Nile virus and encephalitis are two examples of mosquito borne diseases that are a public health concern. It is the policy of the National Wildlife Refuge System that we will allow native mosquito populations to function unimpeded and we may allow mosquito populations to be controlled only in the following circumstances:

1. There is a need to manage a public or wildlife health threat from a specific mosquito-borne disease that mosquito and disease monitoring data, collected by either the Service or state/local public health or mosquito control agencies, have documented as enumerated in Service policy.

2. There are tires, tanks, or other similar debris/containers that may serve as artificial breeding sites for native or non-native species of mosquitoes. We may remove these or treat them with pesticides.

3. We are enhancing, restoring, or managing habitat for other wildlife species to achieve refuge purposes. This may be in the form of habitat restoration or water level manipulations where there is a definable benefit to other wildlife over not undertaking such actions. We prohibit habitat modifications or management actions designed specifically for mosquito control that impact other wildlife species or habitats and are detrimental to refuge purposes or System goals. These modifications or actions include, but not limited to, inappropriate draining, maintaining high water levels that are inappropriate for wildlife, and the importing or enhancing of non-native predators.

4. There is a need to manage a threat to public health and safety from extreme numbers of biting mosquitoes when advised to do so by the Centers for Disease Control and Prevention (CDC) and/or the Federal Emergency Management Agency (FEMA). Such mosquito control may be necessary following natural or human-caused disasters when biting mosquitoes may hamper recovery efforts.

In cases of officially determined health emergencies, any method we use to manage mosquito populations within the refuge will conform to applicable Federal laws such as the Endangered Species Act. Habitat management and pesticide uses for mosquito control will give full consideration to the integrity of non-target populations and communities. They will also be consistent with integrated pest management strategies and with existing pest management policies of the Department of the Interior and the Service.

Goal 5. Ensure that the staffing, facilities, resource protection, and infrastructure necessary for plan implementation are developed.

Objective 5.5.1. By 2007, obtain base funding necessary to fund and maintain minimum staffing, facilities, and operational support of the island refuges.

Basis of the objective.—Only two full-time equivalencies (FTEs) are now funded for the island refuges. The Refuge Complex staffing chart (see appendix D) identifies the minimum staffing level for these refuges. Staff are needed for basic resource inventorying and monitoring, and to ensure the use of the best science for management decisions. Additional biological and maintenance staff are needed to maintain intact and diverse ecosystems, recover endangered species, and to combat the effects of sea-level rise, land subsidence, and invasive species. Law enforcement officers are necessary to ensure the safety of visitors and resource protection. Critical needs exist in the public use programs to respond to expected high levels of visitation and the demand for opportunities for visitors to experience and appreciate wildlife. Existing equipment inventories are not sufficient to provide effective support to existing or additional staff.

This plan will require staff to effectively perform all identified public use, management, inventory, enforcement, and maintenance programs. The existing staff, equipment, and infrastructure for the Refuge Complex cannot manage the additional workload.

Strategies to achieve the objective.—We will obtain congressional, national, and regional support for base funding for approved RONS projects; obtain local community support for implementing programs, including expanding use of volunteers, partners, and interns to accomplish programs and projects; and, seek opportunities for collaborative funding projects.

Monitoring element.—The number of permanent full-time staff.

Management Summaries

A. Biological Diversity, Biological Integrity, and Environmental Health Management

Background

Biological diversity, or "biodiversity," a term much used in conservation science and academic circles, results from the ways in which biological entities, e.g., animals, plants, or humans, interact with their physical environment.[8] We can refer to that interaction as an ecological system, or "ecosystem," which we can define on many different scales: the Chesapeake Bay watershed, the Nanticoke River, or even a vacant lot or small patch of habitat within a residential development. The important point here is that biodiversity is a collection of life occupying a slice of space and time that is dynamic, that intermingles among its members, that is subject to external forces, that may or may not be in balance, that is sometimes affected by natural disturbances, and that reacts to or incorporates humans and their direct or indirect effects.

Another essential point is that Service management programs occur in a fragmented and highly manipulated environment. Human society has removed natural areas or has altered them substantially on the landscape. Small patches of wildlife habitat often occur in areas dominated by agricultural fields, dammed rivers, highways, and residential and commercial developments. Practicing effective conservation in altered landscapes, as on the Eastern Shore, embodies two major precepts.

1. It necessitates shifting management from a strictly hands-off approach to one that considers the need for various interventions, and suggests the need for careful assessment of the dynamic outcomes of that intervention. Interventions will be designed to enhance, or in some cases, restore, the integrity and health of animal and plant populations or natural processes that are absent or have become disrupted due to the effects of habitat loss or fragmentation, pollution, or competition from invasive, injurious and overabundant species.

2. It necessitates recognizing that not all species or processes require human intervention or special management emphasis. Many species of plants and animals and many physical processes sustain themselves regardless of human influences. Many plants and animals actually take advantage of those influences. We call them "weeds," or "exotic, invasive, or overabundant species." Other native species, however, are experiencing declines due to their extremely specific life history requirements for breeding, feeding, and sheltering habitats, or the disruption of the ecosystem processes that sustain them.

Through public participation, consultations with experts, literature review, and other internal and external deliberations, we have identified assemblages of species, plant communities, and processes that we believe have the most immediate management needs. The decision whether to take management actions must also evaluate their expected effects on the identified goals, objectives, and strategies necessary to fulfill the primary purpose(s) for which each refuge within the Refuge Complex was established. We believe that our management programs will achieve biological integrity and diversity and environmental health, will maintain refuge purposes, and will support the relevant policies in the Fish and Wildlife Service Manual [601 FW 3].

Programs to benefit biological integrity, biological diversity, and environmental health are ongoing. The refuge's current management produces collateral benefits to other species and to ecosystem processes. For example, managing invasive, injurious, or overabundant species will also address a significant indirect cause of many rare, declining, or otherwise sensitive species' habitat loss. Similarly, intensively managing wetlands and water management systems will result in some hydrological restoration, and will also support the life history requirements of many wildlife species, some of them sensitive, rare, or declining, which are not identified as Service trust resources.

[8] Biodiversity Communications Handbook 2000

First, we used the classification systems employed by The Nature Conservancy to establish the relative imperilment or vulnerability of species or communities that the public had identified during our scoping and partnership meetings. Our threshold was a global rank of G3 or higher, that is, G1, G2, or G3.[9] Then, we identified marshes and forests requiring more specific attention in the form of step-down plans, and assigned those habitats the highest priorities for allocating Refuge Complex administrative, technical, and financial resources.

Our management plan will develop a baseline inventory program for the entire Refuge Complex and, subsequently, develop programs to conserve, protect, or enhance rare, sensitive, or declining species or communities or those of special concern. We will assess their integrity and health, and identify their special needs for immediate management actions. Once we have collected that information, we will incorporate those special needs into our management and operational infrastructure, developing partnerships with outside groups for issues that extend beyond Refuge Complex boundaries. This plan assumes the funding and staffing capacity to carry out these management programs and activities. Without sufficient personnel and resources, meeting the objectives for each refuge of the Refuge Complex will be problematic.

B. Marsh Management

Background

The Refuge Complex encompasses more than a third of the Chesapeake Bay tidal marshlands in Maryland. Their significance to the ecosystem cannot be overstated. Almost 50,000 acres of brackish high marsh support 6 percent of Maryland's wintering waterfowl population, the largest breeding population of American black ducks south of Maine, the largest nesting population of bald eagles on the Atlantic Coast north of Florida, the second most significant nursery for blue crab larvae in the Chesapeake Bay, both nursery and spawning habitat for eight species of anadromous and nine species of migratory intercoastal and estuarine inland interjurisdictional fish, 16 percent of the SAV beds remaining in the Bay, and the northernmost expanse of Olney three-square (*Schoenoplectus americanus*). Brackish marshes on and around Blackwater NWR have been the source for several rare populations in Maryland, including the black rail (*Laterallus jamaicensis*), coastal plain swamp sparrow *(Melospiza georgiana nigrescens*), and the rare skipper (*Problema bulenta*). All of these superlatives contributed to the designation of the marshlands within the Refuge Complex as a Wetland of International Importance by the Ramsar Convention in 1987, one of only 18 such sites in the United States (see chapters 1 and 3).

However, since its establishment in 1933, Blackwater NWR has lost nearly 7,000 acres of wetlands, primarily in the mesohaline Olney three-square marsh at the confluence of the Little Blackwater and Blackwater rivers, but also progressively downstream. Several scientific studies since the 1970s have focused on this unusually high rate of wetland loss, which may result from several compounding factors including sea-level rise, land subsidence, saltwater intrusion, severely modified hydrology, and excessive herbivory. Similarly, the Nanticoke estuary has lost 122 acres of marsh annually over the same time interval; unlike the Blackwater system, much of this loss has occurred in submerged upland marshes, with rates increasing down the estuary (Kearney, et al. 1988).

Marsh loss of this magnitude is clearly a concern for the Refuge Complex, not only because of the substantial loss of wetland acres, but also because its mandate to provide habitats for waterfowl and threatened or endangered species is compromised. As one of the largest Federally owned systems of lands and waters in the Chesapeake Bay ecosystem, the Refuge Complex has the potential to play a pivotal role in fulfilling goals of the Chesapeake Bay Watershed Partnership, the Atlantic Coast Joint Venture, and Partners In Flight. Although the issue is very real, its solutions are not as apparent, because we lack an understanding of how its factors, many of them external to the refuge, interact. Finding a long-term set of solutions to this problem also demands a response to the overriding concern of how saline Blackwater's estuarine system should be allowed to become over time. The Blackwater River apparently changed from nontidal freshwater to tidal freshwater about 4,000 years ago (Rizzo 1995), and has continued to progress toward a more mesohaline condition.

[9] For complete information, see chapter 3, "Affected Environment."

A comprehensive marsh management plan will involve more active nutria control, prescribed burns, erosion control, the use of dredged material to raise marsh elevation, shoreline protection, and the restoration of key hydrological processes.
Because seawater is predicted to inundate most of the existing refuge lands by the next century, we considered working with, rather than against, these geomorphological processes. That approach will call for protecting the shoreline of uplands, improving the drainage of marshlands to flush flocculent material, and enhancing deep water habitats by stabilizing bottoms and promoting the establishment of SAV beds. We dismissed that approach, because we consider marsh restoration crucial in meeting the mandates of the Refuge System.

Stevenson, et al. (2000) suggest the use of Phragmites to control erosion and entrap sediment. However, until there is convincing evidence that Phragmites is native, Executive Order No. 13112 (February 1999) mandates that Blackwater NWR prevent or control introductions of invasive species in a cost-effective and environmentally sound manner.

Management Strategies

The purpose of the proposed Habitat Management Plan is to develop a comprehensive and cohesive approach to managing the tidal marsh system. Restoration strategies will include restoring the historic marsh plug between the Blackwater River and Stewart's Canal to reduce saltwater intrusion, modifying Shorter's Wharf Road to allow tidal input (sheet flow), riprapping the pine islands, reducing sediment load run-off into the upper watersheds, and thin-layer deposition of dredged material.

Strategies for maintaining and improving floral composition will include prescribed burning to promote regrowth vigor and maintain Olney's three-square bulrush (see approved Fire Management Plan), implementing recommendations from the Nutria Damage Management Program Pilot Study to reduce nutria herbivory, implementing the approved Integrated Wildlife Damage Management Plan for resident Canada geese, maintaining the muskrat trapping and nutria rebate program, applying pesticides and prescribed burning to control invasive flora (in particular, purple loosestrife and Phragmites), and replanting in conjunction with techniques such as thin-layer deposition of dredged material. Continuing our strategic protection of additional marsh is a component of the Habitat Management Plan, which will also include a significant monitoring component, due to the dynamic history of the marsh and the planned restoration strategies.

C. Forest Management

Background

Since the development of the Forest Management Plan (1984), which was highly species-specific and focused on improving habitats for Delmarva fox squirrels and bald eagles, the refuge land base has expanded by more than 10,000 acres, much of it forested. The complexity of management programs has increased, the need for forested habitat management has increased, and public scrutiny of management programs has increased. The old plan no longer accurately represents our current situation, does not provide sufficient information for accomplishing refuge objectives, and does not conform to new Departmental or Service policies and directives.

Blackwater NWR is now more than 36 percent forest, home to several Federal-listed endangered plant and animal species, such as the Delmarva fox squirrel *(Sciurus niger cinereus*), southeastern bald eagle (*Haliaeetus leucocephalus*), swamp pink *(Helonias bullata*), sensitive joint-vetch (*Aeschynomene virginica)* and many other Service trust species. Other equally ranked species groups of concern are Neotropical migratory songbirds: specifically, forest interior dwelling species (FIDs). FIDs generally require large expanses of interior forest for breeding. The refuge encompasses some of the last contiguous, large tracts of forest in Dorchester County. The upland and wetland forested areas that surround the refuge are being cleared and converted to residential areas, agriculture, or pine monocultures, and must be protected, maintained, and actively managed to promote healthy populations of wildlife and plants. A critical need exists for forest management objectives and strategies to focus primarily on the improvement of forest health and the enhancement of forested habitats for the above-mentioned trust resources.

FIDS require large forest areas to breed successfully and maintain viable populations. This diverse group includes colorful Neotropical migrant songbirds, such as tanagers, warblers, and vireos, which breed in North America and winter in the Caribbean and Central and South America, as well as residents and short-distance migrants, such as woodpeckers, hawks, and owls. FIDS are an integral part of Maryland's landscape and natural heritage. They have depended on large forested tracts in the Chesapeake Bay watershed for thousands of years (A guide to the conservation of forest interior dwelling birds in the Chesapeake Bay Critical Area, June 2000).

FIDS also serve as "umbrella species" for a wide range of forest wildlife. They are an important component of a natural forest system. Their habitat needs overlap those of many other plant and animal species, including large mammals, many wildflowers, wood frogs, and wild turkeys. When sufficient habitat is protected to sustain a diversity of forest birds, other important forest components and micro-habitats will be protected. These may include the small, forested streams and headwaters critical for populations of fish and the vernal pools necessary for the survival of amphibians. Forest birds are also an important link in a complex food web. They spread seeds in their droppings, help control insect numbers, and are prey for species higher on the food chain. Warblers and other insectivores eat untold numbers of insects, such as spruce budworms and caterpillars, and help keep those defoliators in check (Yahner 1995).

Although most are still fairly common, populations of some forest bird species have been declining during the last 30 to 40 years. According to the Breeding Bird Survey (BBS), there was a 63-percent decline in the occurrence of individual birds of Neotropical migrant species (many of which are FIDS) in Maryland between 1980–1989. While many factors have contributed to the decline of FIDS populations, including the loss of habitat on wintering grounds and the loss of migratory stopover areas for Neotropical migrants, the loss and fragmentation of forests on the breeding grounds here in North America appear to play a critical role. FIDS are generally more successful at survival and reproduction in large older hardwood-dominated forests. However, the conversion of hardwood and mixed-hardwood forests to pine and the reduction of "old growth" forest to small isolated patches has reduced quality habitat. Prior to European settlement, old-growth forest covered an estimated 95 percent of the Chesapeake watershed (Kraft and Brush 1981). Forest coverage in Maryland today is about 44 percent (USDA Forest Service 1996). About 40 percent of the deciduous forest in the East today consists of small, isolated woodlots of relatively immature trees in agricultural and suburban landscapes. When European settlers arrived in eastern North America in the 1600s, the average height of a hardwood tree was 100 feet or more. The average height of trees in the Chesapeake Bay region today is only 60–80 feet (USDA Forest Service 1996).

The fragmented younger forest found in the Chesapeake Bay region has several negative effects on FIDS. Smaller tracts may no longer accommodate territorial requirements, provide ample food, or provide the forest structure necessary for breeding. Many tracts are too small to support species with large breeding territories, such as the red-shouldered hawk, barred owl, and pileated woodpecker. For example, a breeding pair of red-shouldered hawks require from 250 to 625 acres to sustain them. In addition to those requirements, many FIDS have additional habitat requirements. Most FIDS, even those that have small territorial requirements, will only select larger forest tracts for breeding, i.e., they are "area-sensitive" breeders. And, finally, the reduction of forest size often results in the loss of specialized habitats or micro-habitats, as mentioned above.

Forest fragmentation also increases edge habitat, which leads to indirect effects on FIDS, such as higher rates of nest predation, increased brood parasitism by brown-headed cowbirds, increased human disturbance (including noise), and increased invasion by exotic flora. Edge is most detrimental when it adjoins a lawn, agricultural field, pasture, or wide road. We define the width of forest edge at 100 m, which is consistent with the definition used by the Chesapeake Bay Critical Area Commission (A guide to the conservation of forest interior dwelling birds in the Chesapeake Bay Critical Area, June 2000), the recommended widths of riparian forests (Keller, et al. 1993), and the criteria used by Robbins, et al. (1989) to distinguish forest patches. The area inside this 100-m edge is defined as "interior" habitat, and is measured by changes in "effective area": i.e., the total forested area minus the area within the forest edge. Interior habitat functions as the highest quality breeding habitat for FIDS.

The forest within the Refuge Complex, particularly Blackwater NWR, is in dire need of active management. Throughout the history of the refuge, and more significantly in recent years, the lack of forest management coupled with other endemic processes have had significant impacts on forest health. Much of the forested land protected by Blackwater NWR was in less than desirable condition for wildlife as a result of historical poor forest management practices and the lack of planning for future habitat conditions. A large percentage of the forested land protected

earlier (1933–1969) had either been recently cleared or had been in an early stage of succession (<30 years). A harvest technique called "high-grading" has converted much of the loblolly pine–oak and loblolly pine–hardwood forests that once dominated the landscape to low quality mixed hardwood stands. Essentially, high-grading is "taking the best and leaving the rest" (Jastrzembski 1999). It removes the most commercially valuable trees from a stand and leaves the trees that are in poor condition or are undesirable species. High-grading is not considered silviculture, due to its dysgenetic effects and long-term economic and forest health implications (Helms 1998). Traditionally, the most economically important tree species was, and continues to be, loblolly pine for saw timber, pulp wood, and poles. A viable hardwood market is essentially non-existent on the Eastern Shore, thus resulting in either some degree of residual canopy or extremely heavy slash loads, which have detrimental effects on the natural regeneration of loblolly pine as well as preferred mast producing hardwoods.

At the time of their purchase, the rehabilitation of these tracts was left to natural processes. Some stands have regenerated successfully and are now immature or mature stands of both pine and pine–hardwood cover types. However, many of these regenerated and unmanaged stands are overcrowded and in dire need of silvicultural treatments to ensure optimum growth and long-term survivability. The majority of these previously harvested areas have not been as fortunate, and have been unsuccessful in their ability to regenerate the area with the same species that occupied the site prior to harvest. This in turn, has resulted in a conversion in cover type or vegetative alliance. Many of these sites are now dominated by a dense mix of woody shrubs, vines, and less desired tree species. More recently (1970–present) the Refuge Complex has been acquiring a greater percentage of lands containing mature forests. However, many of these stands also have lacked proper management, or are in the early stages of succession, and require silvicultural treatments to restore them to health.

Forest fragmentation has some of the most dramatic impacts on wildlife populations. For years, scientists have considered forest fragmentation one of the greatest threats to wildlife survival worldwide (Rochelle 1998). Many bird and other wildlife species require large blocks of forest for successful breeding, or some life stage of particular species requires a specialized type of forest habitat more likely to be found in large forested areas than in a small patch. Despite the recent use of sound forest management practices by forest landowners and the forest products industry, we are now losing forest at a rate of 100 acres per day, primarily to development. In the last 15 years alone, the Chesapeake Bay watershed's forest has declined by more than 471,000 acres, equivalent to about half of the state of Delaware (Society of American Foresters 1998). Additional estimates claim that Maryland's forest land base is decreasing by an estimated 10,000 acres per year, also primarily due to development.

The scattered pattern of modern development not only consumes an excessive amount of land, it fragments the landscape. As roads and development divide and isolate forested areas, interior habitat decreases, human disturbance increases, opportunistic edge species replace interior species, and populations of many animals become too small to persist (Weber and Wolf, 2002). Not only are wildlife habitats and migration corridors being lost, but normal ecosystem functions such as the absorption of nutrients, recharging of water supplies, and replenishment of soils are being disturbed or destroyed. Water quality has been degraded in numerous streams and rivers. Many of Maryland's wetlands have been altered by filling, drainage, impoundment, livestock grazing, logging, direct discharges of industrial waste and municipal sewage, freshwater diversion, and non-point discharge such as urban and agricultural runoff.

Increased stress and decreased vigor make our forests highly susceptible to infestations of gypsy moths and southern pine beetles, as well as many other forest insect pests and diseases. The two diseases that primarily have afflicted the forests on and around the Refuge Complex are red heart rot and oak decline. The primary cause of pine mortality in this region is red rot disease or heart decay caused by numerous species of fungi. Heart decay is the decomposition of the central stem wood of living trees, not necessarily limited to true heartwood, and is the most damaging of all types of tree diseases. It is highly common for pine in this area to develop heart rot at a relatively early age (e.g., 60 years) on lower, more flood-prone sites. Although some heart rot may be beneficial for cavity nesting birds, the resulting large-scale mortality has far more negative impacts on the ecosystem. The decomposition of their wood fiber makes infected trees unsalable and, therefore, no salvage operations can be prescribed. Through thinning and other silvicultural techniques, we aim to improve forest health, thus reducing the susceptibility to such a disease. Periodic declines and death of oaks over widespread areas have been recorded since 1900. These outbreaks, variously named oak decline, oak diebacks, or oak mortality, are caused by a complex interaction of environmental stresses and pests. The most frequent outbreaks of oak decline have been in southern New England, the Middle Atlantic States, and the Southeastern States. The disease is not limited to any one species

or species group. Outbreaks have been most frequent and severe among red oak (*Quercus rubra*), scarlet oak (*Q. coccinea*), pin oak (*Q. palustris*), and black oak (*Q. velutina*) in the red oak group, and among white oak (*Q. alba*) and chestnut oak (*Q. prinus*) in the white oak group.

Environmental stresses such as drought, water-logging, frost, or pests such as defoliating or sucking insects weaken these trees. Oaks on ridge tops and in wet areas suffer most severely from drought. Other factors, such as leaf diseases and soils that are waterlogged, compacted, or shallow, have occasionally been implicated in oak decline. Insects and diseases that cannot successfully attack healthy trees are then able to invade and kill weakened trees. The two major pests associated with oak decline are *Armillaria mellea* (Vahl:Fr.), a root disease often referred to as "Armillaria root rot," and *Agrilus bilineatus* (Weber), the two-lined chestnut borer. Dieback symptoms also can result from the effects of stress alone. Indeed, stress, if sufficiently severe or prolonged, can result in tree mortality. However, the continued decline and death of stressed oaks usually results from lethal attacks by Armillaria root rot or two-lined chestnut borers. Usually, the decline is slow, occurring over several years. Trees affected by oak decline show a general and progressive dying back from the tips of the branches. Often, tree growth is significantly reduced prior to the appearance of symptoms. The amount of food stored as starch is reduced, especially in the roots. Defoliated trees that refoliate the same season may exhibit dieback symptoms the next year. The unique relationship of cause and affect and patterns of distribution must be considered in controlling oak decline, and control efforts should focus on reducing or preventing the predisposing stress factors.

In the forest, of course, factors such as drought and frost cannot be controlled. However, management can reduce their effects. Thinning can reduce competition for moisture and nutrients and promote better physiological condition of the remaining trees. Silvicultural practices designed to encourage species best adapted to the site can help reduce the effects of drought or frost. Removal of weak and dying trees may also reduce or delay population buildup of the two-lined chestnut borer. Stress from insect defoliation can be reduced or eliminated in high-value forest stands by spraying the trees with insecticides. Oak decline is initiated by stresses, which can disappear before effects are manifested. A systematic evaluation of the problem can usually reveal the initiating factors and the agents responsible for mortality. Practices to promote good tree health can reduce the potential impacts of damage by oak decline (Wargo 2000).

Upon approval of this forest management plan and the implementation of its recommended practices, Blackwater NWR will focus primarily on improving the health and vigor of the forest while providing quality wildlife habitat for Federal trust species and other wildlife. As the forests on Blackwater NWR improve, the refuge will reduce its reliance on insecticides to control forest pests. However, the use of insecticides will never be completely eliminated, due to their lower cost and greater efficacy.

One of the most significant processes affecting the forests of Blackwater NWR and, to a lesser extent, the Nanticoke protection area, is the ongoing and dramatic rise in sea levels expected over the next 100 years. Although it is very noteworthy, it is unlikely that we will be able to effectively combat this process on a large enough scale to prevent the loss of forest habitats. Tide gauges around the Chesapeake Bay indicate that the apparent sea level in the Bay is rising at twice the global rate of 1.8 mm per year. Fragile wetland ecosystems are being lost at an alarming rate. For example, approximately 20 km^2 (5,000 acres), or one-third of the total area of Blackwater NWR, was lost between 1938 and 1988 (Leatherman 1995). Climate models indicate that the Earth's average surface temperature may increase by 1.5–4.5°C over the next 100 years.

That climatic change and several associated processes are likely to cause the sea to rise by approximately 65 cm by the year 2100 (Kearny 2000). Over time, as sea levels rise, low-lying uplands adjacent to the shore will be converted to wetlands. This conversion unfortunately is not a viable process for replacing the valuable wetlands being submerged by rising sea levels (Leatherman 1995). These accelerated rates of sea-level rise have impacted and will continue to impact the estuarine and palustrine wetlands all along the Chesapeake Bay. In addition to the dramatic loss of estuarine emergent wetlands on Blackwater NWR, sea-level rise has had significant effects on our palustrine and estuarine forested wetlands. Many acres of forest along marsh transition areas are quickly being converted to marsh type habitats. Flood-stressed trees exhibit a range of symptoms, including leaf chlorosis (yellowing), defoliation, reduced leaf size and shoot growth, sprouting, and crown dieback. Early fall discoloration and leaf drops often occur. It is also common for stressed trees to produce large seed crops in years following a stress event, such as flooding. Again, it is common for symptoms to occur over several years. The symptoms may progress and, eventually, lead to tree death, or, they may subside, indicating the tree has recovered (Bratkovich, et al. 1993).

Management Strategy

The primary emphasis of almost all forest management activities will focus on the protection and enhancement of habitat for the endangered Delmarva fox squirrel (DFS), and Neotropical migratory songbirds, most of which are FIDs. Other native wildlife will ultimately benefit indirectly from the forest management objectives carried out to improve habitat for trust species of primary concern. Where applicable specific silvicultural practices will be implemented to create or enhance habitat for other wildlife. In this plan, the forest management program will focus on the development and protection of large contiguous tracts of mature forest land to provide potential breeding habitat for FIDs of significant concern and improving the health and overall quality of forest conditions for DFS and other wildlife.

Through sound forest management and strategic land protection, Blackwater NWR will provide, at a minimum, seven contiguous mature forest patches of at least 400 acres, which reflects the minimum patch size needed to support breeding populations of 5 of 11 species of highly area-sensitive FIDs. Also under this plan, the refuge will actively manage its forested habitats to achieve the objectives of increasing the number of cores and increasing the size of existing cores to a minimum of 865 acres, which will provide habitats to support breeding populations of 9 of 11 species of the highly area-sensitive FIDs known to occur on the refuge. Through proper forest management and the other management strategies, Blackwater NWR has the potential of establishing cores that will provide breeding habitats for all 11 species.

Although the size and age structure of the cores is dictated by minimum habitat area requirements of FIDs, most forest management activities on the Refuge Complex will be performed to enhance forest conditions for the benefit of Delmarva fox squirrels and other endangered or threatened species. Second in priority will be applicable, proven forest management activities to improve the overall health of forest habitats and maintain a diversity of forest cover types, species composition, and age and size classes.

As previously stated, Blackwater NWR has the potential of providing a minimum of 5,292 acres (64 percent of the forested area) of DFS habitats through proper management. However, not all occupied or potentially occupied habitats on the refuge can be classified as optimal for DFS. Many have dense understories or midstories as a result of past timber removal operations or tree mortality due to gypsy moth. Others are nearly pure loblolly pine and contain little in the way of hard mast or cavities. Overcrowding of trees in the upper and mid-canopies is causing declines in growth rates and mast production. DFS habitats on Refuge Complex lands will be maintained or enhanced by ensuring that a minimum average stand diameter of preferred species is maintained collectively across all potentially occupied sites. A variety of TSI and regeneration harvest techniques will be employed in order to enhance growing conditions for the residual stand of trees, allowing them to attain greater diameters in a shorter period of time. Habitats for DFS will also be improved by performing timber stand improvements or selective cuttings to encourage nut-bearing trees and other food species, conducting prescribed burns to control understory and open up the forest floor, or encouraging the growth of large-crowned trees for nesting.

Blackwater NWR also contains 1,270 acres (15 percent) of recently cut-over stands ranging from 0 to 15 years in age and 227 acres (3 percent) of immature trees. With proper management, these stands have the potential of becoming quality DFS and FIDS habitat and being included into existing cores or become cores on their own. These areas will be intensely managed using the proven silvicultural techniques associated with natural and artificial regeneration, site preparation and the control of problem vegetation. Site preparation techniques will be applied in areas where natural regeneration has failed in order to enhance seed germination or prepare the area for planting. Chemical (herbicides), mechanical and prescribed burning will be used to release preferred tree species from competing vegetation.

Both even and uneven-aged systems will be employed to enhance and expand the core areas and create new cores. A wide variety of silvicultural techniques may be applied within the core to maintain forest health and desired species and age class composition. Silvicultural prescriptions known as Timber Stand Improvements (TSI) will be crucial in managing the cores, and include thinnings, release cuttings, salvage cuttings and sanitation cuttings. In most of these stands, mast production could be significantly improved through release cuttings, understory reduced through burning, and stress reduced through thinnings. Other management techniques, such as single tree and group selection, shelter-wood regeneration cuts, and pesticide and herbicide applications, will also be used to improve

forest stands within and outside core areas. Clear cutting may also occur within the core, but only if contiguous forest patches of similar size are incorporated into the core as they reach maturity or are protected.

Consequently, the core can be envisioned as dynamic, moving about in both space and time. Forest stands outside the cores will be intensively managed using both even and uneven-aged management techniques to maximize forest health and promote optimal survivability and growth for the purpose of incorporating them into existing or new cores. This may require that some of the previously mismanaged, (i.e., high-graded), neglected, or degraded stands (i.e., gypsy-moth-killed areas) be clear-cut and restored to a healthier more vigorous stands.

The greatest and, possibly, the most rewarding challenge in managing the forested habitats will be restoring and managing the more recent clear-cuts and high-graded stands. These areas are in their most manageable stage and will respond greatest to silvicultural prescriptions. One of the most effective and economic tools for ensuring survivability and optimizing growth of young trees is the use of herbicide to release desired tree species from undesirable woody tree and shrub competition.

Strategic land protection will play a significant role in establishing and enhancing the size of forest cores as well as maintaining a diversity of forest types and age classes, whereas reforestation and regeneration will be the second most effective strategy in establishing and increasing the size of the cores.

The remaining suite of forest management strategies and silvicultural prescriptions will be applied to both core and non-core forested habitats for the purpose of achieving objectives associated with maintaining and enhancing habitat for DFS, improving forest health, ensuring successful stand regeneration, maintaining a diversity of species and age classes and manipulating stand composition and structure for the benefit of FIDs where applicable and compatible with DFS management.

As cores are established and optimum or maximum potential size is achieved, we will ensure that this acreage remains constant regardless of the management activity. For example, no clear-cuts will be performed within cores unless a patch of forest of equal size and age can be incorporated to mitigate for the resultant decrease in patch area.

Timber Stand Improvements

TSI are treatments to modify or improve the growth of an existing crop of trees, but not to replace it with a new one. Specific treatments that may be used are thinnings, release cuttings, and improvement cuttings. They involve the selective removal of vegetation to allow for the expansion of the crowns and root systems of the plants that remain (Wenger 1984). When a forest is young, it always contains many more trees than it will when it is mature. One thousand or more young saplings may initially compete for a foothold on a single acre of land. Fifty years later, that same acre will only support a few hundred trees.

When forest managers thin a forest, they mimic nature by following the process of natural selection. By cutting out the weak, crooked, and over-crowded trees, the strongest trees can reach their fullest potential to provide supporting wildlife habitat. A thinned forest is typically healthier than a crowded forest. Once thinned, the remaining trees expend less energy competing with other trees and they are better able to fight off invasions of insects or disease. The trees that remain after thinning grow sturdy, thick trunks. In a thinned forest, few trees are lost to windfall, and falling branches are not a big hazard. Many species of wildlife inhabit a thinned forest. Plant diversity in the understory is especially aesthetically pleasing to hikers, hunters, and photographers.

When properly done, thinnings will benefit the forest ecosystem. They will enhance the many values we receive from our forests. Much of the existing commercial woodland in Dorchester County could be improved by thinning out mature trees and undesirable species (USDA 1998). Thinnings will allow increased sunlight to penetrate to the forest floor, which will stimulate the germination of tree seedlings as well as a wide variety of understory plants that are important wildlife foods. Cuttings to release selected trees will directly improve the diameter and crown growth, and will ultimately result in greater mast production for wildlife. Released trees will become mature sooner and attain a larger size at maturity. Authors have suggested that habitat for fox squirrels in general may be improved by leaving mature and large-crowned trees in managed forests, encouraging nut-bearing trees, and opening up the forest understory by burning or light grazing (Chapman, et al. 1982).

Whiteman and Onken (1994) suggest that the enhancement of DFS habitat on Blackwater NWR can be accomplished primarily through silviculture. They recommend that hardwood mast production be maximized and a sparse understory maintained by promoting large crown development of mast producers in the overstory. Mast production in immature stands (average dbh <12 inches) will be very limited. Although these stands can have an open understory, they typically are overcrowded and as a result have smaller crowns. A 12-inch dbh tree will generally produce 225 percent more mast than it did when it had a 10-inch dbh. Generally, mast production increases with diameter of the tree until it reaches 22–24 inches dbh, at which time mast production starts to decline as the tree becomes over-mature. The rate at which immature stands reach the desired conditions for DFS can be expedited by identifying potential hard and soft mast crop trees and performing a light thinning around these trees to encourage crown development. All TSI will result in a reduction in stand densities and tree stress, and an increase in tree growth and mast production of more desirable species.

Prescribed burning will be used throughout all forest cover types and age classes as a form of TSI. When appropriately applied, prescribed burning will benefit most wildlife species, including the endangered Delmarva fox squirrel and certain species of FIDs, by enhancing habitat and reducing hazardous fuel buildup. Prescribed burning in woodlands will aid in creating and maintaining open understory conditions favored by DFS, and promoting habitat diversity and food availability. In contrast to the gray squirrel (*Sciurus carolinensis*), the Delmarva fox squirrel often travels on the ground (Moncrief, et al. 1993) and has been shown to prefer mature forests with a "minimum of underbrush" (Moncrief, et al. 1993), closed canopies, open understories, and a high proportion of forest edge (Dueser, et al. 1988). Authors have suggested that habitat for fox squirrels in general may be improved by leaving mature and large-crowned trees in managed forests, encouraging nut-bearing trees, and opening up the forest understory by burning or light grazing (Chapman, et al. 1982). Fox squirrels have been found to prefer sites where understory closure is 30 percent or less (Allen 1982).

Fire may also reduce habitat suitability for the competing gray squirrel (Weigl, et al. 1989). Studies conducted in southeastern forests have demonstrated effects of fires on fox squirrel habitats, such as improved cone and mast production, restoration of a grassy understory, and increases in other fox squirrel foods such as fungi (Weigl, et al. 1989). Fox squirrels will probably not be able to escape fast-moving wildfires. However, they will easily escape low-intensity, prescribed, ground fires. Researchers found no evidence that prescribed burning caused significant direct mortality among fox squirrels. Wildfires will destroy leaf nests, nest trees, and fox squirrel nestlings. However, cavities used for dens and leaf nests are usually above the impact zone of prescribed burnings. Fire will also help maintain the pine–oak habitat preferred by fox squirrels, and will have a direct improvement on fox squirrel foods. Prescribed burning will also be effective for manipulating understory vegetation, reducing excessive fuel, disposing of logging slash, preparing planting sites and seedbeds, and improving wildlife habitat.

Harvesting of timber products will be viewed as a necessary evil. Some people strongly believe that the harvesting of trees will be detrimental to our environment and will be opposed to many aspects of forest management. It is true that many acres of forests are cut each year. In an average year, 186.5 million board feet of timber are harvested in Maryland for wood products. Yet much of the loss of forests in Maryland is not due to timber harvests but to land development. The Maryland Office of Planning estimates more than 10,000 acres of forests are cut each year for development! When trees are cut for development, the forest is gone forever. When trees are cut for timber, new forests usually begin to grow back immediately.

The harvesting of trees from Blackwater NWR will be performed for the primary purpose of stand replacement in order to maintain a healthy and diverse forest land base to benefit wildlife, not commercial interests. These methods are known as "regeneration harvests," and are discussed under the topic of regeneration. A certain level of older and less productive trees will be harvested to make way for new healthy and vigorous stands of trees. Stand replacement through timber harvesting and regeneration will ensure the maintenance of a diversity of forest age classes, structures and species composition. While there are many different methods of harvesting timber, there are even more habitat objectives that can be achieved through timber harvests. Clear-cutting and selective harvesting methods will be performed primarily to optimize the growth of a selected crop of trees whether it be a stand of new seedlings or residuals of a desired species. Other harvest methods will focus on ensuring and optimizing regeneration of or within a stand. The impacts of these methods are discussed under "regeneration," below.

Clear-cuts will be the primary method of harvesting trees in an even-aged system. The desired effect of a clear-cut is to start all regeneration at ground level so that the resulting timber crop is made up of desirable sun-loving species,

which are the fastest growing, straightest, healthiest, and most superior trees possible. Diverse species of food plants sprout up almost overnight after a clear-cut, and the slash provides homes for mammals and birds. A 20- to 60-year-old clear-cut is a textbook case of survival of the fittest. Because full sunlight is provided for future crop trees, rates of growth are the greatest. Clear-cut areas show 1.5 to 2.0 times the growth rates per acre than selectively cut areas. The temporary loss of forested habitat will have minimal impacts on wildlife since emphasis will be put on ensuring that adjacent habitat is provided to harbor displaced species.

Selective cuttings will be used for partial removals of trees, usually in uneven-aged stands of hardwoods to promote the growth of desired shade tolerant or intermediate tolerant species. The remaining trees will be able to better receive sufficient light, moisture, and nutrients to grow to optimal size. Part of this method will also be the manipulation of sunlight on the ground to successfully regenerate desired species. This activity will have significant beneficial impacts on the growth and productivity of desired tree species and wildlife. Selection system harvesting will allow a timber stand to retain its forested appearance in the years immediately following harvest. Disadvantages of selective cutting will be slower long-term growth, allowing undesirable species to predominate, allowing undesirable epicormic branching on future crop trees, holding back valuable sun-loving species, and being an easily and frequently abused method.

The regeneration of many species of trees will require some canopy removal to allow light to the forest floor to stimulate seed germination. Natural regeneration of desirable tree species will be the preferred method of stand replacement following prescribed management operations of any type. The advantages of relying on natural regeneration will include: lower establishment costs, less labor and heavy equipment required, the origin of the seed is usually known, reduction in chance of tip moth damage, enhanced early root development, and less soil disturbance. The methods of stimulating natural regeneration will vary widely in the amount of overstory that is removed. Therefore, the impacts on wildlife populations will also be varied. The most commonly used strategies to stimulate and enhance natural regeneration will include seed tree methods, strip or patch clear-cuts, shelterwood cuts, and single tree and group selections. A more detailed description of these and all other silvicultural techniques can be found in the “Forest Management Plan.” The overall benefits regarding regeneration and stand replacement, species composition diversity, forest health, and long-term sustainability of forest habitats will far outweigh any temporary negative impacts of executing these prescriptions.

Unfortunately, natural regeneration is not always a sure thing, and is subject to many natural and anthropogenic variables. When natural regeneration fails, or does not result in the adequate stocking of desirable species, then planting will be required. Some of the benefits of artificial regeneration will include control of initial spacing and stocking, genetically improved plant stock, less chance of seedbed loss, and less need for precommercial thinnings. The initial expense of planting, however, will be far greater than natural regeneration due to the cost of seedlings and potentially a greater amount of site preparation (Wenger 1984). The regeneration of hardwood species differs significantly from pines and is achieved through several means. For most hardwood species the planting of seedlings for regeneration will neither be necessary nor warranted. Unless control measures are taken, the planting of more shade tolerant species such as oaks in clear-cuts or large openings will not be practical since the seedlings will soon be out competed by fast growing sun-loving species such as red maple, sweet gum, and pines, as well as woody shrubs. More times than not, hardwood seedlings will require tree tubes in order to protect them from browsing herbivores and to maintain good form, which, in turn, will substantially increase planting costs.

In areas such as prior converted wetlands (agricultural fields) that will be reforested to create travel corridors or minimize fragmentation, a mix of desirable species suitable for those sites will be planted. A mix of hard and soft mast producers will be planted and maintained to ensure a successful conversion back to a diverse forested habitat. Tree shelters will likely be required on all seedlings regardless of species depending on the anticipated level of herbivore damage. Drought is a major cause of mortality for planted seedlings, especially in areas with low rainfall during the growing season. The rate of seedling mortality will be reduced by planting seedlings in early spring so that the seedlings can obtain sufficient moisture from spring rains. Proper care, handling, and planting of nursery stock and adequate site preparation for control of competing vegetation will be used to ensure proper survival by indirectly increasing moisture stress.

Sunken soils, typical of this area, are slowly being inundated by brackish waters (becoming submerged uplands), and the future use of these soils for producing quality timber is severely limited. Planting salt-tolerant species of grass,

shrubs, or trees in harvested areas helps to stabilize the soil, provide wildlife habitats, and reduce the potential for salt crusting on the soil surface (USDA 1998).

Site preparation or site disturbance will be used to promote natural regeneration of most pine species and the germination of some hardwood species. Most site preparation methods will be aimed at the preparing the seed bed through scarification. Some of the more common methods will include logging, chopping, discing, dozing, herbicide application, and prescribed burning (Wenger 1984). Scarifying the seedbed will expose mineral soil and increase contact of the seeds with moist soil surfaces. Failure of the root radicle to penetrate compacted or puddled soil surface will reduce seedling establishment, especially on major skid trails and log decks. Soil compaction and puddling also reduce root growth, seedling survival, and shoot growth. Seedbed preparation by scarification or burning will greatly increase seed germination and seedling survival, which will reduce the number of seeds required to produce one seedling.

For example, undisturbed seedbeds with a litter depth of 8 to 10 cm. (3 to 4 in) require five to six times more seeds to produce the number of seedlings produced in disturbed seed beds. Seed germination decreases with age of seed bed and increases with clay content of the soil. Two-year-old seed beds require three to four times more seed for successful establishment than do 1-year-old seed beds, and 3-year-old seed beds require 9 to 14 times more seed than is needed in the first year. Thus, favorable seedbeds usually exist for only 1 year after disturbance, after which they rapidly deteriorate (Baker and Langdon 1990). Site preparation methods like prescribed burning and herbicides will offer little to no soil scarification, but will provide more than adequate relief from competing undesirable woody sprouts (see below).

Management of problem or undesirable vegetation will be essential for ensuring optimum growth and survival of desired regeneration, whether natural or planted. By definition, when vegetation conflicts with the land management goals it becomes a weed problem. Forest weeds may be grasses, herbs, shrubs, vines, and trees of any species that interfere with the objectives whether they are timber, wildlife habitat, recreation or other uses. Weed control will increase the survivability, growth, and production of desired species, and therefore increase their wildlife benefits. Many of the more successful weed species are of exotic origin and native species are not adapted to compete. Significant occurrences of weed problems often lead to a weed or weed-dominated community replacing the trees removed. The results are brush fields or stands of undesirable species and substantially decreased value.

More specifically, competition affects the growth of loblolly pine in varying degrees depending on the site, the amount and size of competing vegetation, and age of the loblolly pine stand. Growth and survival of loblolly pine seedlings during the first 7 years after a stand is regenerated may be reduced by 80 percent because of the faster growth of competing hardwood sprouts and shrubs. Pine seedlings not overtopped by hardwoods at age 3 or older have an excellent chance to outgrow the hardwood competition (Baker and Langdon 1990). Woody species that grow rapidly from seed or sprouts are likely to be primarily a shading problem, causing mortality and loss of growth for many years after establishment. Hardy plants, especially grasses and low shrubs, are serious competitors for moisture for 1 to 3 years in areas of deficient summer moisture. Grasses that deplete moisture early in summer are among the most important causes of mortality in new regeneration (Wenger 1990).

Across the southern region, the average loss of volume production resulting from hardwood competition has been estimated at 25 percent in natural stands and 14 percent in plantations. Residual canopy, following high-grading operations, also has a detrimental effect on regeneration and stand replacement. Weeds also cause physical injury to forest regeneration. Vines, such as grape, Japanese honeysuckle, poison ivy, and Virginia creeper; aerial portions of tall herbs such as fronds; and leaves, branches and stems from woody vegetation compact and sometimes deform or break small seedlings. The systematic removal of weeds will favor the development of the desirable species. Forest weed control is simply a group of silvicultural practices for controlling certain species to benefit others.

Chemical control of woody weeds will be the least accepted method by the public. Chemical control will be used primarily in areas that are dominated by loblolly pine, where pine is the desired cover type during the early stages of seedling and sapling development, when other methods such as prescribed burning and mechanical control will cause substantial harm to regeneration. The primary benefits of chemical control are that it is generally the least expensive, causes the least amount of soil disturbance, and provides control for the longest period of time. Only approved chemicals that are labeled for these specific uses will be considered. Although many chemicals are registered and labeled site preparation and release, the most effective and widely used chemical to control woody

weeds is the isopropyl amine salt of imazypar, known by the trade name "ARSENAL." Another commonly used chemical, especially in and around areas of open or standing water, is glyphosate. An entirely different suite of chemicals may be applied systemically to individual trees in order to kill selected trees and reduce competition, while at the same time leaving the tree standing to provide additional years of shelter and foraging habitat.

Those substances, when used in accordance with their labeling, have been proven to have little to no impact on non-target fauna and flora. Extreme care will be taken to prevent drift to non-target areas as well as non-Federal lands. The Refuge Complex will continue to implement IPM strategies to reduce the use of chemicals. We will continue to explore new products as they become available in an effort to find equally effective, biologically safe, and less expensive materials to help enhance regeneration and forest conditions. All applications will be performed in accordance with current labeling and Federal, state, and local regulations. See Forest Management Plan for a list of chemicals approved for application in Region 5 and the labels from selected chemicals.

Manual methods of controlling weed species are generally limited to work with hand tools and are very labor intensive. For site preparation, hand cutting is generally followed by fire to remove the slash. Without burning, the cost of planting is very high and sprout growth is rapid. Best results are attained when the vegetation is sprayed before cutting to reduce sprouting. Nearly all common forest brush species are able to sprout vigorously after tops have been cut. Virtually no plants are killed by cutting alone. The effects on the competing brush community are limited to the temporary reduction in height and an increase in the number of stems. The regrowth of some species is so rapid that repeated treatments may be needed to accomplish release.

However, each successive treatment is more costly than the first, due to the accumulation of debris and the proliferation of sprouting stems. Treating the stumps immediately after cutting with herbicide can also be instrumental in reducing sprouting. However, a delay of more than 20 minutes between cutting and herbicide treatment will reduce the effectiveness on some species. Manual release is also a very effective method of timber stand improvement. Some additional advantages to this method are that it is highly specific and selective, and creates a source of employment that will contribute to the local economy or provide for volunteer opportunities. Some other disadvantages include high cost per treatment, difficulty in finding a willing labor force and high personal injury rate.

Mechanical control methods include grubbing, discing, bedding, chopping, and crushing. Heavy equipment may be used to grub out brush. The traditional method is to use a large bulldozer equipped with brush rakes that can uproot brush with minimal soil movement and allow soil to shake out of the roots en route to the brush piles. Traditional blades tend to shear off stems so they sprout, and also move considerable amounts of soil to the piles. Heavy equipment has a greater impact on the site than any other method, and has resulted in reductions in productivity in some southern and western operations. Roller-choppers are also very effective in crushing and breaking up undesirable woody vegetation. This method is best suited for flat terrain and small stems. If soil is dry, site disturbance is minimal. Because roots are often left intact, release may be required after several years to control new sprouts. Discing may be used to uproot weed species in previously unforested areas such as abandoned fields. The use of discing equipment is severely limited in cut over areas due to stumps and slash material. Bedding is a technique generally used in wet areas to create raised micro-environments where seedlings are planted. However, by creating micro-topography, the beds may also deter the growth of some woody species. The plowing of the beds may also result in damage to the roots of potential weeds, thus providing some level of control.

The advantages of mechanical methods are that the probability of attaining prescribed objectives is high. The operations can also provide residual browse, and can double as preparation for prescribed burning. Disadvantages include comparatively higher cost, high energy consumption, possible soil degradation, and the resulting debris may affect access and plant response.

Prescribed burning is equally effective as a tool for weed control or for TSI. Prescribed burning will be used extensively for seedbed preparation, site preparation for planting, and the control of undesirable vegetation. In the Atlantic Coastal Plain, a series of prescribed burns, such as a winter burn followed by three annual summer bums before a harvest cut, has been more effective than discing for control of competing hardwood vegetation and improvement of pine seedling growth after establishment of natural regeneration (Baker and Langdon 1990). Fire can reduce litter depth so that oak seedlings can become established. Fire can also reduce stocking rates of other

species, allowing oak species to increase in basal area. Fire can induce vigorous sprouting from older root stocks, which may be a preferred reproductive technique (Snyder 1992).

Van Lear (1992) lists several ways in which fire benefits oak regeneration. Fire removes excessive litter buildup from the forest floor, thereby preparing a favorable seedbed. Seedlings from freshly germinated acorns are unable to emerge through a heavy litter cover. Squirrels and blue jays prefer thin litter for burying acorns. Jays collect and disperse only sound acorns, which implies that any acorns not consumed have a good chance of developing into well-established first-year seedlings. Fire helps control insect predators of acorns and new seedlings. Many of these insects spend all or part of their lives on the forest floor. Infestations, which can vary from year to year and even from tree to tree in some areas, are major contributors to the oak regeneration problem. Burning also may damage rodent habitats; in turn, that will reduce the threat of these formidable acorn consumers.

A regime of frequent burning over long periods of time creates an open stand. In hardwoods, long-term burning tends to eliminate small understory stems outright and gradually reduces the midstory and overstory canopy through mortality resulting from fire wounds. Increasing the light reaching the forest floor in these open stands will maintain the vigor of oak regeneration. Severe or frequent fires xerify the surface of forest sites by consuming much of the forest floor and exposing the site to greater solar radiation through canopy reduction.

Adequate advanced oak regeneration in the East is generally found more often on xeric sites than on mesic ones. Conversion of mesic sites to more xeric conditions by intense fires or by long regimes of low intensity fires could explain in large part the ability of oaks to dominate sites where more mesic species normally occur. The absence of fire since the turn of the century has allowed species that are intolerant to fire to become established and grow to a size where they, because of thicker bark associated with age, can now resist fire (Carter 2000). Prescribed burning is comparatively cheap, causes little soil disturbance, and may enhance the availability of nutrients. However, the chance of fire escape is always a factor; smoke may degrade air quality; if fire is too hot, it may damage soils; and there is often a narrow window when treatments can be applied.

Integrated pest management is an integral part of forest management and protection. The primary strategy under our IPM program will be to improve the overall health of the forested habitats in an effort to reduce their susceptibility to forest insect pests and diseases. Until this objective is achieved, we will continue to rely on the latest and most effective control measures developed by the USDA Forest Service. Currently, the most effective and widely used control tactics is the use of biological insecticides such as *Bacillus thuringiensis* and Gypchek. Integrated Pest Management and the monitoring and treatment for disease outbreaks will be performed throughout all applicable forested habitats and therefore will not be illustrated in the Prescription Matrix, below (table 4.2). The consequences of these IPM strategies are covered under the section on exotic species control.

Table 4.2. Silvicultural prescriptions for seven years

Dimensions	***Core Areas***							***All Other Forests (current boundary)***
	1	2	3	4	5	6	7	
Current Acres	427	617	864	722	348	283	0	5,447
Effective Area	209	294	445	355	132	10	0	N.A.
Perimeter-to-Area Ratio	86	25	68	92	32	58	N.A.	N.A.
Prescriptions	*Proposed Acres If Available*							
**Crop Tree Release	100	120	250	100	100	N.A.	N.A.	1,030
**Thinning	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	630
**Improvement Cutting	N.A.	120	N.A.	N.A.	100	N.A.	N.A.	478
Regeneration and Selection Harvest	250	375	300	100	200	58	N.A.	750

Prescriptions	*Proposed Acres If Available*							
Prescribed burning (TSI)	225	280	500	250	N.A.	100	N.A.	700
**Reforestation and Planting	9	95	78	50	N.A.	7	N.A.	500
**Control Problem Vegetation	9	95	72	292	N.A.	150	N.A.	2,000
***Land Protection	507+	552	1,006	1,112	552	204	634+	N.A.
****No Management	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	2,750
Desired Acres	1,043	{1517}	1,869	2,153	{1517}	1,158	634	N.A.
Desired Effective Area	779	{959}	1,498	1,733	{959}	843	366	N.A.
Desired Perimeter-to-Area Ratio	36	{17}	29	31	{17}	12	69	N.A.

* Prescriptions have not been predetermined for those lands that have not yet been protected. As those lands are protected, they would promptly be assessed for management needs. The forest management activities would then be appended to the forest management plan and would be subject to Informal Consultation (section 7) by our Ecological Services Office.

**These activities will be performed on currently owned forest lands that are not yet incorporated into cores, but the management of these lands is crucial to enhancing the respective core. These acreages, some of which are specific to certain cores, will be reflected in the totals for this activity under the "All Other Forest" column, but will be added to the core area once they meet the minimum requirements. The reforestation of prior converted wetland is not illustrated in this table. The "Control Problem Vegetation" column also includes acres duplicated in the "Reforestation and Planting" column.

***The acreage figures for land protection represent the area of one or several priority parcels to be protected to meet the minimum optimum requirements of establishing or enhancing a core.

****The lands included under the "No Management" column are a combination of both low-lying, stunted stands that are too far gone to be managed effectively and stands that are in a condition that does not warrant silvicultural treatment within the next 15 years.

{..} The "Desired Acres", "Desired Effective Area" and "Desired Perimeter-to-Area Ratio" figures inclosed in braces are the same for both Cores 2 and 5, due to the conjoining of the two cores that will result from strategic land protection in that area.

Please note: These area values represent an estimate of management needs based on current landownership and the current condition of the forest resources on Blackwater NWR. These values and the location of management activities will change significantly as the Refuge Complex continues to expand. Also note that this is a 15-year plan, and all activities are of the highest ranking priority. The need for additional management activities may exist; however, it is unlikely that we will pursue them during the term of this plan.

Managing Forest Cores

The following cores were delineated based on the criteria relating to minimum breeding area requirement for FIDs as described in the Environmental Assessment prepared for the Chesapeake Marshlands NWR Complex's Comprehensive Conservation Plan and the Forest Management Plan for Blackwater NWR of which this document is an attachment. The criteria describes cores of having to be a minimum of 400 - contiguous acres of forests which are greater than 40 years old (ie. mature). The current refuge land base has been delineated to create four cores of 400-acres or greater and two cores less than 400-acres which exhibit the greatest potential for becoming cores. A seventh core will be established in the near future through land acquisition. Figure 4.4 below demonstrates the size and location of the four current cores. Figure 4.5 displays all seven cores in their 'unmanaged' condition as well as the projected or desired future condition of all seven cores. Although all cores are representative patches of contiguous mature forest of a minimum size and developmental stage, each core is dynamic in the fact that they are essentially revolving in both space and time. Although the general location and minimum size of a core will not change, the actual boundaries of, and forest conditions within a core, may shift as management activities are carried out or new lands are acquired. A core may not always consist of the same physical forested acres. For example: As stands within a core reach the point of over-maturity and declining health, these stands may be harvested (removed from the core), but only when adjacent parcels of forested land of equal or greater value can be incorporated into the

core to offset the decrease in patch size and effective area. Once four of the seven cores reach the optimum size of 865-acres, that acreage will then be maintained as the core's minimum size. The proposed management for each of the seven current and potential cores as well as other stands within core compartments will be prioritized based on what types of management are most likely to be accomplished with the least amount of conflicts. In most cases, the ranking for proposed forest management aimed at improving the integrity of the core will be timber stand improvement, reforestation/restoration, regeneration cutting, and controlling problem vegetation to release regeneration. A series of priority management strategies will be described both narratively and most importantly, geographically. Geographically displaying these management strategies within and around the designated core areas will provide a better understanding of the ecological significance of the management prescriptions proposed.

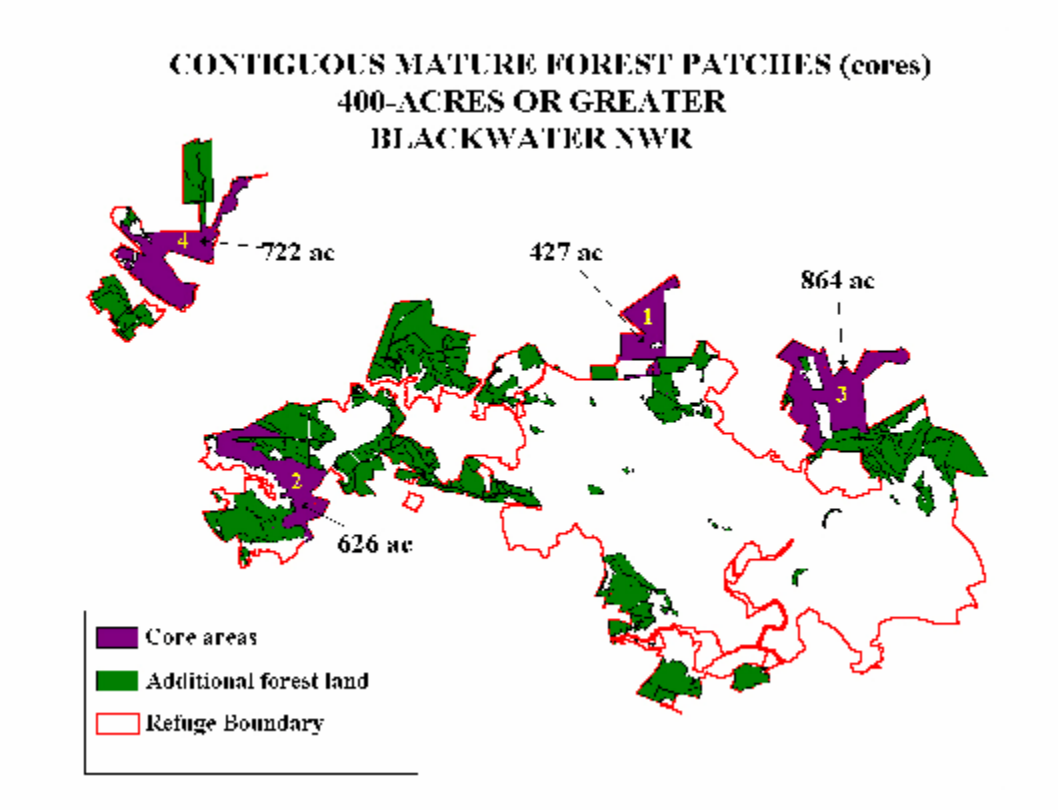

Figure 4.4.Map of four currently established forest cores.

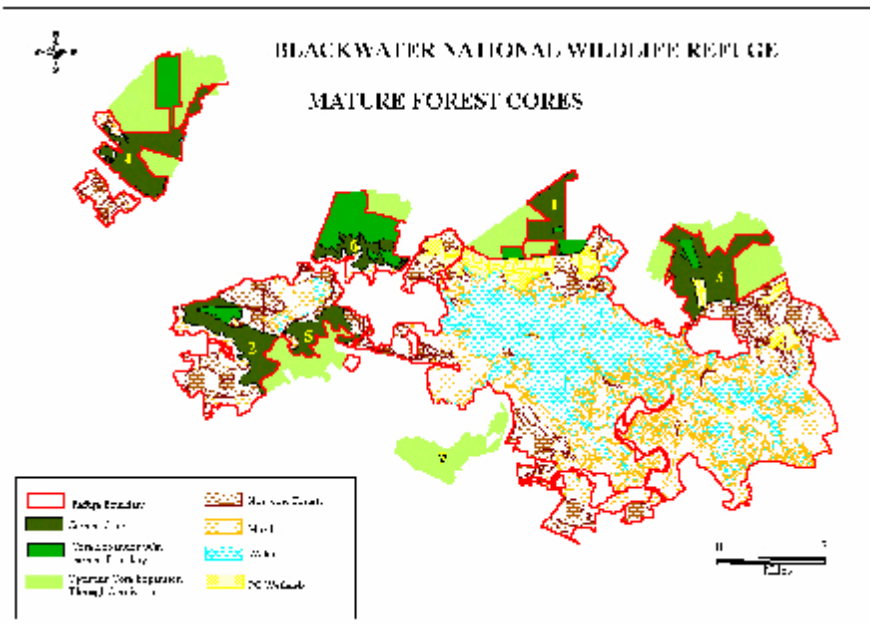

Figure 4.5. Map of all seven cores displaying current or unmanaged conditions as well as desired future conditions.

Core 1

Core 1 is a subset of forested habitats within compartment D. Core 1 was delineated by grouping all contiguous mature and over-mature stands within the compartment. The current core is comprised of 427 contiguous acres of mature and over-mature loblolly pine/hardwood forest. A more detailed description of the forests in this compartment can be found in the Affected Environment Section of this plan and the Forest Management Plan. A closed canopy road extends South to North bisecting the entire core and a secondary closed canopy road also exists in the western part of the core. The fact that these roads are narrow and are closed canopy makes them an insignificant detriment to the integrity of the core. The core is however, negatively impacted by a 9-acre abandoned field which serves in part as the refuge's bone yard. The current effective area of Core 1 within the 100-meter buffer is 209-acres and the perimeter to area ratio is 86 (table 4.3, figure 4.6). The following forest management prescriptions have been determined to be the highest priority for improving the quality of this core. The proposed actions and consequences will be described and geographically displayed.

Table 4.3. Change in core area and effective area by prescription

Prescription	*Core Area*	*Cum. Change Core Area*	*Effective Area*	*Cum. Change Effective Area*	*Perimeter-to-Area Ratio*
Current Status	427 ac.	N.A.	209 ac.	N.A.	86
Timber Stand Improvement	498 ac.	17%	243 ac.	17%	80
Reforestation	507 ac.	19%	272 ac.	31%	74
Land Protection I	637 ac.	48%	357 ac.	71%	62
Land Protection II (Optimum)	1,043 ac.	145%	779 ac.	275%	36

1.) Timber Stand Improvement.

The highest ranking management recommendation consists of performing TSI in the 71-acre stand of immature loblolly pine and hardwoods directly adjacent to the core. The stand is dominated by very dense 30-year-old pines and hardwoods with a remnant canopy of over-mature pines. In addition to an overstocking of pine, the stand also contains a high percentage of sapling and pole size oaks of various

species. The future of this oak component is severely limited by the high degree of competition from pines and less-desirable, more vigorous hardwoods. The effects of competition on oak ability to become established in the canopy are already evident. Due to their slower rates of growth and density of the stand, the oaks quickly being suppressed. In order to promote and ensure the establishment of both pines and oaks in the upper canopy of this stand prior to becoming incorporated into the existing core, it is recommended that a 'Crop tree release' be performed in this stand to reduce competition and improve growth and vigor of preferred mast producing species hardwoods and pine.

By significantly decreasing the competition for resources throughout the stand and targeting a specific number of preferred tree species for release will improve tree growth and mast production and ensure that this stand will be a healthy and beneficial addition to the core. The increase in tree growth and mast product will provide tremendous benefits for DFS as well. By adding this particular stand, the overall size of the core is increased by 16.71 percent, and the effective area is increased by 16.67 percent (34.76-acres). The perimeter to area ratio is also decreased from 86.08 to 80.47 (6.5 % decrease). By adding such a significant parcel to the core, it will allow for the regeneration or restoration of some of the older, less vigorous and unhealthy portions of the core without significantly impacting the effective area of the core. This management prescription will not result in any changes to species competition, but will directly affect stem density and stand structure for the benefit of DFS, FIDs and all wildlife. Figure 4.7 below demonstrates the consequences of implementing prescription A and how the core would be improved by the addition of this 71-acre stand. Since the age of this stand is slightly over 30-years and our definition of mature forests states an age of 40-years, this 71-acres stand will be incorporated into the core in less than 10-years. This map also provides excellent visual explanation of the consequences of each prescription.

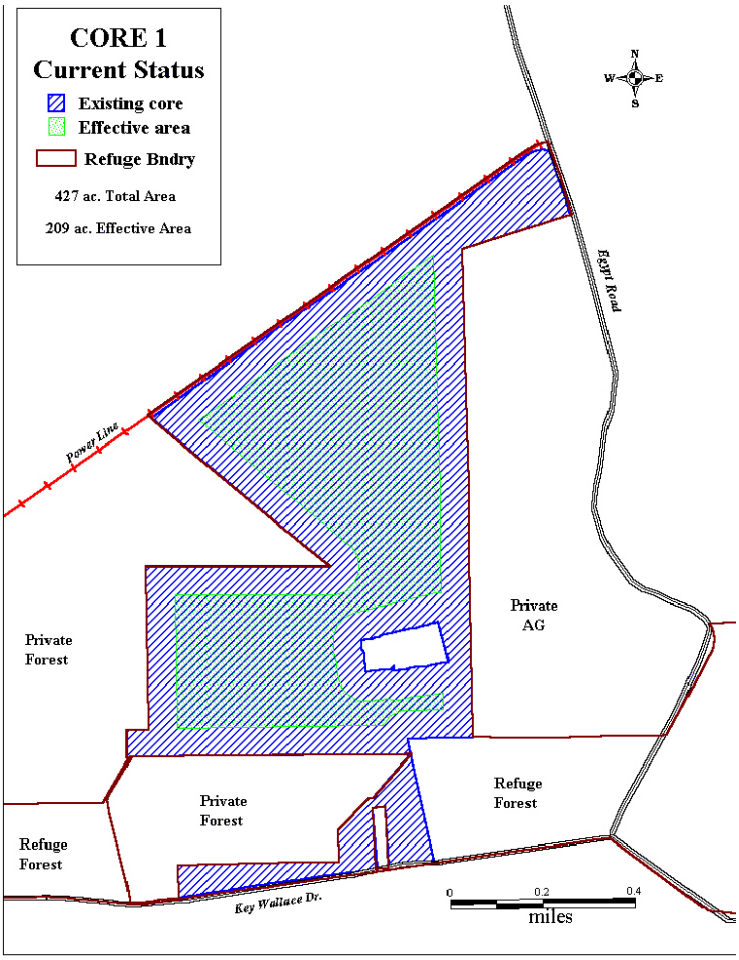

Figure 4.6. Core 1

2.) Regeneration Harvests

Techniques to enhance the natural regeneration of both hardwood and pine species under a mature canopy will be performed on approximately 250-acres of mature and overmature forested habitat within this core over the next 15-years. The proposed acreage is based on current conditions and current land base. As this core expands as a result of land acquisition, the proposed treatment acres may also increase.

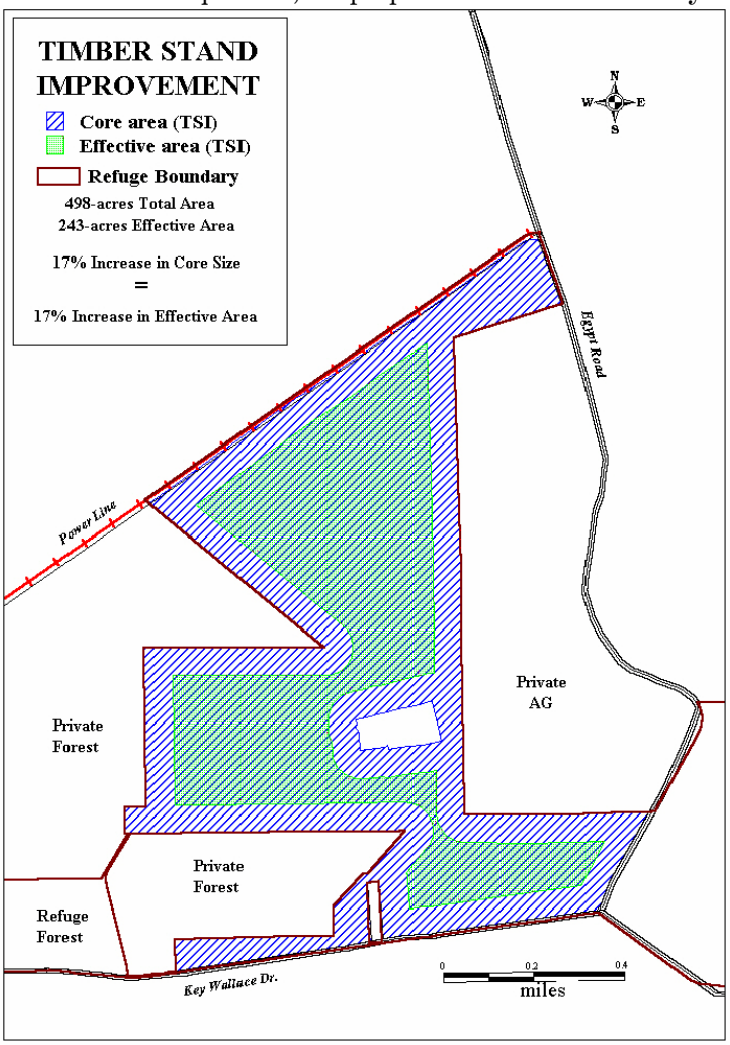

Figure 4.7. Core 1 and the consequences of performing TSI and enhancing 71-acres of immature

Core 2

Core 2 comprises 617 contiguous acres of mature forest within compartment M. This assemblage of connected pine, pine/hardwood, and mixed hardwood stands comprises possibly the most diverse assemblage of mature forested habitats on Blackwater refuge (figure 4.8). This core is highly variable with respect species composition, age class, and stand conditions. A more detailed description of these forested stands can be found in the Affected Environment Section of Environmental Assessment prepared for the Chesapeake Marshlands NWR Complex's Comprehensive Conservation Plan of which this document is an attachment and the Forest Management Plan. This core also exhibits some of the greatest potential for expansion through silviculture and land acquisition. However, due to its somewhat linear shape, the current 'effective area' of the core is only 294-acres. The most significant ecological factor which does, and will continue to, detract from this core is the vast areas of salt induced tree mortality. In 1987/88, more than 165 acres of large hardwoods and pines were lost due to storm tides and prolonged salt water intrusion. The following forest management prescriptions have been determined to be the highest priority for improving the quality of this core. Some of the prescriptions are to be carried out directly within the current core, while, others will be performed in forested habitats adjacent to the core which will eventually improve the integrity of the core. The proposed actions and consequences will be described and geographically displayed.

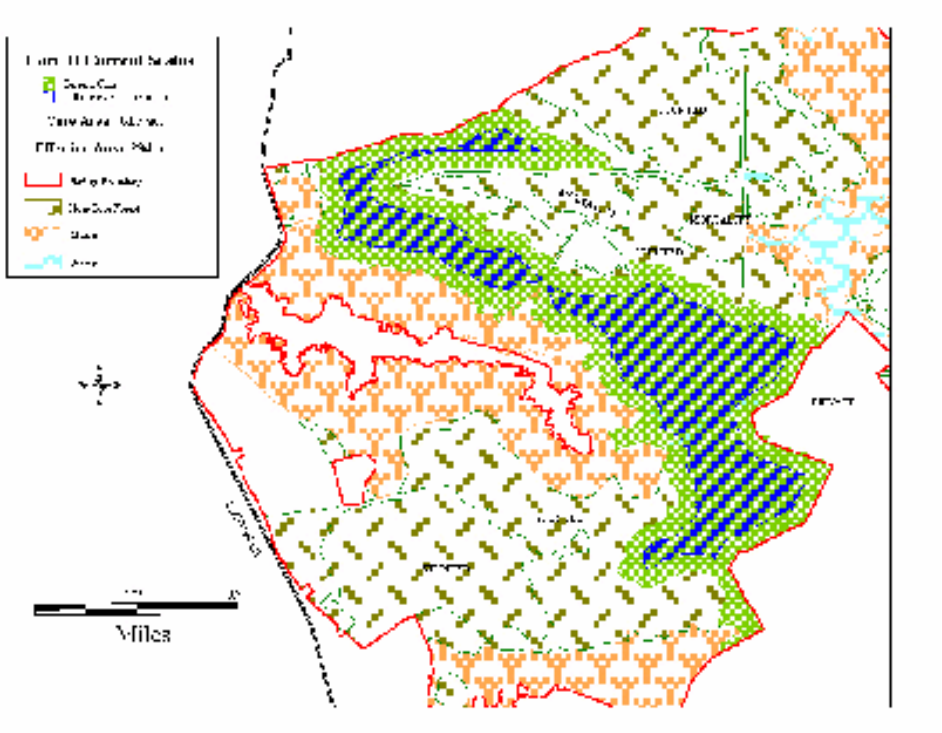

Figure 4.8. Core 2

1.) Timber Stand Improvement.
Timber stand improvement is currently proposed on only 120-acres within this core due to the fact that the majority of the stands within the current core are mature to overmature and are more in need of regeneration harvesting than thinning or crop tree release. As this core expands as a result of land acquisition, the proposed treatment acres may also increase.

2.) Regeneration Harvests
Techniques to enhance the natural regeneration of both hardwood and pine species under a mature canopy will be performed on approximately 375-acres of mature and overmature forested habitat within this core over the next 15-years. As this core expands as a result of land acquisition, the proposed treatment acres may also increase.

Core 3

Core 3 comprises 864 contiguous acres of mature hardwood dominated forest within compartment U. This expansive tract was previously harvested where the large valuable pines were extracted and the more numerous hardwoods were left. This assemblage of high-graded stands not only turns out to be the largest block of mature hardwoods on the refuge, it is also currently the largest mature forest core with the greatest amount of effective area, 445-acres (figure 4.9). In its current state, this core provides potential breeding habitat for 9 of the 11 priority FID species which we are managing for. Much of the remaining pine within the core is becoming over-mature and is of lower quality as a result of being suppressed for most of their lives. The majority of the hardwoods, particularly oaks, are also old and stressed due to the sudden changes brought on by the harvest and subsequent ingrowth of more vigorous hardwoods such as maple and gum. Past gypsy moth infestations have also taken their tole on the oaks in this area. Very little to no regeneration is occurring in many of these stands. The increased amount of sunlight reaching the forest floor following the harvest resulted in extremely dense understories which preclude natural regeneration and may have negative impacts to DFS populations. The following forest management prescriptions have been determined to be the highest priority for improving the quality of this core. Some of the prescriptions are to be carried out directly within the current core, while others will be performed in forested habitats adjacent to the core which will eventually improve the integrity of the core. The proposed actions and consequences will be described and geographically displayed.

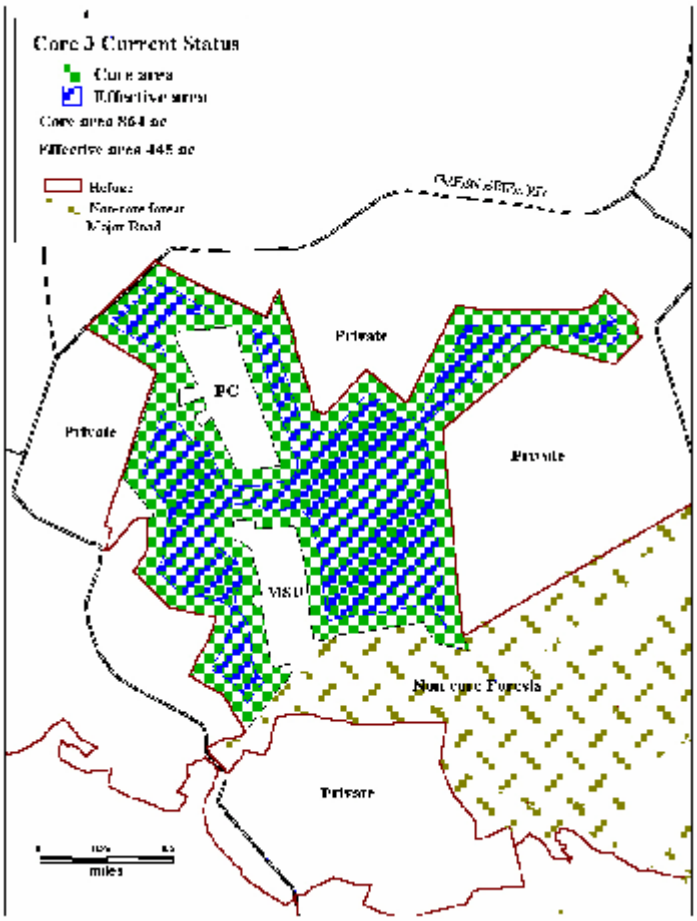

Figure 4.9. Core 3

1.) Timber Stand Improvement.
Timber stand improvement is currently proposed on approximately 250-acres within this core. The preferred method of TSI will be crop tree release or a combination of this and one other TSI method. As this core expands as a result of land acquisition, the proposed treatment acres within the core may also increase.

2.) Regeneration Harvests
Techniques to enhance the natural regeneration of both hardwood and pine species under a mature canopy will be performed on approximately 300-acres of mature and overmature forested habitat within this core over the next 15-years. As this core expands as a result of land acquisition, the proposed treatment acres may also increase.

Core 4

Core 4 comprises 722-acres of contiguous mature forests within compartment T. The effective area of core 4 is 355-acres and has a perimeter to area ratio value of 92 (figure 4.10). The current core area consists predominantly of a mixture of pine and hardwood which tapers to a pine dominated forest as it gets lower in elevation and closer to the marsh. A more detailed description of the forests in this compartment can be found in the Affected Environment Section of the Environmental Assessment prepared for the Chesapeake Marshlands NWR Complex's Comprehensive Conservation Plan of which this document is an attachment. The current core size of 722-acres should provide potential breeding habitat for 5 of the 11 area sensitive FIDs.

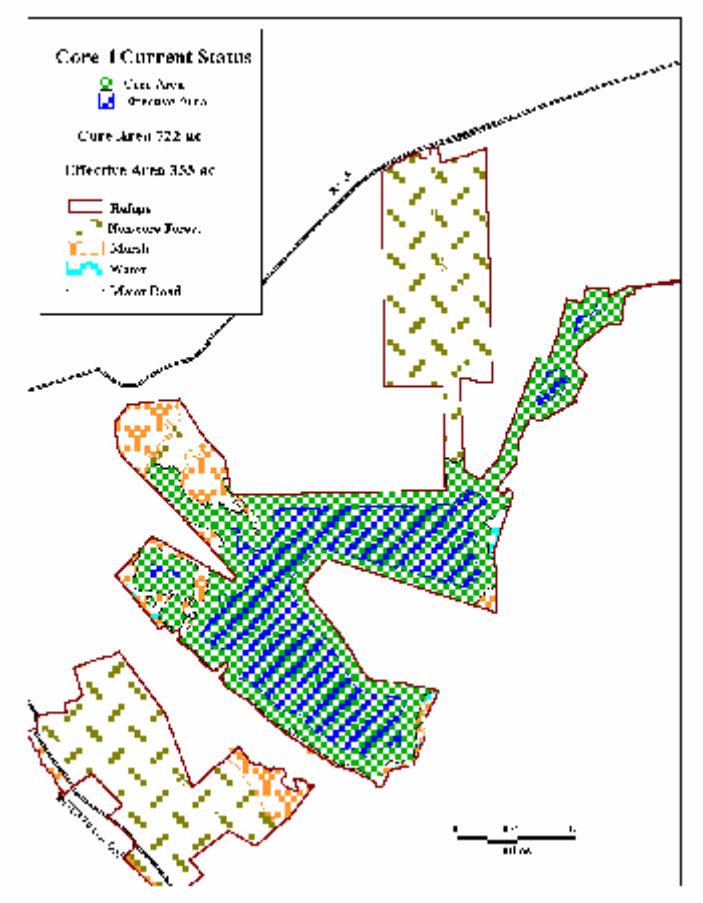

Figure 4.10. Core 4

1.) Release Cutting / TSI

Approximately 292-acres of mature loblolly pine timber had been harvested from this compartment prior to acquisition in 1994. The harvest was in the form of a clear-cut, but in areas where the hardwood was denser than pine, the pine was selectively removed and the lower-grade hardwoods were left. Many of these remnant trees were of poor health and form to begin with and continue to show signs of declining health. Although a more detailed stocking inventory needs to be performed, preliminary observations revealed that the majority of this area currently contains an adequate stocking of loblolly pine regeneration. However, the shading from the residual trees has been a significant hindrance to the growth and establishment of a new vigorous stand of trees. Oak regeneration is virtually absent from the stand, most likely due to the dense growth of more vigorous hardwood vegetation and possibly the lower prevalence of oaks in the original canopy. These factors coupled with the competition from other woody vegetation and the lack of proper management has been a significant setback in the establishment of a new stand. Other areas which served as logging decks during the operations currently contain no regeneration of any tree species. The compaction of the soil and residual debris has precluded the germination of stored or newly fallen seed. The growth and establishment of pine seedlings and saplings is currently hampered by the dense shrub competition and in some areas, shading from residual canopies. Therefore, the regeneration within these stands is in dire need of release. By ensuring the successful regeneration of these stands and their inclusion into the core we will increase the overall size of the core by 292-acres (40%) to 1015-acres. While the effective area will be increased by 173-acres (49%) to 528-acres (figure 4.11). The perimeter to area ratio value will subsequently be decreased by 12-percent from 92 to 81. Despite the significant increase in core size as a result of this activity, effective area will still be compromised due to the narrow band of forest which connects these restored lands to the original core. This wooded corridor is bordered by clear-cuts and contains no effective area for FIDs. The total effective area of the newly established core is actually not contiguous and is separated from the original core by this narrow wooded corridor. This factor will only be mitigated through the acquisition and reforestation of the adjacent lands. However, by increasing the overall size of the core to 1015-acres, the new core will potentially provide breeding habitats for all 11

species of the area sensitive FIDs listed.

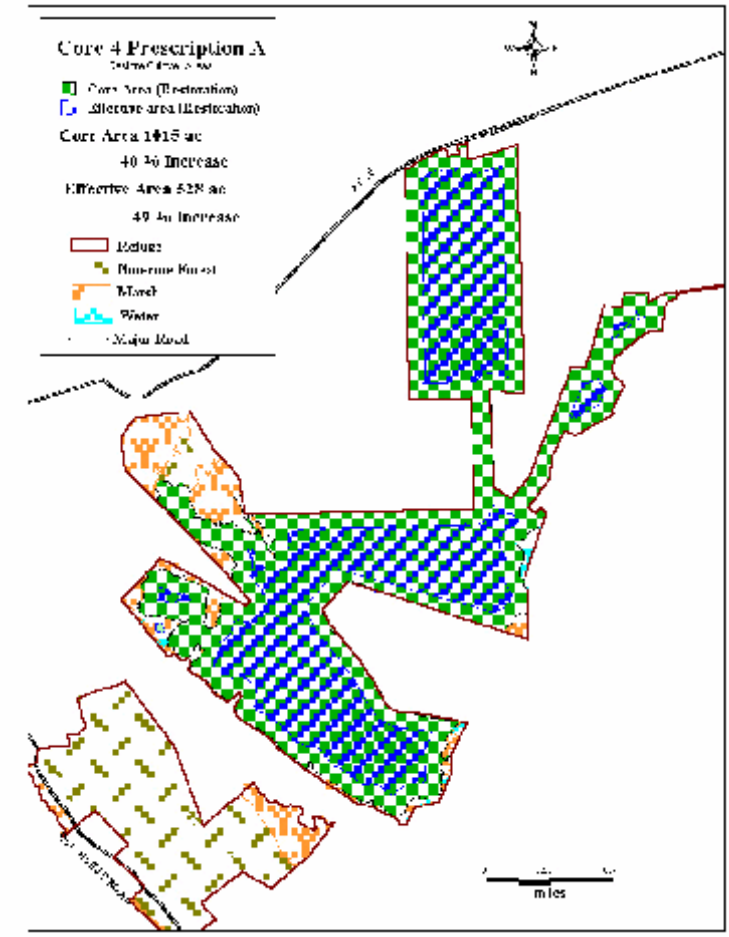

Figure 4.11. Core 4 with consequences of performing Release Cut.

2.) Timber Stand Improvement .
Timber stand improvement is currently proposed on approximately 100-acres within this core. The preferred method of TSI will be crop tree release or a combination of this and one other TSI method. As this core expands as a result of land acquisition, the proposed treatment acres within the core may also increase.

3.) Regeneration Harvests
Techniques to enhance the natural regeneration of both hardwood and pine species under a mature canopy will be performed on approximately 100-acres of mature and overmature forested habitat within this core over the next 15-years. As this core expands as a result of land acquisition, the proposed treatment acres may also increase.

Core 6

Core 6 is located within compartment R and is currently only 283-acres in size. Due to its linear shape and expansive clear-cut within its boundary, the current effective area for FIDs is only 10-acres (figure 4.12). This assemblage of mature forest stands consists primarily of pure pine forests which are located within the 'Critical Areas' and a previously high-graded overmature hardwood dominated stand. The Critical Area can be defined as a zone of protection which may extend out to 1000 feet from the mean high tide delineation along tidal wetlands and waterways. These 'Critical; Areas' are protected and governed through the Maryland Critical Area Act and regulations are enforces by the Critical Ares Commission. Therefore, no management activities will be proposed on forested areas within the designated 'Critical Area'. The only management which will be

implemented within the current core boundaries will be a very light selection harvest to promote natural regeneration within this stand. The entire future of this core hinges on the management of the surrounding immature and regenerating stands. The primary management objective will focus on enhancing these adjacent lands to someday include them into the core. The current forest conditions in this compartment are a result of timber harvesting which occurred over a 25-year period. The time factor coupled with the different harvest techniques performed under various site conditions has resulted in a highly diverse forest with respect to age class, species composition and stand conditions. A more detailed description of the forests in this compartment can be found in the Affected Environment Section of the Environmental Assessment prepared for the Chesapeake Marshlands NWR Complex's Comprehensive Conservation Plan of which this document is an attachment. In order to perpetuate the growth and development of stands within this compartment for the goal of establishing a core, an equally diverse combination of forest management strategies will be required. The specific commercial management practices which will be performed in the near future are discussed below.

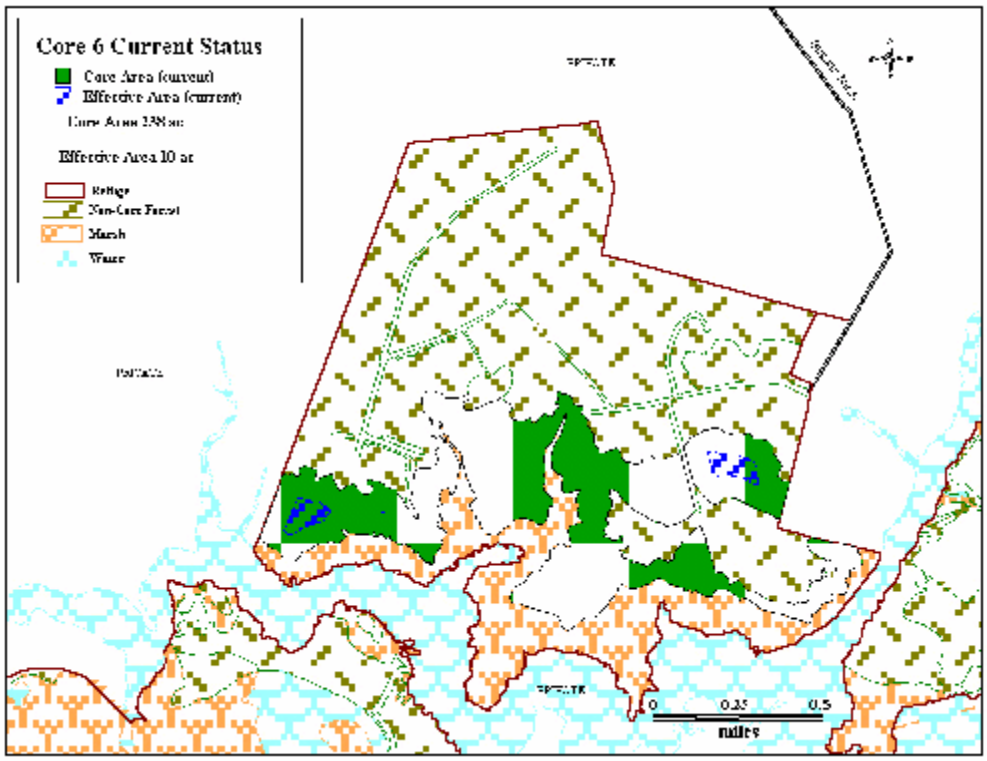

Figure 4.12. Core 6.

1.) Timber Stand Improvement

Timber stand improvement is currently proposed on approximately 87-acres within this core. It is highly likely that the preferred method of TSI will be a thinning within the 35-40-year-old pure pine stands directly North of and adjacent to the current core. The objective of this thinning will be to reduce the total basal area of the stand to between 80 and 90 square feet per acre, thus enhancing growing conditions for the remaining trees. The long term benefits to the quality of these stands will be most evident at maturity when they will be added to the core. By adding these stands to the core, the overall size of the core will be increased by 31-percent to 370-acres, while, the effective area is increased by 97-acres or 870-percent (figure 4.13). Despite the tremendous percentage increase in effective area, the size of the core remains below the minimum size requirements and will provide potential breeding habitat for only 5 out of the 11 highly area sensitive FID species.

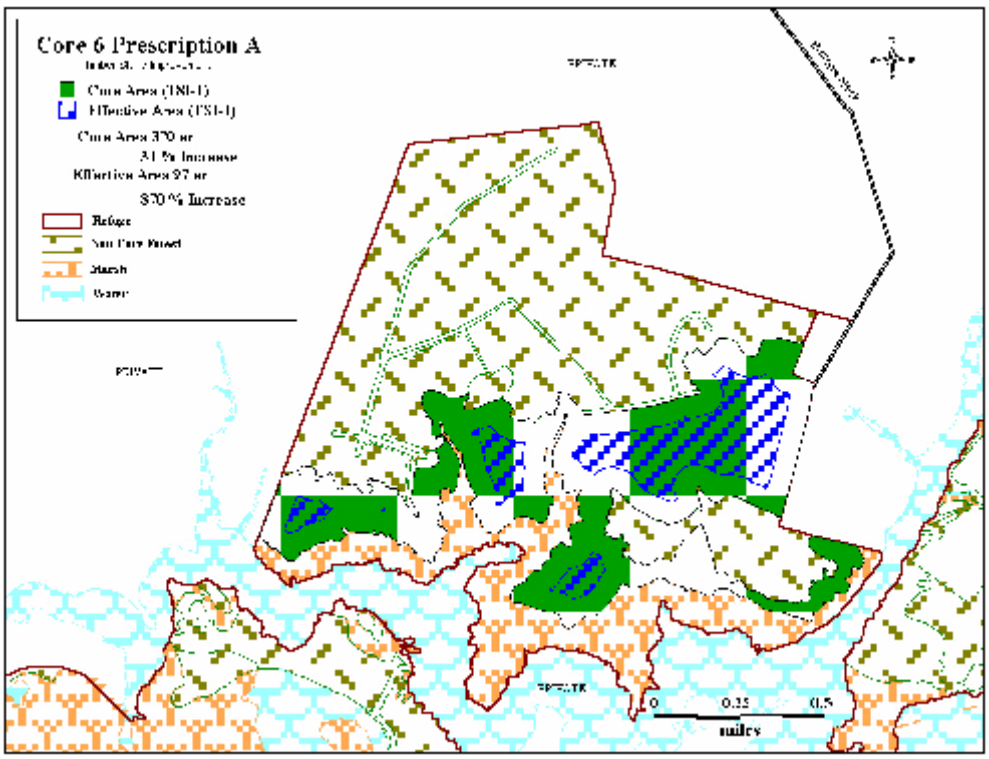

Figure 4.13. Core 6 with consequences of TSI.

2.) Release cutting

Approximately 150-acres or more of mature loblolly pine timber was harvested from this compartment prior to and post-acquisition throughout 1994 to 1999. The harvest was in the form of a clear-cut or the selective removal of residual trees left during previous harvest operations. A 66-acre clear-cut is located directly within the current core, therefore regeneration of this stand is a high priority. Although a more detailed stocking inventory needs to be performed, preliminary observations revealed that the majority of this area currently contains an adequate stocking of loblolly pine regeneration. However, dense growth of competing shrubs, vines, and *Phragmites* has significantly impacted the growth and establishment of pine regeneration. Oak regeneration is virtually absent from the stand, most likely due to the dense growth of more vigorous hardwood vegetation and possibly the lower prevalence of oaks in the original canopy. These factors coupled with the competition from other woody vegetation and the lack of proper management have been a significant setback in the establishment of a new stand. Since the original stand was a predominantly pine forest, it will be our intent to manage this area for similar future conditions. If it turns out that loblolly pine stocking levels are more than adequate throughout much of the stand, and oak regeneration is not occurring, management strategies will focus on improving the growth of the existing pine regeneration. As previously stated, the growth and establishment of pine seedlings and saplings are currently hampered by the dense shrub competition and in some areas, shading from residual canopies. Therefore, the regeneration within these stands is in dire need of release. The actual inclusion of these lands to the current core will not take place for another 35-years when the stand has reached maturity. By not managing these areas, we will increase this time frame considerably. The actual impacts of including these areas in the core have been analyzed and illustrated below in figure 4.14.

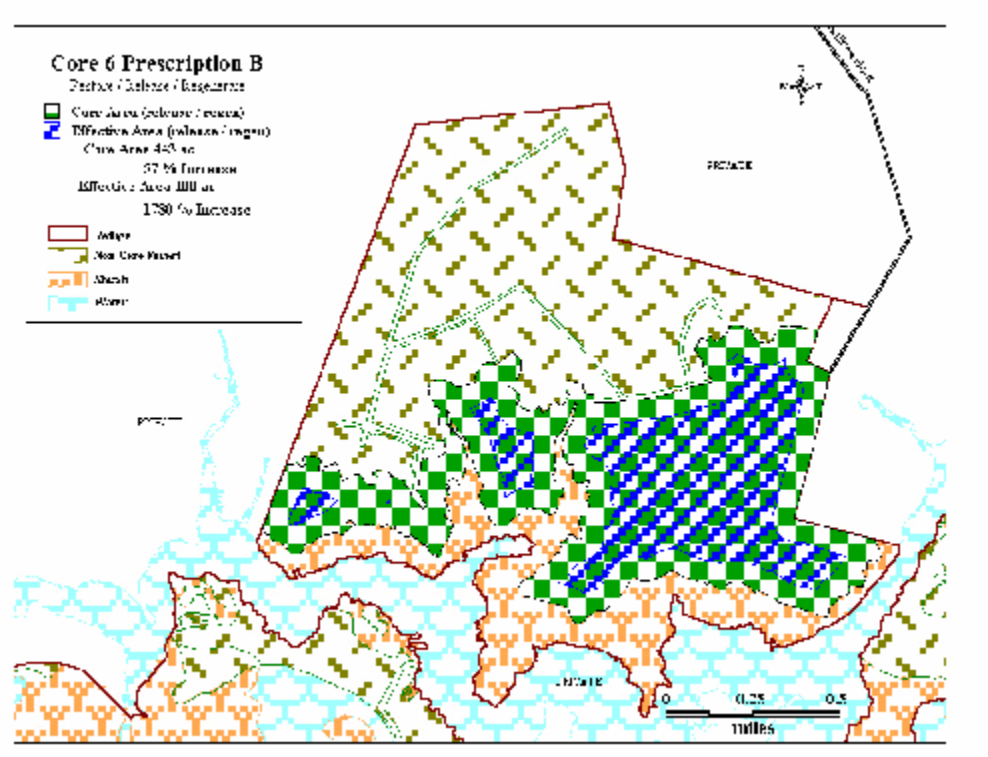

Figure 4.14. Core 6 with consequences of Release.

3.) Timber Stand Improvement 2 .
A variety of timber stand improvement techniques will be used within the next 15-years to improve growing conditions for preferred species on approximately 580-acres of previously harvested land. These areas were virtually clear-cut with the exception of some small hardwood dominated pockets which were high-graded. These previously pine dominated areas have since regenerated to a hardwood dominated forest consisting of mostly red maple and sweet gum. Due to the dense and vigorous growth of these early successional species, pine regeneration is sparse and oak regeneration is almost non-existent. The age of the newly established stand is 10 to 15 years. Due to the lack of management during the early stages of stand regeneration, management at this stage will be extremely labor intensive and very expensive. By enhancing conditions of these acres along with the cut-over areas discussed under the previous prescription and ensuring that they eventually become part of the core will significantly increase this core's ability to provide potential breeding habitat for FIDs. By including these areas (in addition to the 87-acres of immature pine stands) we will collectively increase the overall size of the core by 671-acres (237%) to 954-acres. Whereas the effective area will be increased by 642-acres, or an unbelievable 6,420-percent, to 652-acres (figure 4.15). The perimeter to area ratio value will subsequently be decreased by 76-percent from 58 to 14. The resulting 954-acre core will provide potential breeding habitats for at least 9 of the 11 area-sensitive FIDs listed.

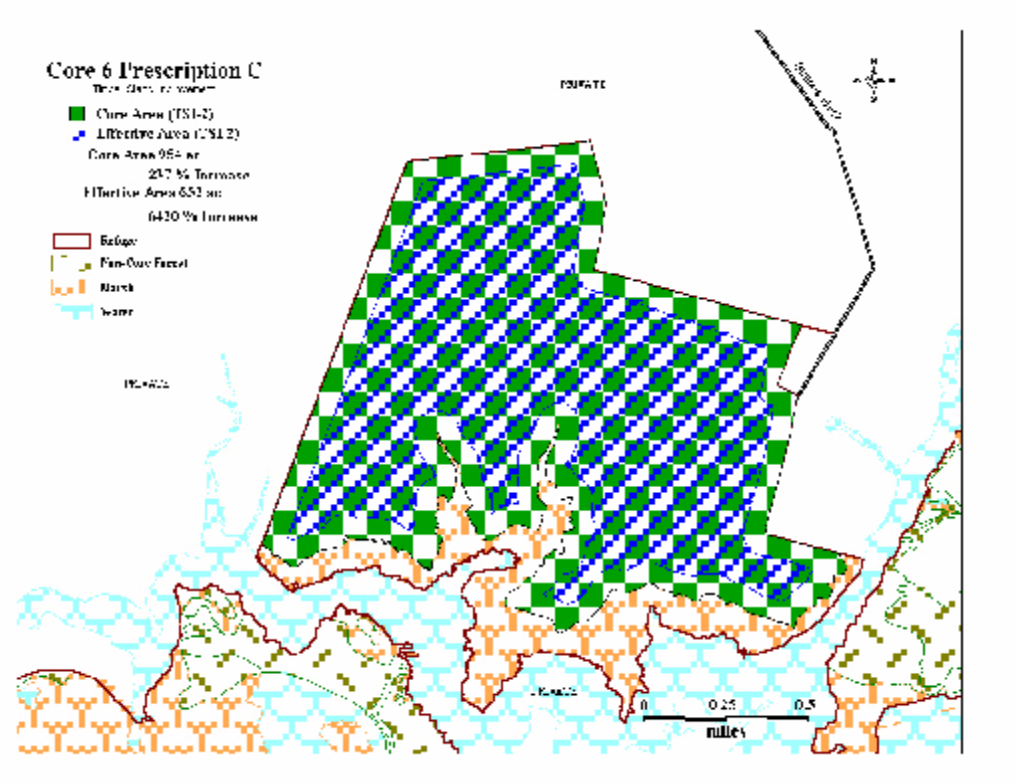

Figure 4.15. Core 6 with consequences of TSI 2.

4.) Regeneration Harvests

Techniques to enhance the natural regeneration of both hardwood and pine species under the mature canopy of high graded stands may be performed on approximately 58-acres of overmature forested habitat within this core over the next 15-years. As this core expands as a result of land acquisition, the proposed treatment acres may also increase.

The management prescriptions which will be proposed on non-core forest habitats are of somewhat less significance and will not be described in as great a detail. Additional forest management will continue to be performed within the current refuge boundary as well as newly acquired lands, however many of these specific management needs cannot be projected at this time without additional inventories and data collection. Future and ongoing management of the forest habitats will be driven by the same management goals and objectives which led us to the development of the following management strategies.

Core 7

1.) Prescription A. Land protection

Core 7 will consist of a combination of several parcels of land that are currently in the approved Conservation Biology for Trust Species Diversity yet are not under Federal ownership. These parcels are located to the north and south of Blackwater Road and have the potential of creating a 634-acre core of mature mixed pine and hardwood forested habitats. The effective area and perimeter-to-area ratio value of this core will be 366 acres and 69, respectively. No silvicultural prescriptions have been proposed for this core, since it essentially does not exist yet. However, all forested habitats will be assessed as they are protected to determine management needs. Newly protected forest lands and their management prescriptions will be appended to this plan and the forest management plan at each of the 5-year updates.

Prescriptions Common to all Forested Acres (Core and Non-core)

Timber Stand Improvements

Timber Stand Improvements (TSI), which include, but are not limited to, crop tree release, thinning, and improvement cutting, may be performed on as many as 2800 acres of immature and mature stands on Blackwater NWR that are stressed due to overcrowding and competition for resources. These techniques will most likely also be employed on the Nanticoke protection area, however, an acreage estimate could not be derived at this point. These intermediate cuttings will result in improving the growth of an existing crop of trees, but will not result in stand replacement. The selective removal of less preferred, overstocked, intermediated and co-dominant vegetation will allow the expansion of the crowns and root systems of remaining trees. The vacancies created in the growing space will not be large or permanent enough to allow height growth of any new trees that become established as a result of the treatments.

When a forest is young, it always contains many more trees than it will when it is mature. One thousand or more young saplings may initially compete for a foothold on a single acre of land. Fifty years later that same 1-acre of land will only support a few hundred trees. Performing thinnings of various types in overstocked stands will free up nutrients and other resources and promote faster growth rates, greater mast production and healthier trees. Thinning overcrowded stands will significantly reduce competition and decrease stress. Competition affects the growth of loblolly pine in varying degrees depending on the site, the amount and size of competing vegetation, and age of the loblolly pine stand. Across the southern region, average loss of volume production resulting from hardwood competition has been estimated at 25 percent in natural stands and 14 percent in plantations.

In a crowded forest, trees tend to grow very tall due to competition with its neighbor for sunlight. Tall trees in a crowded forest usually have very thin trunks. All new growth goes toward obtaining height, not girth. While crowded trees are constantly competing with each other, they also depend on each other for support. Tall, thin trees cannot support the weight of their own branches by themselves. The interwoven branches of crowded trees provide support for one another. Openings that naturally occur in a forest due to one or more trees falling will result in several thin-trunked trees losing their support. In an opening, a thin-trunked tree will suddenly find itself being buffeted by the wind, causing the trunk to sway. In response to the bending, the tree will add wood to its stem to stabilize itself. Growth hormones allow the tree to direct the growth to the stem when environmental conditions require it. The fact that trees can concentrate growth in a specific region of the tree in response to external environmental conditions is valuable knowledge to a forest manager.

By thinning forests, land managers mimic nature by following the process of natural selection. By cutting out the weak, crooked, and over-crowded trees, the strongest trees can reach their fullest potential. A thinned forest is typically healthier than a crowded forest. Once thinned, the remaining trees will expend less energy competing with other trees, which will enhance their ability to fight off invasions of insects or disease. The trees that remain after a thinning will grow sturdy, thick trunks and few will be lost to windfall.

Wildlife will benefit from these thinnings due to both the increased growth and mast production as well as the abundance of new food available on the forest floor. Most of the plants used by wildlife for food grow on the forest floor and require sunlight (Jastrzembski 2000). Thinning forest stands will temporarily increase the amount of sunlight hitting the forest floor, which will allow for the germination of many new plants. The resulting plant diversity in the understory is especially aesthetically pleasing to hikers, hunters, and photographers. When properly performed, thinnings will benefit the entire forest ecosystem and enhance the many values we receive from our forests. Thinning will also help to reduce the risk of oak decline by reducing competition for moisture and nutrients and promote better physiological condition of the remaining trees. Silvicultural practices designed to encourage species best adapted to the site can help reduce the effects of drought or frost. Removal of weak and dying trees may also reduce or delay buildups of two-lined chestnut borers.

Release cuttings (crop tree release) will result directly in increased growth rates and mast production and may also be used to regulate or modify species composition in a young stand. Precommercial crop tree releases will increase tree diameters and help ensure survival. Released trees will become mature sooner and attain a larger size at maturity. Crop tree selection will always focus on healthy trees with well-formed crowns, and should include species from both the red and white oak groups along with beech and pine. The crop tree species diversity will promote a

more consistent mast crop (Whiteman and Onken 1994). Crop tree selection will also focus on mast production, providing dens and timber quality. Crop tree release will consist of cutting only trees that are directly competing with crop trees. The process will not consist of selecting crop trees and cutting all other trees in the stand. Therefore, an acceptable level of species diversity and richness will be maintained.

Mast producing hardwoods, when released, will be able to respond by increasing both height and diameter growth and most importantly crown diameter. Hardwood mast production can be maximized and a sparse understory can be maintained by promoting large crown development of mast producers in the overstory. Mast production in immature stands (average dbh < 12inches) is likely to be very limited. Although these stands can have an open understory, they typically are overcrowded and as a result have smaller crowns. A 12-inch dbh tree will generally produce 225 percent more mast than it did when it had a 10-inch dbh. Generally mast production increases with diameter of the tree until it reaches 22–24 inches dbh, at which time mast production starts to decline as the tree becomes over-mature. The rate at which immature stands reach the desired conditions for DFS can be expedited by identifying potential hard and soft mast crop trees and performing a release cutting around these trees to encourage crown development (Onken and Whiteman 1994).

Loblolly pines that have developed in a suppressed condition respond in varying degrees to release. Increases in diameter growth after release are related to live-crown ratio and crown growing space. Trees of large diameters generally respond less than trees of small diameters. Trees with well-developed crowns will usually respond best to release. Trees long suppressed may grow much faster in both height and diameter after release but may never attain the growth rate of trees that were never suppressed (Baker and Langdon 1990). The following map illustrates the approximate location of stands in which timber stand improvements are likely to be performed over the next 15 years on Blackwater NWR.

Regeneration Harvests

Techniques to enhance the natural regeneration of both hardwood and pine species under a mature canopy may be employed on as much as 2,033 acres of mature and overmature forested areas on Blackwater NWR over the next 15 years. These techniques most likely will also be employed on the Nanticoke protection area; however, an acreage estimate could not be derived at this point. A variety of the previously mentioned regeneration treatment will be implemented and closely monitored to evaluate the level of success for each technique. The various methods may consist of single tree and group selection, shelterwood, seed tree or strip and patch cuts. The most frequently used methods will be single tree selection and shelterwood techniques due to the minimal impacts on the forest canopy and the lesser effects on the integrity of the cores. Performing these prescriptions will have no direct impacts on the size, effective area or perimeter-to-area ratio of the core.

Additional techniques such as group selection, strip and patch cuts and seed tree harvests will only be used when it has been determined that they are the only or best option for regenerating an over-mature or unhealthy stand. Within core areas, these methods will only be performed when lands of equal or greater quality in terms of acres, age and species composition can be added to the core to offset the temporary impacts on the size and perimeter-to-area ratio of the core.

Performing regeneration harvests in some of the mature and over-mature stands throughout the Refuge Complex will reduce the potential for forested habitats to become stagnant. As trees become over-mature and reach the end of their life, as is the case with many pines in these stands, their growth rates slow considerably and mast or seed production is severely reduced. The selective removal of dominant and co-dominant canopy trees that are nearing the end of their life will allow necessary light to reach the forest floor to facilitate seed gemination and free up additional resources to enhance the growth of new regeneration.

In most cases, the resulting natural regeneration will likely be dominated by pine, red maple, sweet gum and possibly beech. Due to the many complications related to the germination of oak seeds, such as parasitism, predation, and other various site conditions, it is likely that oak regeneration will be minimal. The planting of oak or other hard mast producing species may be required in these openings in order to ensure their replacement and continued occupancy of the stand. Additional future silvicultural treatments may be required to ensure survival and optimum growth of new trees, thus increasing their chances of achieving dominance in the stand.

Creating openings in the canopy will not only enhance natural regeneration but will also enhance growth and mast production of remaining trees, much like a crop tree release. The perpetuation of the stand through promoting regeneration and the associated improvements in mast production will have significant long-term benefits for DFS. Future implementation of TSI techniques will ensure that the species composition of these stands is not significantly altered. The following map demonstrates an approximate location of regeneration harvest to be performed over the next 15 years on Blackwater NWR.

Reforestation and Planting

Reforestation or tree planting may need to be implemented on as much as 500 acres of recently harvested forest lands pending results of regeneration survey. Harvested areas that are stocked with less than 500 trees per acre of either pure pine or a mix of pine and hard mast producing hardwoods will require supplemental planting. These measures will be implemented to ensure that these areas regenerate and replace the harvested stand with a new stand of the same cover type and species composition. Assisting the regeneration of replacement of pine and hard mast producing hardwood will reduce the chances of these areas converting to nearly pure red maple and sweet gum stands.

In areas where the stocking of preferred species is extremely low or nonexistent and undesirable vegetation has dominated the site, site preparation will be required before supplemental planting takes place. Some areas may still contain seed trees that continue to provide a fresh seed source. However, as a result of dense undesirable vegetation and less than desirable seed bed conditions, these seeds are unable to germinate. Site preparation techniques will be employed to improve the likelihood of successful seed germination. Site preparation methods may be performed in conjunction with methods to control competing vegetation (below) when necessary.

Subsequent treatments to reduce competition will also be implemented to ensure the survival and dominance of preferred species. It is highly probable that these same strategies will be implemented on similar lands within the Nanticoke protection area. Restoring these heavily cut over areas will significantly improve the fragmentation of forested habitats and in many cases directly enhance core areas. Sustaining and managing our forests to their optimum potential will provide long-term benefits to the health of the Chesapeake Bay watershed.

This acreage estimate does not include the 60+ acres of prior converted wetlands that will be restored to forested habitats, unless it is directly related to enhancing the integrity of a core. All of the prior converted wetlands that currently are slated to be reforested are illustrated in the “Prior Converted Wetlands Management Program.” The map below illustrates the approximate areas that may require.

Control of Problem Vegetation, Regeneration Release, and Site Preparation

Undesirable vegetation is widespread throughout the forest of North America. By definition, when vegetation conflicts with the land management goals it becomes a weed problem. Forest weeds may be grasses, herbs, shrubs, vines and trees of any species that interfere with the objectives whether they are timber, wildlife habitat, recreation or other uses. The control of weed species will be performed on approximately 2,000 acres of currently owned cut over areas or abandoned agricultural fields. Most weed control is performed to enhance timber production but wildlife habitat goals are also achieved through weed control. Weed control in these areas will increase the survivability, growth and production of desired species and therefore increase their wildlife benefits.

Forest weed problems are usually a result of human activities, such as logging or abandonment of agricultural fields. Many of the more successful weed species are of exotic origin, against which native species are not adapted to compete. Significant occurrences of weed problems often lead to a weed or weed-dominated community replacing the trees removed. The results are brush fields or stands of undesirable species and substantially decreased value. The systematic removal of weeds favors the development of the desirable species. Weed control will also ensure faster establishment and maturation of desired tree species. Forest weeds, if not treated may preclude the production of more desirable species for decades or centuries. We must also take into considerations that forest weed control operations are extremely visible and may result in a certain level of public scrutiny. However, through sound public education efforts, this issue should be resolved before it becomes an issue.

Nonchemical methods of forest weed control tend to disturb soils and be limited in effectiveness. They may even stimulate other weed problems. The use of chemicals for the control of woody weeds is probably the least accepted method by the public. However, it is generally the least expensive, causes the least amount of soil disturbance, and provides control for the longest period of time. All applications will be performed in accordance with current labeling and Federal, state, and local regulations. Therefore, negative biological impact will be minimal.

Manual methods of controlling weed species are generally limited to work with hand tools and are very labor intensive. The effects of manual weed control methods on the competing brush community are limited to the temporary reduction in height and an increase in the number of stems. The regrowth of some species is so rapid that repeated treatments may be needed to accomplish release; However, each successive treatment is more costly than the first due to the accumulation of debris and the proliferation of sprouting stems. Some other disadvantages include high cost per treatment, difficulty in finding a willing labor force and high personal injury rate.

Mechanical control methods include grubbing, discing, bedding, chopping, and crushing. Heavy equipment has the greatest impact on the site than any other method and has resulted in reductions in productivity in some southern and western operations. The advantages of mechanical methods are that the probability of attaining prescribed objectives is high. The operation can also provide residual browse and can double as preparation for prescribed burning. Disadvantages include comparatively higher cost, high energy consumption, possible soil degradation, and the resulting debris may affect access and plant response.

Bedding is generally used in wet areas to create raised micro environments where seedlings are planted; however, by creating microtopography, the beds may also serve as a deterrent to the growth of some woody species. The plowing of the beds may also result in damage to the roots of potential weeds thus providing some level of control.

Prescribed burning will be used extensively for seedbed preparation; site preparation for planting; and the control of undesirable vegetation. Prescribed burning benefits oak regeneration in several ways (Van Lear,1992). Fire removes excessive litter buildup from the forest floor, thereby preparing a favorable seedbed. Areas of thin litter are preferred by squirrels and blue jays for acorn burial. Jays collect and disperse only sound acorns, which implies that any acorns not consumed have a good chance of developing into well-established first-year seedlings. Seedlings from freshly germinated acorns are unable to emerge through a heavy litter cover. Fire helps control insect predators of acorns and new seedlings. Many of these insects spend all or part of their lives on the forest floor. Infestations, which can vary from year to year and even from tree to tree in some areas, are a major contributor to the oak regeneration problem. Burning may also cause damage to rodent habitats which, in turn, will reduce the rodents' consumption of acorns.

Severe or frequent fires will tend to xerify (dry) the surface of forest sites by consuming much of the forest floor and exposing the site to greater solar radiation through canopy reduction. Adequate advanced oak regeneration in the East is generally found more often on xeric sites than on mesic ones. Conversion of mesic sites to more xeric conditions by intense fires or by long regimes of low intensity fires could explain in large part the ability of oaks to dominate sites where more mesic species normally occur. The absence of fire since the turn of the century has allowed species that are intolerant to fire to become established and grow to a size where they, because of thicker bark associated with age, can now resist fire (Carter 2000).

Prescribed burning is comparatively cheap, causes little soil disturbance, and may enhance availability of nutrients. However, the chance of fire's escaping is always a factor; smoke may degrade air quality; if fire is too hot it may damage soils; and, there is often a narrow window when treatments can be applied. Fire will induce vigorous sprouting from older root stocks of oaks and other hardwoods, which also may prove to be a preferred reproductive technique (Snyder 1992).

Prescribed burning (for TSI)

Prescribed burning will be used to enhance wildlife habitat and forest condition on approximately 2055 acres of currently owned forested habitats. Conducting a single prescribed burn in areas that contain an extremely dense understory will provide temporary control woody and herbaceous vegetation in the understory. A series of two or more annual burns will provide a significantly greater period of control, thus enhancing habitat quality for DFS. The

reduction in understory density will improve the ability for DFS to forage and escape predators. Prescribed burning will also be used to reduce excess fuel loads that have built up over the years due to a lack of or poor management.

Prescribed burnings in forested habitats will benefit most wildlife species including the endangered Delmarva fox squirrel and certain species of FIDs through hazard reduction and habitat enhancement. Prescribed burning will assist in maintaining open understory conditions that are favored by DFS and promoting habitat diversity and food availability. Studies conducted in southeastern forests have demonstrated effects of fires on fox squirrel habitats, such as improved cone and mast production, restoration of a grassy understory, and increases in other fox squirrel foods such as fungi (Weigl, et al. 1989). Fire will help maintain the pine and pine–hardwood habitats preferred by fox squirrels and will directly increase the availability of fox squirrel foods. Prescribed burning at 2- to 5-year intervals can be beneficial to fox squirrels by maintaining an open understory and better foraging habitat.

Responses of the understory to prescribed burning will vary with frequency and season of burning. Periodic winter burns keep hardwood understories in check, while a series of annual summer burns usually reduces vigor and increases mortality of hardwood rootstocks (Baker and Langdon 1990). Dormant-season prescribed burning is often used in hazard fuel reduction practices, and is frequently used on the mid-Atlantic coastal plain. Studies in southeastern forests (Wade and Lunsford 1988) have shown that growing-season fire can be more effective at reducing forest understory and other woody cover. While dormant-season fires top-kill woody plants, many species resprout vigorously following such fires, using stored energy reserves. In contrast, growing-season fires are more likely to damage root collar tissues (Wade and Lunsford 1989), reducing vegetative resprouting. Growing-season fires kill aboveground woody plant organs after plants have mobilized photosynthate reserves, making such plants less competitive.

Common understory plants targeted for reduction to benefit fox squirrels include vines such as greenbrier (*Smilax* sp.), Virginia creeper (*Parthenocissus quinquefolia*), and Japanese honeysuckle (*Lonicera japonica*), and mid-story species such as sweet pepperbush (*Clethra alnifolia*), American holly (*Ilex opaca*), sweet gum *(Liquidambar styraciflua)*, black gum (*Nyssa sylvatica*) and even red maple (*Acer rubrum*). Growing-season fires may be more effective at reducing cover of these species than dormant-season fires. The open stands produced by fire will result in better pine cone and hardwood mast production. Pines and oaks growing in the open receive more light, maintain more branches at lower levels, and produce heavier crops of cones and acorns. Additionally, nutrient availability and the enhanced vigor of burned pine forest are associated with larger crops of fungi, which are also important fox squirrel foods. A lush, grassy understory maintained by fire is important as protective cover.

Fox squirrels may not be able to escape fast-moving fires; however, they could probably easily escape low-severity ground fires. Researchers found no evidence that prescribed burning caused significant direct mortality among fox squirrels. Wildfires could destroy leaf nests, nest trees, and fox squirrel nestlings. However, cavities used for dens and leaf nests are usually above the impact zone of prescribed burnings. Care will be taken to protect den and nest trees.

Fire has probably been a determining factor in the niche separation between gray and fox squirrels on the Coastal Plain. Both exist in mixed pine–oak forests and feed heavily on acorns, but the more competitive gray squirrel dominates where the overlap of oak crowns allows tree-to-tree travel throughout the canopy. Fox squirrels are more abundant where patches of oaks comprise less than 30 percent of pine–hardwood stands and do best in fire-type pine forests with scattered hardwood inclusions. Fire could be a deciding factor in determining the availability of suitable habitats and resources for one or the other species. Fire may also have a negative effect on fox squirrels by destroying acorns in the forest duff layer.

While it suggested that prescribed burnings are beneficial for Delmarva fox squirrels, the potential impacts on other species, such as breeding or wintering bird communities in coastal plain forests are unknown. Changes in the structure and function of the plant community may influence the productivity of individual bird species, and affect seasonal avian community structure and richness. Some members of the avian community in mature forests of the coastal mid-Atlantic nest or forage on the ground; e.g., Common Flicker (*Colaptes auratus*), Black and White Warbler (*Mniotilta varia*), and Louisiana Waterthrush (*Seiurus noveboracensis*). Species such as the White-eyed Vireo (*Vireo griseus*) nest and forage in the shrub canopy. Wintering species, such as the Hermit Thrush (*Catharus guttatus*), forage on the ground while other winter species, such as Yellow-rumped Warbler (*Dendroica coronata*), depend upon food and cover from mid-story plants such as poison ivy (*Toxicodendron radicans*), winterberry (*Ilex*

verticillata), American holly and greenbrier. Ground- and mid-story nesters and foragers may be affected by prescribed burning through elimination of escape or nesting cover, foraging substrate, and shrub and vine foods. Growing-season fires may directly disrupt breeding activities for ground- or mid-story nesters if carried out during peek breeding seasons (Mitchell 2000).

The acres shown under "Prescribed burning" in the "Silvicultural Prescriptions Matrix" reflect only those acres that will benefit from prescribed burning in the near future based on current conditions. As conditions change in other forested areas and new lands are protected, these figures will change significantly during the life of this plan. These acres do not reflect those lands that the Refuge Complex Fire Management Officer or Fire Control Officer declares as having excess fuel loading and as wildfire hazards. Hazardous fuel reduction burns may be performed at the discretion of the Fire Management Officers, with informal coordination with Biological and Management Staff to determine any significant negative impacts on wildlife populations or their habitats and Refuge Complex infrastructures.

Prescribed burning is not only effective for manipulating understory vegetation to enhance wildlife habitat, but also for reducing excessive fuels (hazard reduction), disposing of logging slash and preparing planting sites and seedbeds. For more details on the environmental consequences of prescribed burning please refer to the "Fire Management Program" section of this document as well as the "Fire Management Plan" and associated Environmental Assessment for Blackwater NWR.

Restoration of Atlantic white cedar on Nanticoke protection area will result in minimal negative yet significant positive biological impacts. Atlantic white cedar usually grows in pure of near pure stands. Restoring applicable sites to historical conditions will once again result in a dramatic shift in species composition and forest structure. Tree species that are more suited to adequately drained soils will ultimately die off, if not harvested as part of the restoration process. The majority of hardwoods and pines that have occupied or dominated these sites following the most recent extraction of Atlantic white cedar timber and the installation of ditches will most likely be removed in order to allow for the germination of stored cedar seed and facilitate the growth and survival of seedlings. Converting the current mixed deciduous and coniferous forest to a conifer-dominated forest may displace certain avian and terrestrial species that are more adapted to drier mixed forest stands. The removal of hardwood and pine species will reduce the amount of available mast and may force those species that depend on hard and soft mast as a seasonal food source to disperse in search of food.

It is most likely that restoration will only be performed on a small scale, therefore, impacts will be minimal. If remnant cedars still occupy the site, the removal and subsequent control of all other trees will allow adequate light to reach the forest floor and facilitate the germination of viable seed stored in the duff layer of the soil, while effectively scarifying the soil in preparation for newly fallen seed. In cases where no cedars remain, soil disturbance during the harvest operations will expose the organic layer of the soil and created micro-relief, which will enhance survival of planted seedlings. The alterations in hydrology will decrease the ability of most trees' seeds to germinate due to longer periods of standing water. The increase in soil and surface water will enhance the breakdown of leaf litter, the accumulation of organic matter and, possibly, the restoration of sphagnum moss beds, which are essential factors in the storage and germination of Atlantic white cedar seed. The changes in surface water conditions (i.e., longer periods of flooding) will also displace certain ground dwelling species that cannot tolerate flooded conditions.

However, increased soil moisture will significantly improve the habitat suitability for amphibians. Although certain species of wildlife will be negatively impacted by the temporary loss of habitats, change in hydrology and ultimate cover type conversion, many species will end up benefitting from the restoration of Atlantic white cedar swamps. Mature cedar stands form dense tall canopies that are preferred by many species of birds including Neotropical migrants and FIDs. The dense canopy shades the forest floor resulting in a very sparse understory. The understory composition will likely be converted from a dense cover of *Smilax,* fetter bush and sweet pepper bush to a scattering of highbush blueberry, sweet bay magnolia and sweet pepper bush. Mature cedar stands also provide excellent shelter for all wildlife during severe weather.

D. Cropland Management

Background

Agriculture, more than any other human activity, has had a profound influence on North American waterfowl and other wildlife (Ringelman 1990). Sadly, many people relate only to the negative influences and environmental effects of historical agricultural practices: the conversion of grasslands and the clearing of forests, the drainage of wetlands, the use of pesticides, and the degradation of water and air quality due to siltation and dust, just to mention a few of the most obvious. However, the benefits of present-day croplands to waterfowl and other wildlife are significant and beneficial (Ringelman 1990).

Although the use of crops as a wildlife management technique is relatively new, the consumption of grain by waterfowl and other wildlife is not. Archaeologists tell us that Native Americans cleared creek and river bottoms and planted them in diverse crops 2500 years before the arrival of Europeans. Chroniclers of the Ponce de Leon, Narvaez, and DeSoto expeditions in the 16th century mention the extensive agriculture practiced by the southeastern tribes. Corn was a major crop, and when their fields in river bottoms were flooded, the corn that grew there and the ducks that visited them were brought together.

Writers of the late 17th century tell how ducks flocked to the rice fields of early settlers in South Carolina. David Doar, in "Rice and Rice Planting in the South Carolina Low Country," writes "After harvest, birds were left to glean the fields, and no one on a plantation dared molest them. After they had gotten through and the ducks came down, every field was flowed for them and though there were thousands of them in each field, they were as sacred as the white elephant, and neither the Negroes on the place nor the sons of the planter were bold enough to take a shot." The explanation lies in the fact that the waterfowl were reducing the volunteer and red rice the following year. Waterfowl and many other species of wildlife are opportunistic feeders, and have learned to adapt to changes in the environment around them. For example, many species of waterfowl, including, but not limited to, Canada geese (*Branta canadensis*), snow geese (*Chen caerulescens*), mallards (*Anas platyrhynchos*), northern pintails (*A. acuta*), and green-winged teal (*A. crecca*) have learned to capitalize on the abundant foods produced as human expansion and anthropogenic effects on native habitats changed the face of North America. In the last four centuries, much of our best wildlife habitat has been drained, filled, and cleared for development; ditched and channeled for drainage, flood control, and navigation projects; and polluted with heavy metals, chemicals, and pesticides. As agriculture has spread over the landscape, waterfowl migration routes and wintering areas have changed in response to these readily available high energy foods. Many species have developed such strong traditions in their use of certain croplands that many populations are now dependent upon agricultural foods for their winter survival (Ringelman 1990). The production of enough food to support winter populations remains one of the major problems in managing waterfowl today.

Cropland management has been an integral component of the development of Blackwater NWR since its establishment in 1933. In fact, its expanding and changing cropland management practices first brought Canada geese to the refuge. Every year for the past 65 years, the refuge has been encouraged to use cropland management to produce large quantities of highly nutritious foods on relatively small areas to help offset the loss of natural foods. The proof of the success of these cropland management programs is the diversity and abundance of the wildlife that now depend on them.

As waterfowl populations increased on the refuge in the late 1950s, particularly Atlantic population (AP) Canada geese, it is interesting to note that refuge staff began conducting all of the cropland management activities after 26 years of cooperative farming. Staff continued managing all cropland management activities until 1970, when there was a return to cooperative farming. This shift in management emphasis and direction coincided with a decade of significant marsh loss and natural habitat degradation, and waterfowl populations soon fell by as much as 70 percent or more. As historical waterfowl numbers continued to decline, refuge staff, in an effort to better meet the nutritional needs of wintering and migrating waterfowl and other wildlife, resumed "force account" management in 1989.

We base our cropland management on the principle "Wildlife First," rather than on primarily economical, historical, or sociological considerations. We are not proposing cropland management on the Chesapeake Islands.

Strategies for Blackwater NWR

A minimum of 420 acres of existing croplands, or 2 percent of the total refuge acreage, will be managed annually to achieve refuge purposes and wildlife management objectives.

Our first option will involve planting approximately 100 to 120 acres in corn and milo (sorghum), and approximately 300 acres in cool season grasses and forbs, consisting of ladino or crimson clover, annual rye grass, and winter wheat (over-seeded with buckwheat). A total of 100 percent of the crops will be left unharvested exclusively for wildlife utilization. Lands having Conservation Reserve Program or similar easements will be managed and maintained in accordance with NRCS guidelines and requirements. The planting of the corn and milo will be contracted each year on a competitive bid basis to a local farmer for a fixed price per acre, and will be left unharvested for use by waterfowl and other wildlife. Refuge staff, equipment, and operational dollars will be used to plant and cultivate the cool season grasses and forbs. Crop rotations will occur on a three to one ratio: three years in cool season grasses or forbs, followed by 1 year corn or milo, then back to grasses and forbs for another 3 years. The corn and milo acreage will not be plowed under in the spring, but will be left to succeed to warm season grasses after the annual rye grass, or crimson clover has died with the onset of warm weather. Only in the fall will these lands be cultivated and replanted to winter wheat or buckwheat, which later will be over-seeded back to ladino clover the following February (freezing in the seed rather than planting with normal tillage). The wheat will be allowed to mature in early summer to provide food for passerines and other wildlife.

If sufficient funding for the first option described above were not available, our second option would be to manage the cropland program with cooperating farmers. Please refer to the procedure described in the section on the Nanticoke protection area, below. Because of the nature of cooperative farming and the requirement for an economic incentive to obtain or retain cooperating farmers, the cropland management scheme and rotations would be significantly different than the first option. Most likely, 100 to 120 acres of corn or milo and 300 to 320 acres of soybeans would be planted annually with the refuge's share being the entire corn crop for wildlife use. The cooperating farmer would harvest all the soybeans as his 75-percent share and his incentive for planting and leaving the 100–120 acres of corn or milo unharvested to meet refuge purposes. While this option would save operational dollars, such a program would significantly reduce the amount of high protein clover crops and "green browse." To maintain similar benefits for wintering waterfowl and other wildlife, these important food resources would be replaced by top-seeding the harvested soybean fields with winter wheat or crimson clover in the fall, following soybean harvest. Because wintering waterfowl would totally consume these "green browse" crops, over-seeding would not be economically feasible for cooperating farmers and, thus, necessitate that the work be done "force account" by refuge staff.

Regardless of the option, filter strips will be planted and maintained by refuge staff around each of the field units. Runoff will be directed into existing impoundment systems prior to entering natural waterways. Only annual cropland management plans that utilize BMPs and integrated pest management will be developed and approved by NRCS prior to implementing actions. Conservation tillage and no-till farming practices will be widely utilized and preferred over conventional methods. While animal waste is readily available and will be considered as a substitute to inorganic sources of fertilizers, the Service's Wildlife Disease Lab has recommended against use of organic fertilizers due to the potential of disease transmission. All crops, to the greatest extent possible, will remain unharvested to be utilized by wintering waterfowl, Neotropical migrants (birds and butterflies), endangered species, and other wildlife. Standing crops, corn and milo, will only be manipulated (mowed or knocked down) after the waterfowl season to avoid conflicts with baiting laws. The unharvested corn crop will be aerially over seeded with annual rye grass or crimson clover to provide additional forage, soil stabilization, and improved water quality during winter. Cropland areas will be closed to public use to ensure undisturbed availability and utilization. A special effort will be made to plant corn and milo food plots in strips adjoining forest lands to provide supplemental food for Delmarva fox squirrels. Corn and milo fields will be set back from roadways by a minimum of 100 feet to minimize vehicular mortality to Delmarva fox squirrels that might be enticed to these food sources.

Annual monitoring programs will be implemented to evaluate the program's contributions to refuge purposes on both areas. Adaptive management techniques will be applied on all refuge lands.

E. Moist Soil Management

Background

Wetland habitats for waterfowl and other wildlife in the Atlantic Flyway have been significantly reduced in both quantity and quality due to adverse natural and human impacts over the last 200 years. An estimated 53 percent of the wetlands in the lower 48 states was lost between 1780 and 1980, and losses continue at the staggering rate of 260,000 acres per year (Frederickson and Reid 1987). Nearly half of that loss occurred in the Atlantic Flyway States as a result of urban sprawl, commercial development, dredging, road construction, agricultural drainage, and other factors.

In addition to experiencing similar external pressures during the past 70 years, waterfowl using Blackwater NWR have been adversely impacted by the loss of more than 7,000 acres of historically important wetlands due to sea-level rise, land subsidence, saltwater intrusion, and excessive herbivory. These threats have also adversely affected the wetlands in the Nanticoke protection area. The resulting impacts on breeding, migrating, and wintering waterfowl and other wildlife have been significant. Once, waterfowl and other wetland-dependent species had innumerable options to meet their needs in the annual cycle. Today, however, those options are very limited, making habitat enhancement and management more essential in meeting the demands of wildlife and people. Waterfowl are being forced to concentrate in fewer and smaller areas. Continued wetland losses increase the importance of sound management of the remaining wetlands and the need for the creation of new wetland habitats.

Human activities have modified the natural hydrology of most remaining wetlands in the conterminous United States, and such hydrologic alterations have frequently reduced wetland productivity. Therefore, the restoration of wetland functions and productivity often requires the development of water distribution and discharge systems designed to emulate natural hydrologic regimes.

In waterfowl conservation, it is becoming more difficult to maintain populations at a stable level. Thus, the need to maximize waterfowl management efforts (Whitman, et al. 1995). The possibility of acquiring substantial tracts of wetlands or other waterfowl habitat is decreasing. Moist soil management is a relatively new science that often is used to offset the loss of natural wetlands and provide their historical functions and productivity. In his early work in the Illinois River Valley, Dr. Frank Bellrose coined the term “moist soil” plants to refer to species that grew on exposed mudflats. Since then, wildlife managers have used the term “moist soil management” to refer to the management of man-made seasonally flooded impoundments. This very intensive management activity requires the construction of dikes or levees, the correct placement of water control structures, the construction of water delivery and discharge systems, and the active manipulation of water levels (1) create soil and water conditions for the germination of desirable plants, (2) control nuisance vegetation, (3) promote the production of invertebrates, and (4) make foods available for wetland-dependent wildlife.

Moist soil management has been an integral component of Blackwater NWR since the first dikes (levees) were constructed in the early 1940s. As the science of moist soil management improved, it encouraged the refuge to produce large quantities of highly nutritious foods on relatively small areas, to help offset the loss of foods in the degraded and quickly disappearing natural marshes. The proof of the success of our moist soil management program lies in the diversity and abundance of wildlife, particularly migratory birds, that now depend on its products. Within the Nanticoke protection area, only by a few private landowners and the Maryland Department of Natural Resources now practice moist soil management.

Strategies for Blackwater NWR

A minimum of 460 acres of moist soil management impoundments will be annually managed to achieve refuge purposes and wildlife management objectives. An additional 90 acres of existing prior converted croplands will be restored to this type of wetland management requiring an estimated two additional miles of levees, 10 more water control structures, and two and a half more miles of ditches and water distribution systems. It should be noted that additional cropland acreage is not being proposed for conversion to moist soil management because the remaining cropland acreage does not contain soils suited for this type of management, and because the conversion of the

remaining cropland will result in flooding neighboring private lands or create drainage problems on state and county highways.

Improvements in the existing 370 acres of moist soil management impoundments will stress fine tuning of water control; improved monitoring and research related to water chemistry and plant and invertebrate response; improvements and replacements of water control structures; reconfiguring dike slopes; maintaining water distribution canals and ditches; and providing individual water control for each unit. Two 8-inch vertical low lift pumps, one in each of the existing Pool 3 and Pool 5 systems, will be installed to better facilitate drawdown and flooding. Three additional water control structures will be installed between Pools 3A-3B, 3B-3C, and 5A-5B. In the Pool 4 system, the water control supply structure will be replaced and a new pumping and delivery station will be install. The main river dike around Pools 3 and 5 will be resloped and rip-rapped on the marsh side to prevent erosion.

Strategies for the Nanticoke protection area

It is currently impossible to determine the exact acreage that will be included in a moist soil management program, but it is certain that moist soil management will be desirable and practiced on new additions to the Refuge System. It is estimated that moist soil management will be practiced on 2 percent, or less, of the entire refuge acreage. Moist soil management impoundments will be constructed only in prior converted, existing agricultural fields where the proper soil, topography, and water supply exist to accommodate the infrastructures and management actions.

Specific management activities in all the moist soil impoundments, regardless of the specific refuge area, will attempt to mimic natural conditions with drawdowns in the spring and reflooding in the fall. Drawdowns will typically occur between mid-March and early June, depending on the wildlife objectives and plant and invertebrate response desired. Drawdowns will be staggered among moist soil management units. All drawdowns will be completed by mid-June and pool bottoms will be maintained as moist as conditions will allow to facilitate the germination, growth, and production of a wide diversity of emergent moist soil plants. (See chapter 3, “Affected Environment.”)

Water levels and chemistry will be monitored and recorded weekly during the growing season and biweekly during periods of flooding. Exact water level management protocols will be described in an Annual Water Management Program, and will consider bird migration phenology. Vegetation transects will be conducted between mid-June and mid-July, and again in early September, to determine success of vegetative response and required management action. When preferred vegetative response failed, and weeds such as cocklebur and fleabane became dominant, these areas will be disced and planted in milo or millet, rather than let these weeds mature and further contaminate the seed bed. Gradual reflooding, using rainfall runoff and the assistance of pumping from adjacent ponds and existing wells, where available, will occur in September. Optimum water depths of 6 to 12 inches will be maintained throughout the winter season.

The general objective will be to have 85 percent of the surface area of a moist soil management unit flooded to the optimum foraging depth at the peak of fall waterfowl migration. Water from the adjacent Blackwater and Nanticoke rivers will not be used for flooding and moist soil management purposes due to the high salinity that will kill the soil and the fresh water vegetation. Rejuvenation of the seed bed and control of “undesirable” species will be required. Occasionally, chemical control will be necessary to combat invasive species such as Phragmites and purple loosestrife, but mechanical control will be the preferred method of control.

Annual monitoring programs will be implemented and improved to evaluate the program’s contributions to refuge purpose(s). Additional research will be conducted to determine effects of the management activity on wildlife populations, water quality, and waterfowl energetics and nutritional needs. Adaptive management techniques will be applied.

F. Prescribed Fire Management

Background

In 2000, we completed NEPA compliance and planning, along with our Environmental Assessment (EA), of the wildfire management program for using prescribed burning as a tool in managing woodlands, croplands, and marshes on the Refuge Complex. Our Regional Director approved the FONSI and the final Fire Management Plan (FMP) on September 7, 2000, and September 15, 2000, respectively. Therefore, for the purposes of this CCP, the fire management program will be conducted as previously approved and described in the FMP.

Please note that the fire management program is presented in this context rather than as separate components or tools of the respective habitat management activities because of the tight parameters of how, when, and in what habitats we will use prescribed burning. A complete copy of the FMP and EA can be obtained upon request from Refuge Complex headquarters. The relevant consequences of those actions are described in detail in the original EA.

The Fire Management Plan preplanning began in January 1995. Its purpose was twofold: (1) to develop a FMP as a guide to fire management activities that complied with Department of Interior policy as set forth in 910 DM and Service guidance in 621 FW; and, (2) to address the role of fire in the stewardship of public lands. Operating under NEPA requirements to "use a systematic, interdisciplinary approach that will insure the integrated use of the natural and sdocial sciences in planning and in decision making," Service and Maryland DNR staff recommended and agreed upon an external, five-member, interdisciplinary team to independently and objectively review and evaluate the issues and develop the alternatives. Both professional and general public scoping meetings were held in July 1995, and 48 issues were identified and presented to the panel. The panel convened at Blackwater NWR on August 28, 1995 for briefings and site tours for two consecutive days. On August 30, 1995, the panel heard testimony from 22 expert witnesses, who gave presentations on various topics related to the issues identified during public scoping. On August 31, 1995, the panel deliberated on the issues with DNR and Service staff, and sequestered themselves on September 1, 1995, for final deliberations on the reasonable and prudent alternatives to be considered.

The Service, in cooperation with DNR, developed a Fire Management Plan (FMP) that would use a multiple-objective fire program on Blackwater NWR and Fishing Bay WMA. Under this program, the Service established, in conjunction with its annual prescribed burning and wildfire suppression programs, monitoring areas to document and evaluate vegetative responses to fire exclusion and to prescribed burning rotation intervals of 1 year, 3 years, and 10 years, in representative marsh and woodland habitats on Blackwater NWR and Fishing Bay WMA. This effort would identify which rotation would yield the most beneficial vegetative response and associated wildlife and public benefits so that such knowledge could be incorporated into fire management practices in order to best accomplish the following management objectives.

Nineteen Fire Management Objectives

1. Provide a level of wildland fire management that will result in the least cost plus net value change (cost efficient level) commensurate with resource management objectives and constraints.

2. Reduce wildfire impacts on all resource management activities. Reduce the threats associated with accumulations of hazardous fuel loads in marsh and woodland habitats, and with arson fires in the intermingled Federal, State, and private lands along the wildland–rural interface.

3. Assure that no disruption of service or adverse impacts on transportation and utility corridors occur from wildland fires.

4. Provide, maintain, enhance, and protect habitats for State and Federal endangered and threatened species, and species of special concern.

5. Provide, maintain, enhance, and protect feeding, resting, nesting, and brood habitat that meets the

requirements of migratory waterfowl, other migratory birds, and resident wildlife.

6. Maintain health and vigor of marsh vegetation, maintain current marshland acreage and species composition, and reduce brush invasion into marshlands.

7. Facilitate the control of resident and exotic furbearers.

8. Manage refuge woodlands to produce traditional forest habitat values: wood, water, wildlife, and recreation.

9. Encourage the regeneration and growth of desirable forest stands by disposal of logging slash, preparing sites for seeding and planting, reducing encroachment of undesirable species, and reducing understory competition.

10. Protect, maintain, and enhance refuge grasslands.

11. Encourage and maintain native herbaceous growth on abandoned cropland areas.

12. Provide diverse and abundant food crops in agricultural and moist soil management units to meet the nutritional requirements of various wildlife species.

13. Control Phragmites expansion.

14. Maintain current ecosystem diversity within the landscape context.

15. Contribute to the recovery and restoration of the Chesapeake Bay ecosystem's diversity and function.

16. Comply with State Air Quality Implementation Plans to protect public health and the environment.

17. Provide public trapping opportunities for furbearer population management, exotic species control, recreation, and economic benefit.

18. Serve as an outdoor laboratory for ecological research, study of management effects, and public education.

19. Protect valuable resources of international, regional, and local significance.

Reasonable alternatives, for the purposes of this evaluation process and planning effort, were alternatives that were justifiable, practical, and feasible from the technical, ecological, legal, policy, and economic standpoints.

The fire review panel proceeded with their work according to their charge and completed the evaluation process in April 1996. Their report was entitled "Technical Review of Fire Management Alternatives in the Blackwater National Wildlife Refuge and Adjacent Wetland Management Areas." In developing this report, panelists considered Blackwater NWR and Fishing Bay WMA as an ecological unit for the purposes of the evaluation and recommendations. In developing its recommended alternatives, the panel evaluated each of the possible burning regime's ability to meet refuge management purposes and objectives.

A joint-agency review of the panel's report was held in August 1996. The report was then distributed to those parties who had previously provided comments or expressed interest in the process. The report was also made available to the general public at the Dorchester County Library.

In January 1997, a public meeting was convened to discuss and accept comments on the panel's report. Parties in attendance were those who had provided comments at the earlier public meeting, presented information as expert witnesses to the panel, or expressed interest in attending. The consensus of those at the meeting was to accept the panel's recommendation.

Six Fire Management Regimes

The panel developed six alternative fire management regimes, including three that conform to the alternatives presented in the draft CCP and EA. See the table that follows for the acreage burned each year under each regime.

1. *Annual Fire Regime,* consistent with current management
2. *Multiple Objective Fire Regime,* consistent with our new management direction
3. *Annual Marsh plus Five-year Woodland Fire Regime*
4. *Annual and Five-year Fire Regime*
5. *Limited Suppression Fire Regime*, no active management
6. *Fire Suppression Regime*

Annual Fire Regime (Current Management: Species–specific Management)

This regime conforms to current management, the species-specific alternative in the draft CCP and EA. Under this regime, the Service will develop a FMP that will continue fire management as practiced up to 1997. Annual prescribed burning will be applied to approximately 3,000 acres (29 percent) of the marsh land on Blackwater NWR and approximately 10,000 acres (48 percent) of the marsh land on Fishing Bay WMA, for a total of 13,000 acres (42 percent). Approximately 110 acres (1 percent) of the refuge woodlands will be prescribed burned annually. Approximately 80 acres (9 percent) of refuge agricultural lands will also be burned.

One of the primary goals of burning marshes and woodlands will be to reduce fuel loading hazards and resultant wildfire dangers. Additional goals of the marsh burning program will be to maintain marsh health, encourage Olney three-square bulrush growth, reduce brush invasion in marshlands, assist in control of muskrat and nutria populations, and assist in control of common reed (*Phragmites australis*). In the woodlands, additional goals will be to enhance Delmarva fox squirrel habitat, increase habitat diversity (such as enhancing or developing grassland habitat), and reduce encroachment of undesirable species. In the agricultural burning program, the primary goal will be to facilitate tillage operations by reducing the vegetative litter. In all habitats, appropriate suppression actions will be taken on all wildfires based on firefighter and public safety, values at risk (property and natural resources), and cost of suppression.

This regime will define specific conditions under which burning will occur. The refuge will conduct marsh burns in the winter, normally between late-December and mid-March. Woodlands and agricultural lands will be burned during other seasons depending upon environmental conditions necessary to meet objectives. Wind directions will be chosen for a particular burn that will minimize fire escape potential and adverse impacts of smoke and particulate matter. Wind speeds will be selected to ensure that fire intensity will be commensurate with firefighter and public safety requirements and with burn and habitat objectives. Air temperature, relative humidity, and fuel and soil moisture will also be important factors of the burning prescription. Upper and lower limits of these factors will be set to produce fire intensity and behavior to meet burn objectives.

Multiple Objective Fire Regime (New Management Direction: Conservation Biology for Trust Species Diversity)

The Multiple Objective Fire Regime conforms to the new management direction. Under this regime, the Service and DNR will develop a FMP that provides guidance for wildfire suppression and prescribed burning. It will include a monitoring program to evaluate the effects of various burn rotations in all major vegetative community types. The panel recommended four fire frequency regimes with a representative range of years between burns. Based upon this recommendation, the following rotations will be implemented: (1) frequent fire regime (approximately 1-year burn rotation); (2) moderate fire regime (approximately 3-year burn rotation); (3) occasional fire regime (approximately 10-year burn rotation); and, (4) no fire regime (fire exclusion).

Burn monitoring areas will be established on both Blackwater NWR (three marsh sites and four woodland sites) and Fishing Bay WMA (three marsh sites). These areas are representative of marsh and woodland habitats that have been or could be subjected to prescribed burning. These 10 sites will total approximately 1,830 acres (1,380 acres of marsh land and 450 acres of woodlands). Within each site, four treatment areas will be established and assigned to one of the four burn rotations. These areas and treatment rotations will allow evaluation of the effects of varying intervals of prescribed burning application on various vegetative communities, to determine which rotation will yield the vegetative and wildlife responses that best meet management objectives.

This regime will result in a decrease of 1,035 acres in marsh habitat burned annually, and an increase of 450 acres of woodland burning over the current level. Wildfires will be aggressively suppressed in all areas where fires were occurring outside the planned rotation or burning outside prescription parameters. Appropriate suppression actions for all habitats and areas will be based on firefighter safety, values at risk (property and natural resources), and cost of suppression.

Selection of the sites identified for burn monitoring areas will be based upon extensive surveys of the refuge and Fishing Bay WMA. Consideration will be given to public safety, the likelihood for arson or wildfires, representative vegetation, burn logistics, trapper use, and suitability of the site for division into four treatment areas.

Primary marsh species of interest will be Olney three-square, saltmarsh hay, giant cordgrass, smooth cordgrass, saltgrass, black needlerush, and woody shrubs. Marsh vegetation characteristics will be monitored, such as species, frequency of occurrence, area of coverage, and areas of bare ground. Monitoring efforts will also include herbivore abundance, water salinities, and climatic conditions in order to reduce the influence of confounding variables.

Primary forest communities included in the burn rotations will be loblolly pine, loblolly pine–oak, loblolly pine–mixed hardwoods, and mixed hardwoods. Characteristics of the woodland community to be monitored will include species, diameter breast height (dbh), frequency of occurrence, percent coverage, height, and basal area. Overstory, shrub and herbaceous layers in the woodlands will be monitored. Based on long-term results, the refuge's burning program could be altered in the future to reflect the results of these evaluations in terms of the most beneficial fire regime to meet refuge management objectives and future planned increases in refuge acreage. Specific burning conditions similar to those in the Annual Fire Regime could be used.

Annual Marsh plus Five-year Woodland Fire Regime

The Service will develop a FMP that continues the current annual burning program on approximately 3,000 acres (29 percent) of refuge marsh lands and 10,000 acres (48 percent) of DNR marsh lands, for a combined total marsh burn acreage of 13,000 (42 percent). The Service also will begin using prescribed burning on 500 acres (4 percent) of woodlands on approximately a 5-year rotation interval, in addition to the 110 acres of woodlands burned under the current annual woodland burning program. Of all the regimes, this would be the greatest amount of woodland acres burned (610; 5 percent). The amount of agricultural lands subjected to annual burning will not change under this alternative. Appropriate wildfire suppression actions will be taken in all habitats relative to firefighter and public safety, resources at risk, and cost of suppression.

Annual and Five-year Fire Regime

The Service will develop a FMP that ensures frequent fire regimes are maintained in all vegetative community types. Under this regime, wildfire suppression and prescribed burning activities will be planned to ensure that all major public land vegetative community types have representative areas of approximately 1- and 5-year fire rotation intervals. Under this regime, there will be a reduction in annual marsh acreage that will be prescribed burned because part of the current annually burned acreage will be converted to a 5-year rotation.

Therefore, 12,310 acres (39 percent) of marsh will be burned annually, and 690 acres (2 percent) will be burned every 5 years. Also, 335 acres (3 percent) of woodlands will be burned on an annual basis, and 225 acres (2 percent) will be burned on a 5-year rotation. This will be the most woodland acreage burned annually under any of the regimes. The amount of agricultural lands subjected to annual burning will not change under this regime. Appropriate wildfire suppression actions will be taken in all habitats relative to firefighter and public safety, resources at risk, and costs of suppression.

Limited Suppression Fire Regime (No Action Management: Maximum Public Use with No Habitat Management)

The limited suppression fire regime conforms to no action management. The Service will develop a FMP that ensures appropriate wildfire suppression actions will be taken in all habitats relative to firefighter and public safety, resources at risk, and cost of suppression. Under this alternative, no prescribed burning will be used in any habitat. It is anticipated that aggressive suppression will be taken where public safety, property, or natural resource values are at risk, but less aggressive actions may be used where the fire is causing little human threat or ecological impact. Prescribed burning will be eliminated on 13,000 acres of marshlands, 110 acres of woodlands, and 80 acres of agricultural lands. It is anticipated that much more than the 13,000 acres of marsh and 110 acres of woodlands currently prescribed burned could be burned by wildfires.

Suppression Fire Regime

The Service will develop a FMP that ensures ALL wildfires will be controlled at a minimum size irrespective of values at risk or suppression cost, and no prescribed burnings will be used in any habitat. Under this regime, aggressive wildfire suppression will be taken on all fires regardless of the values at risk to ensure that a minimum of public land will be affected. We expect less average annual acreage will be burned, compared to the current program.

Table 4.4. Acres and percentage of habitat burned as prescribed in each fire regime

Fire Regime	***Habitat*** [a]														
	Marsh[b]					*Woodland*					*Agricultural*				
Rotation (Years)	1	3	5	10	None	1	3	5	10	None	1	3	5	10	None
Annual	13,000 42%	0	0	0	0	110 <1%	0	0	0	0	80 9%	0	0	0	0
Multiple Objective	11965 38%	345 1%	0	345 1%	345 1%	223 2%	113 <1%	0	113 <1%	113 <1%	80 9%	0	0	0	0
Annual Marsh + Five-year Woods	13,000 42%	0	0	0	0	110 <1%	0	500 4%	0	0	80 9%	0	0	0	0
Annual and Five-year	12,310 39%	0	690 2%	0	0	335 3%	0	225 2%	0	0	80 9%	0	0	0	0
Limited Suppressionc	0	0	0	0	13,000 42%	0	0	0	0	560 4%	0	0	0	0	0
Fire Suppression	0	0	0	0	13,000 42%	0	0	0	0	560 4%	0	0	0	0	0

[a]Percentages reflect acreage treated versus total acreage of same habitat available on Blackwater NWR and Fishing Bay WMA
[b]Marsh burns would be conducted on both Blackwater NWR and Fishing Bay WMA; woodland and agricultural burns would be conducted only on Blackwater NWR.
[c]Under the Limited Suppression regime, no prescribed burning would occur, but "limited suppression" of wildland fires could occur on a substantial portion of the 13,000 acres.

G. Land Protection Management

Background

Population growth, fragmentation, and other related land use changes must serve as an important backdrop in the Refuge Complex CCP. These forces ultimately affect the ability of the Service and its conservation partners to protect, enhance and restore the natural resources in the watershed. With respect to the value and importance of protecting land, the salient issue is what role should the Complex (and each refuge and division) play, as part of the emerging larger interconnected system of protected lands within the watershed. The concept embraces the fact that the Service alone cannot protect enough land in the Chesapeake Bay watershed to achieve the CCP objectives. Indeed, the fee-simple protection of lands within the protection areas is not the preferred conservation tool; protection of lands can occur without government ownership. Land and resource protection, in various forms and via a myriad of landowner assistance programs, will support the goals of the CCP and help achieve its ambitious landscape focus. The Service will rely heavily upon partners, including private landowners and existing government and NGO conservation programs.

We will design our programs to facilitate and encourage the overwhelming support for conservation that comes naturally to many landowners. America's farmers, ranchers, and other landowners know that if they exhaust the soil, abuse the land, or pollute its waters, their fields, pastures, streams, and woodlots will become less productive. They embrace conservation because it makes economic sense to them and, because they love their land. Many landowners have also worked diligently to attract wildlife and protect other natural resources. Whether because they enjoy hunting, fishing, or just watching and listening, most landowners are happy to share their land with wildlife. Indeed, the chance to have interesting plants and animals close by has long been one of the real joys of landownership.

Today, however, some of these landowners are wondering whether they should keep the welcome mat out for wildlife: not because they no longer enjoy wildlife, but because they fear that the presence of some animals, especially endangered species, could restrict what they can do with their land. This is unfortunately ironic. Most endangered species will need more and better habitats if they are to recover, and who better than America's landowners to provide those places. Yet if landowners believe that creating these habitats threatens their own future, they are not likely to do so. As a result, the refuges will work with other Service programs to ensure that landowners in the protection areas are informed and educated on options available to them with respect to the issue of endangered species, including the use of Safe Harbor agreements.

Similarly, many landowners have areas in need of habitat restoration and enhancement. For example, an individual landowner's decision to restore wetlands is as varied and complex as most other social decisions one makes. However, recent surveys clearly indicate that private landowners will restore and conserve wetlands if they believe that as good stewards of the land it is the right thing to do, if they can afford it, and if they can get some technical help (National Wetland Conservation Alliance 2001).

It is important to note that no single entity can effectively protect land in all cases and in all circumstances. A coalition effort has been developed to achieve long-term habitat protection for the Nanticoke and Blackwater River watersheds and the islands of the Chesapeake Bay, and share both funding and protection responsibilities. This plan considers the real possibility that other conservation-oriented agencies or organizations, including state resource agencies, either individually or through the combined efforts of a variety of agencies and groups, may provide long-term protection to those habitats susceptible to changes in land use without Service involvement. That is now the case in The Nature Conservancy, the Chesapeake Bay Foundation, the State of Maryland, and The Conservation Fund holding real property or perpetual easements. Similarly, other Service programs and USDA programs are in place, and offer financial and technical assistance in support of the land protection goals in this plan.

The coalition also may employ variety of land protection mechanisms. Those will include (1) conservation easements or restrictive easements may be protected in order to assure protection and use of land, where public and private uses are compatible; (2) delivery of landowner incentive programs; (3) fee-title protection; and, (4) cooperative management agreements, wherein a landowner, working with a public or private organization, voluntarily agrees to abide by an established set of guidelines for the long-term stewardship of his land.

In this final plan, the Service will take the lead in conserving and protecting internationally and nationally important wildlife populations and their habitats within the protection areas. Other land protection and habitat restoration and protection programs, administered by the USDA, The Nature Conservancy, The Conservation Fund, Partners In Flight, the State of Maryland, local land trusts, will contribute in collaborative and strategic partnerships as noted above.

H. Exotic, Invasive, or Injurious Species Management

Background

The Refuge Complex has set a goal of maintaining a healthy, diverse ecosystem with a full range of natural processes, natural community types, and the full spectrum of native plants and animals. That is an ambitious goal, because more than 200 species of rare, threatened, or endangered plants (G1-G5, S1-S3) and almost 70 species of rare, threatened, and endangered animals have been documented within the Refuge Complex by the Maryland and Delaware Natural Heritage Programs.

Exotic, invasive, and injurious species have, by definition, the potential to negatively affect the integrity of this system and, perhaps, the perpetuation of certain species. As Fofonoff, et al. (1998) observe, every established exotic species probably has some impact on native communities, but relatively few of these impacts are known, even on a qualitative basis. Of 202 introduced and cryptogenic species, 38 (19 percent) were considered to have probable impacts in the Chesapeake Bay. At least 15 of those 38 species are known to live within the Refuge Complex (see table 4.5, "Introduced and cryptogenic species reported to have impacts on native species in the Bay," below).

Executive Order No. 13112 (February 1999) directs all Federal agencies to prevent the introduction of invasive species; detect and respond rapidly to and control populations of such species in a cost-effective and environmentally sound manner, subject to funding, monitor invasive species populations accurately and reliably; provide for the restoration of native species and habitat conditions in ecosystems that have been invaded; and promote public education on invasive species and the means of addressing them. In addition, the Maryland Department of Agriculture maintains a list of noxious weeds that landowners must control.

Our legal mandate for extirpating or at least controlling exotic, invasive, and injurious species is clear. However, of the 38 species in table 4.5, the Refuge Complex has targeted only five: nutria (*Myocastor coypus*), resident Canada geese, mute swans, common reed (*Phragmites australis*), and purple loosestrife (*Lythrum salicaria*). In addition to those five aquatic-dependent organisms, populations of gypsy moth (*Lymantria dispar*) and two noxious weed species are aggressively monitored and controlled. These eight species are thought to constitute the most serious threat to maintaining natural biodiversity and meeting the other legal mandates imposed on the Refuge Complex (e.g., protecting endangered Delmarva fox squirrel habitat).

Nutria are indigenous to southern South America, and were introduced at Blackwater NWR in 1943. Their high population density, high reproductive rates, and unique foraging attributes are thought to have contributed to the loss of more than 7,000 acres of tidal marsh on the refuge during the past six decades. Nutria live within the Nanticoke protection area, but are not known to live on the Chesapeake Island Refuges. Refuge Complex staff completed the NEPA process to evaluate alternatives for controlling nutria in 2001. An individual EA was developed by USDA and the FONSI was signed in December 2001 (see "Furbearer Management," above).

The resident Canada goose population on Blackwater NWR has increased from an estimated 350 in 1989 to more than 5,000 in 2000. They have contributed to marsh loss, and to depredations of crops and moist soil plants that are grown for migratory waterfowl. Resident geese may also served as vectors for transmission of DVE, cryptosporidiosis, giardiasis, chlamydiosis, and West Nile virus. Resident geese occur throughout the Refuge Complex, but are centered on Blackwater NWR. Refuge Complex staff completed the NEPA process to evaluate alternatives for controlling resident Canada geese in 1999. An individual EA was developed, public input was solicited, and a Finding of No Significant Impact was signed by our Regional Director in February 2000.

Mute swans are exotic birds that escaped into the Chesapeake Bay in 1962 and currently number approximately 4,000 birds (Hindman 2000). Mute swans destroy beds of submerged aquatic vegetation and disrupt nesting colonial waterbirds. The Chesapeake Island Refuges harbor most of the mute swans on the Refuge Complex, but Blackwater NWR and the Nanticoke protection area sustain a few pairs. Mute swans are protected under Federal law, but are classified as "wetland game birds" under Maryland law (10–101). The Atlantic Flyway Council has adopted a policy advocating the control of the mute swan population in the Atlantic Flyway, and has urged state and Federal partners to institute effective management programs to control existing population levels while preventing the establishment of new problem areas. The USFWS Directorate specifically endorsed the recommendations of the Atlantic Flyway Council regarding mute swans.

Gypsy moths were brought to Massachusetts from Europe in 1869 to interbreed with silkworms. Gypsy moth larvae defoliate hardwoods, but may feed on several hundred different species of trees and shrubs. Blackwater NWR has been plagued with repeated infestations of gypsy moths, particularly in areas that have been salt-stressed. Defoliation, reduced mast production, and tree mortality threaten habitat used by endangered Delmarva fox squirrels. Gypsy moths occur on the Nanticoke protection area but population levels are not known. Gypsy moth infestation is not known to be an issue in the Chesapeake Island Refuges.

Phragmites has spread dramatically among both freshwater and brackish wetlands along the Atlantic Coast in recent decades. Phragmites seeds profusely and spreads vegetatively by a vigorous system of rhizomes and stolons. This invasion has changed basic ecosystem processes and caused replacement of diverse wetland plant communities by monotypic Phragmites stands. Dense Phragmites stands decrease native biodiversity and impact the quality of wetland habitat, particularly for waterfowl. Phragmites is prevalent throughout tidal marshes on the Refuge Complex. At present, convincing and decisive evidence for the status of Phragmites as native, introduced, or both, is not available (Blossey and McCauley 2000).

Purple loosestrife is an exotic plant that aggressively invades wetland communities. It was first observed on Blackwater NWR in 1996, and spot treatments appear to have contained and, perhaps, eradicated it. Purple loosestrife occurs within the Nanticoke protection area, but its distribution is not known; it is not known to occur on the Chesapeake Island Refuges.

Johnson grass (*Sorghum halepense*) forms weedy hybrids with cultivated sorghum (*S. bicolor*). Both Johnson grass and Canadian thistle (*Cirsium arvense*) are poisonous to mammals, and are listed as noxious weeds by the Maryland Department of Agriculture. Both occur within the moist soil impoundments and croplands on Blackwater NWR; their distribution elsewhere on the Refuge Complex is not known.

This plan offers our preferred management program, with more aggressive control of all eight species, including an Integrated Wildlife Damage Management Plan for resident Canada geese, the eradication of loosestrife, more intensive nutria control, surveys for other forest insect pests, and the control of Phragmites in the natural marsh ecosystem.

Management Strategies

We will control nutria by implementing the recommendations of the Nutria Damage Reduction Pilot Program, a 3-year study to develop control techniques and evaluate the demographic and reproductive response of nutria to reduced population densities. We will also continue the nutria trapper rebate program at Blackwater NWR.

Resident Canada goose populations and depredation will be controlled by implementing the Integrated Wildlife Damage Management Plan (IWDMP), approved December 1999. This program will include nonlethal scare techniques, such as pyrotechnics, propane cannons, eagle effigies, reflective tape, balloons, and flags. Geese will also be excluded from certain areas with the use of perimeter fencing. Lethal components of this program will include nest and egg destruction, live capture with humane euthanasia by certified processors, and selective killing of individuals to reinforce nonlethal methods.

Mute swan control will comply with the Atlantic Flyway Council's recommendations. Also, these recommendations will be modified by the findings of the Maryland DNR-sponsored Mute Swan Task Force, current legislation, and actions to authorize the taking of eggs and adults.

Table 4.5. Introduced and cryptogenic species reported to have impacts on native species in the Bay[1]

Species	*Common name*	*Impact*[2]	*Abundance*
Regular residents, definite-probable			
Haplosporidium nelsoni	MSX	P,C,HC	abundant
Hydrilla verticillata	hydrilla	C,HC,F/P	abundant
Iris pseudacorus	yellow iris	C,HC,T	common
Murdannia keisak	Asian dewflower	C,F/P	abundant
Alternanthera philoxeroides	alligatorweed	C	rare
Lythrum salicaria	purple loosestrife	C,HC,F/P,X	common
Myriophyllum spicatum	Eurasian watermilfoil	C,F/P,HC	abundant
Trapa natans	water chestnut	C,HC	rare
Cordylophora caspia	freshwater hydroid	C,HC	abundant
Garveia fanciscana	rope grass	C,P,HC,F/P	abundant
Bithynia tentaculata	faucet snail	CC,F/P	common
Corbicula fluminea	Asian clam	H,F/P,C,HC	abundant
Rangia cuneata	wedge clam	F/P,C,HC	abundant
Loxothylacus panopaie	parasitic barnacle	P	abundant
Orconectes virilis	crayfish	C	abundant
Drosoma petenense	threadfin shad	C	common
Cypinus carpio	common carp	P,H,bioturbation	abundant
Ictalurus punctatus	channel catfish	P,H	common
Lepomis macrochirus	bluegill	H,C	abundant
Micropterus dolomieu	smallmouth bass	C,P	rare
Micropterus salmoides	largemouth bass	C,P	common
Morone saxatilisXchrysops	hybrid striped bass	C,X,P	rare
Anas platyrhynchos	mallard	C,H	abundant
Branta canadensis	Canada goose	C,HC	common
Cygnus olor	mute swan	H,C,HC	common
Myocastor coypus	nutria	C,H,HC	abundant
Rattus norvegicus	Norway rat	C,P	bundant
Regular residents, cryptogenic			
Perkinsus marinus	dermo	P,C,HC	abundant
Phragmites australis	common reed	C,HC,F/P	abundant
Typha angustifolia	narrow-leaved cattail	X,C,HC	abundant
Nematostella vectensis	starlet sea anemone	P,F/P	unknown
Victorella pavida	cushion moss bryozoan	HC,C,F/P	abundant
Ischadium recurvum	hooked mussel	C	abundant
Botryllus schlosseri	golden star tunicate	HC,C,F/P,T	common
Occasional residents, definite-probable			
Polygonum perfoliatum	mile-a-minute vine	HC,C,F/P	common
Lampsilis cardium	pocketbook mussel	CC/H	unknown
Cervus nippon	sika deer	H,C	abundant
Equus caballus	pony, horse	H,HC	rare

[1]Fofonoff, et al. 1998
[2]P=parasitism, C=competition, HC=habitat change, F/P = food/prey, T=toxicity, X=hybridization

Gypsy moth populations will be controlled using Integrated Pest Management techniques on the Refuge Complex. The IPM program will include coordination with the U.S. Forest Service to monitor gypsy moth populations and recommend treatments of Btk or Gypcheck. Those efforts will be extended to forested lands protected on the Nanticoke protection area. This plan also includes silvicultural prescriptions, identified in the draft Forest Management Plan, to reduce the susceptibility of trees to gypsy moth and other forest pest infestations by improving forest health and vigor.

Phragmites will be controlled over more extensive areas of the tidal marsh, contingent on funding. The most widespread and successful approach is the application of glyphosate late in the growing season, followed by prescribed burning or mechanical removal of dead stalks. Additionally, biological control agents specific for Phragmites, which are being investigated at Cornell University, will be considered for use if feasible. Specific strategies to control Phragmites will be developed as part of the Marsh Management Program.

Purple loosestrife, Johnson grass, and Canadian thistle will be controlled with the spot application of glyphosate. These three invasive and injurious species are associated with the moist soil management units and croplands. Constant vigilance is required on the part of refuge staff to maintain the advantage of early detection. It may be necessary to consider the use of biological control agents developed by the Plant Protection Section (Maryland Department of Agriculture). Of the three species, agents have only been identified for Canadian thistle; these include several insects (*Cassida rubiginosa*, *Ceutorhynchus litura*, *Cleonis piger*, *Rhinocyllus conicus*, *Urophora cardui*, *Larinus planus*) and two diseases (*Puccinia punctiformis*, *Pseudomonas syringae* pv. *tagetis*). The refuge will continue the current policy, established in 1989, of no insecticides in the farming program. In addition, surveys for exotic flora will be conducted (see "Inventory, Monitoring, and Research"). As previously noted, EAs and FONSIs were approved for the existing Fire Management Plan (Sep 2000,) the Integrated Wildlife Damage Management Plan for Resident Canada Geese (Dec 1999), and the Nutria Damage Reduction Pilot Program (Dec 2001).

More than eight exotic, invasive, and injurious species could be controlled within the Refuge Complex. At issue is the extent to which the Refuge Complex should go. Some species are exotic and may be somewhat invasive, such as Japanese honeysuckle (*Lonicera japonica*), but may not directly impact existing refuge management objectives. Others, such as many roadside weeds (e.g., yarrow [*Achillea millefolium*]), are so well-established across North America that control within refuge boundaries will be a futile gesture. However, if certain communities are identified as rare in the Nanticoke protection area, for example, should the Refuge Complex seek to eradicate non-indigenous species that infringe on those communities? An exotic species needs to be perceived as invasive or otherwise injurious before warranting consideration for management. This is pragmatic, but not necessarily consistent with concerns for maintaining and promoting the diversity of native biota. However, until the distribution of other exotic species and their effects are better understood, and additional funding becomes available, the control of other exotic species will not be considered.

I. Supplemental Nest Structure Management

Background

Since 1973, Blackwater and the Chesapeake Island Refuges have provided artificial nest structures for several avifauna to supplement naturally occurring availability. All of the targeted species were considered species in need of conservation for various reasons (their global TNC and regional PIF rankings are in parentheses): eastern bluebird (G5,14), wood duck (G5,15), barn owl (G5, 20), osprey (G5, 15), American black duck (G5, 20), prothonotary warbler (G5, 22), and peregrine falcon (G4, 16). The eastern bluebird, wood duck, barn owl, and prothonotary warbler are cavity nesters; nest boxes are an effective management tool for increasing potential nest sites. Peregrine falcons and ospreys declined in number and distribution primarily due to organochlorine use in the 1950s and 1960s; nest platforms are considered critical in reintroduction and recovery efforts. American black ducks on the Chesapeake Island Refuges nest in low-lying black needlerush marshes, which are subject to tidal and storm-induced inundation; floating nest platforms are considered a feasible but unproven option for improving production.

Now that populations of these species have recovered in recent years, the efficacy of continuing this program is being questioned for a number of reasons: (1) these artificial structures require annual maintenance and periodic

monitoring; if not monitored and controlled, many of the nest boxes will harbor and produce exotic species such as house sparrows and European starlings; (2) most of the wood duck boxes on Blackwater NWR were erected as duplexes; however, recent research indicates that the clustering of nest boxes causes high rates of brood parasitism and can actually depress nesting success (Semel, et al. 1990, Semel and Sherman 1995); (3) regional translocations of peregrine falcons are now recommended only for the Maryland and Virginia Piedmont which, unlike the Delmarva Peninsula, are considered part of their former breeding range; (4) although natural nesting sites for ospreys are limited on some of the island units, this is not the case for most of the Refuge Complex; furthermore, ospreys will readily nest on other structures such as channel markers, towers, and bridge abutments.

Management Strategies

The Refuge Complex will evaluate the efficacy of maintaining, downsizing, or expanding the supplemental nest structure program. Specifically, the contribution of the various structures to desired local, regional, and national population goals will be compared with the program costs. Novel placement of nest structures will be considered; e.g., placing nest boxes for prothonotary warblers and wood ducks on the same pole in appropriate habitat. Part of this evaluation will be an assessment of the availability of natural nest sites on the Refuge Complex, including the recognition that the Refuge Complex maintains more than 5,000 acres of palustrine forested wetlands, and that tree mortality due to periodic saltwater intrusion and repeated gypsy moth defoliation has provided significant acreages of natural nest trees (i.e., snags) on the Blackwater NWR and Nanticoke protection area. Silvicultural treatments (including contract sales and TSI) will specifically retain from two to five snags of at least 12" DBH per acre to ensure a good distribution of natural cavities on the refuge (see Forest Management). Also, the use of floating nest platforms to increase American black duck production, particularly on the Chesapeake Island Refuges, will be field-tested as part of the American Black Duck Initiative.

J. Furbearer Management

Background

Since its establishment in 1933, Blackwater NWR has lost nearly 7,000 acres of wetlands. That loss has occurred primarily in the mesohaline Olney three-square marsh at the confluence of the Little Blackwater and Blackwater rivers, but now is also progressing downstream. Similarly, the Nanticoke estuary has lost 122 acres of marsh annually over the same time interval. Unlike the Blackwater system, much of that loss has occurred in submerged upland marshes, with rates increasing down-estuary (Kearney, et al. 1988). Several scientific studies since the 1970s have focused on these unusually high rates of wetland loss, which may be the result of several confounding factors, including sea-level rise, land subsidence, saltwater intrusion, severely modified hydrology, and excessive herbivory. Although several species have reached population levels high enough to cause marsh degradation, e.g., muskrats (*Ondatra zibethica*) in the 1930s, wintering Canada geese in the 1960s, and resident Canada geese in the 1990s, none have been as persistent a problem as the introduced nutria (*Myocastor coypus*).

Nutria are South American semi-aquatic rodents similar to beavers that were first introduced in the United States in 1899 (Willner, et al. 1979). Nutria now are established in 14 states, and sightings have been reported in 40 states (LeBlanc 1994; Hess, et al. 1997). Nutria introduction into the Chesapeake Bay occurred in 1943 with attempts to stimulate the local fur farming economy (Maryland DNR 1997). Nutria introduction efforts included the establishment of an experimental fur production facility on Blackwater NWR (Meanley 1978). Nutria escaped from the facility and were released by private entrepreneurial trappers. The first known take in the wild at Blackwater NWR was in 1952. By 1961, nutria were regularly being trapped on the refuge.

Nutria are large, surface-feeding herbivores that can be extremely destructive to marsh vegetation. These powerful animals forage directly on the vegetative root mat, leaving the marsh pitted with digging sites and fragmented with deep swim canals. A 3-year study of 342 fixed vegetative plots within 57 quarter-acre experimental units clearly demonstrated that “eatouts” into the root mass by nutria are degrading the ability of the marsh to maintain itself (Mike Haramis, USGS–BRD). In the face of rising sea levels, nutria damage is particularly problematic, because it accelerates the erosion associated with tidal currents and wave action. The situation is extremely delicate within the tidal marshes of the Blackwater River, because much of its marsh is underlain by a layer of fluid mud that is easily

washed away once the vegetation becomes fragmented. The cumulative result of an overabundance of nutria and rising sea level at Blackwater NWR has been a rapid conversion of emergent marsh to open water.

Limited mark-and-recapture estimates of tagged nutria have suggested that population densities range from 2.6–10.3 nutria per acre, with estimates as high as 50,000 nutria on Blackwater NWR (B. Giese, pers. comm.). Nutria are extremely prolific, reproducing throughout the year and having two to three litters annually (Brown 1975, Willner, et al. 1979). On average, nutria have five young, but a female may have as many as 13 offspring per litter (Nowak 1991). Nutria weigh up to 18 pounds, which is 5 to 10 times the size of native muskrats. Nutria are also a highly invasive species, partly because no natural predators are present. There are confirmed reports of nutria on the Eastern Shore from the Chesapeake Bay Bridge to Ocean City, Maryland and south to the Virginia border. On the Western Shore, nutria are in the Patuxent and Potomac Rivers, and to the northeast in Delaware (R. Colona, pers. comm., MD DNR).

The jurisdiction for managing most resident wildlife rests with the MDNR, which has the authority to request other agencies' assistance in achieving management objectives. Our authority to remove nutria from Refuge System property stems from Executive Order No. 13112 (see "Exotic, Invasive, and Injurious Species") and our authority to assist the State of Maryland from Public Law 105–322. Nutria are managed as furbearers with no closed season in Maryland, and have limited economic importance in some localities. Currently, MDNR manages nutria as a furbearer, but nutria are legally defined as an unprotected species (COMAR §§ 10–101(s)). If necessary, the MDNR has the option and authority to reduce restrictions on trapping, snaring, or hunting, to provide more harvest opportunities for sportsmen and sportswomen. Although there is no closed season for nutria in Maryland, most private trappers and hunters are not able to provide year-round, site-specific nutria damage reduction. However, that option remains open to entities experiencing damage or the threat of damage.

The Marsh Management Plan details strategies to deal with the conservation and recovery of the existing marsh. Part of that plan includes the control of nutria and muskrat populations as a strategy to prevent excessive herbivory in the marsh. It will continue permitted muskrat trapping and the monetary rebate for nutria, allow only incidental take of other furbearers, and implement the Nutria Damage Reduction Pilot Program.

Management Strategies

Although nutria were introduced to support the fur industry, private fur trappers have not kept pace with this invasive animal's ability to reproduce. From a fur trapper's perspective, nutria are less valuable than other furbearers such as the native muskrat, because only a portion of the pelt is usable, the quality of nutria fur is inferior, nutria pelts are time-consuming to process, and nutria are heavier to carry out across the marsh than muskrats. In addition, fur markets and the profits from nutria pelts have been subject to fluctuations for a variety of factors, such as the animal rights movement, fashion trends, U.S. exchange rates, and the political and economic trends in consumer nations (Maryland DNR 1997).

Consequently, Blackwater NWR initiated a nutria rebate program in 1990. That program and incidental take by refuge staff have removed almost 58,000 nutria from the refuge in the past15 years. However, that number likely represents a very small fraction of the population. Limited mark-and-recapture estimates of tagged individuals suggest that populations have been as high as 50,000 nutria on the refuge. Using those values as averages, less than 8 percent of the nutria population has been removed annually by this program on the refuge. The difficulty in controlling nutria populations has been demonstrated at Tudor Farms, which is a privately owned, 7,000-acre hunting preserve in Dorchester County. Population density estimates range from 5–8 nutria per acre of marsh (L. Ras, unpubl. data). Despite an annual harvest of 4,000–5,000 nutria per year, the nutria population appears to be unaffected and signs of excessive herbivory are prevalent. Therefore, a systematic and well organized nutria damage reduction and marsh recovery program is needed to curtail vital marsh loss and recover habitats and ecosystems vital to native wildlife populations.

The most viable furbearer management program will ideally encompass the integration of regulated trapping and hunting of furbearer species, habitat management, population monitoring and harvest analyses, research on furbearer ecology, and public education for achievement of an overall goal of conserving furbearer populations (and other faunal populations), their ecological roles, and their habitats in the public interest. Furthermore, such a fully integrated program is attained not only by the planned, coordinated, and complementary use of various adaptive

management programs within the refuge and surrounding lands, but also in concert with the statewide furbearer management strategy carefully designed and implemented by Maryland DNR.

The feasibility of nutria population control or eradication will be studied by completing the Nutria Damage Reduction Pilot Program. This is a 3-year pilot project to develop control techniques, evaluate demographic and reproductive responses of nutria to reduced population densities, and demonstrate marsh restoration techniques. The Nutria Partnership of 27 organizations was formed in 1997 to deal with this problem. Partners include Blackwater NWR (USFWS), the Chesapeake Bay Field Office (USFWS), Patuxent Wildlife Research Center (USGS–BRD), MD Cooperative Fish and Wildlife Research Unit (USGS–BRD), MD Department of Natural Resources, MD Dept of the Environment, UM–ES, UM–College Park, Tudor Farms, Ducks Unlimited, National Fish and Wildlife Foundations, Friends of Blackwater, the American Aquarium and Zoological Association, the MD Fur Trappers Assoc., the MD and DE Chapter of the Wildlife Society, and the Salisbury Zoo. A pre-decisional EA was drafted in March 2001 and the FONSI was signed in December 2001.

Under this plan, recommendations resulting from the three-year pilot program will subsequently be implemented. Additionally, muskrat trapping and the nutria trapper rebate program at Blackwater NWR will be continued and, perhaps, modified to reflect recommendations forthcoming from the Nutria Damage Reduction Pilot Program. Furbearers other than nutria and muskrats will be taken only incidentally under this plan.

Control Methods Considered But Dismissed

Harassment

Harassment has generally proven ineffective in resolving aquatic rodent damage problems (Jackson and Decker 1993). Also, the removal of food supplies to discourage nutria activity is generally not feasible nor ecologically desirable.

Repellents

No repellents are registered for nutria or muskrat damage reduction at this time.

Contraception

A review of research evaluating chemically and surgically induced reproductive inhibition as a method for controlling nuisance aquatic rodents is contained in Novak (1987b). Although these methods were effective in reducing beaver reproduction by up to 50 percent, the methods were not practical, or were too expensive for large-scale application.

Under this strategy, nutria and muskrats would be surgically sterilized or contraceptives administered to limit their ability to produce offspring. However, at present, no chemical or biological contraceptive agents for nutria are registered by the EPA, FDA, or MDA, and the use of immunocontraceptives is still under research. A nutria contraceptive, chemosterilant, or immunocontraceptive, if delivered to enough individuals, could temporarily suppress local breeding populations by inhibiting reproduction. The reduction of local populations would result from natural mortality combined with reduced fecundity. No nutria would be killed directly with this method; however, treated and untreated nutria will continue to cause damage. Nutria populations outside the treatment area would probably be unaffected.

Contraceptive measures for mammals can be grouped into four categories: surgical sterilization, oral contraception, hormone implantation, and immunocontraception (the use of contraceptive vaccines). These techniques would require that nutria receive either single, multiple, or possibly daily treatment to successfully prevent conception. The use of this method would be subject to approval by Federal and state agencies. This strategy was not considered in detail because: (1) it would take many years of implementation before the nutria population would decline, and therefore, damage would continue at the present unacceptable levels for years; (2) surgical sterilization would have to be conducted by licensed veterinarians, would therefore be extremely expensive and labor-intensive; (3) it is difficult to effectively live trap or chemically capture the number of nutria that would need to be sterilized to

effect an eventual decline in the population over large areas; and, (4) no chemical or biological agents for sterilizing nutria have been approved for use by state and Federal regulatory authorities.

Fumigants

Several fumigants are registered for controlling burrowing rodents, but none are registered for use against nutria or muskrats; in marsh habitat, nutria generally do not burrow extensively. Some fumigants, such as aluminum phosphide and carbon monoxide, may have potential as nutria control agents, but their efficacy has not been scientifically demonstrated. In addition, these methods are neither practical nor legal, because they are not registered for this purpose.

Bounties

Bounties were not considered because they are not generally effective in reducing damage and have not been found effective in reducing populations, circumstances surrounding the take of animals are largely unregulated, the Service does not have the authority to establish a bounty program, and Maryland law prohibits the MDNR from paying bounties (COMAR §§ 0–107).

Nonlethal management and relocation

Nonlethal damage management and the relocation of native species may be appropriate in some situations with some species (e.g., if the problem species' population is at very low levels, there is a suitable relocation site, and, the additional funding required for relocation can be obtained.) However, nutria are an exotic, invasive species that competes with native fauna. Executive Order No. 13112 stipulates that each Federal agency whose actions may affect the status of invasive species shall, to the extent practicable and permitted by law, "not authorize, fund, or carry out actions that it believes are likely to cause or promote the introduction or spread of invasive species in the United States or elsewhere unless, pursuant to guidelines that it has prescribed, the agency has determined and made public its determination that the benefits of such actions clearly outweigh the potential harm caused by invasive species; and that all feasible and prudent measures to minimize risk of harm will be taken in conjunction with the actions." In addition, relocation would be illegal under Maryland statute (COMAR §§ 08.03., 09.03).

K. Inventory, Monitoring, and Research Management

Background

The Refuge Complex has strategically protected land, intentionally managed habitats, and experienced significant natural changes in habitats. Some species have been extirpated (e.g., red-cockaded woodpecker) and others have been introduced (e.g., Sika deer, purple loosestrife). Not only does the Refuge Complex lack a good historical benchmark from which to reference these changes in the landscape and biota, it also does not have adequate data to determine existing floral and faunal distributions. Blackwater NWR has supported several species-specific surveys over the years to monitor trends of managed populations, but the effects of management on nontarget species are almost unknown.

The lack of scientific data about wildlife populations, their habitats, and the effects of management actions has been a persistent lament among both managers and researchers for decades. This is particularly true today, when managers and biologists are tasked with developing adaptive management programs, when habitat-specific rather than species-specific management is being emphasized, when promoting biodiversity has become an almost universal management goal, when long-term ecological monitoring is considered a critical component by the scientific community, and when the occurrence of rare species is both of public and regulatory interest.

In general, any inventory, monitoring, and research program serves several critical functions. A comprehensive biological inventory is the first step in identifying nontarget species that could be affected by ongoing management programs. It will also help identify species, such as those that are rare, threatened, or endangered, that should be a management focus. Subsequent population monitoring is what creates opportunities to change a management program to more optimally affect the target population (i.e., adaptive management), to evaluate the effects of a

management program on nontarget species, and to promote early detection of environmental degradation. Applied research can focus existing management and identify new management needs by helping us understand underlying ecological functions and processes, and species-habitat relationships. Rarely will implementing these program components have a negative effect on the physical or biological environment. However, the failure to implement these programs may result in lost opportunities to more effectively manage target populations, to more positively affect nontarget species, and to detect early evidence of invasive species, insect outbreaks, contaminants, or other signs of environmental degradation.

Based on those concerns, this plan will substantially increase monitoring and research efforts by implementing a Refuge Complex-wide inventory and monitoring (I&M) program, by aggressively pursuing funds to support new research efforts (particularly to support tasks identified in endangered species recovery plans), and by implementing new monitoring programs to support island and marsh restoration, forest management, and moist soil impoundment and cropland management (i.e., adaptive management).

Management Strategies

The Refuge Complex will address four specific information gaps: (1) a baseline inventory to determine the occurrence and spatial distribution of flora and selected fauna; (2) a long-term monitoring program to determine temporal trends in selected flora and fauna; (3) an adaptive management program to guide significant habitat and population management actions (this is most salient for the moist soil and cropland, prescribed burning, marsh restoration, and forest management programs); and (4) detailed research into habitat–species relationships (some of the more obvious relationships to investigate are waterfowl use of refuge habitats and habitat requirements for T&E and FID species).

The Refuge Complex will continue its present inventory and monitoring, and will include annual surveys for anurans (North American Amphibian Monitoring Program protocols), saltmarsh sparrow (R5 protocols), marshbirds (R5 protocols), colonial waterbirds (MD-DNR protocols), and shorebird populations in the marsh, all to be conducted by Refuge Complex staff. A comprehensive, Refuge Complex-wide I&M Program will be implemented on a 500m-interval grid system for selected flora and fauna. Forest stand inventory (particularly of regenerated sites and newly protected lands) will continue. MAPS (Monitoring Avian Production and Survivorship) stations will be established on Blackwater NWR to monitor the avian response to implementation of the Forest Management Plan. The water quality monitoring program will be expanded to included real-time sensors, permanent sampling sites, and a permanent tide gauge on the Little Blackwater River. In addition, one-time surveys of tiger beetles and migrant Neotropical birds and lepidopterans on the Chesapeake Island Refuges will be contracted. Similarly, one-time surveys of anadromous fish in the Nanticoke and Blackwater Rivers will be contracted.

A number of research projects will be initiated to facilitate adaptive management. As part of the Forest Management Program, funding will be sought for several studies including the effects of prescribed woodland fire on DFS and FIDs, the effects of selective harvesting techniques on DFS and FIDS, and the effects of TSI on DFS and FIDS. As part of the Marsh and Island Management Programs, several studies will be implemented including wetland mapping in the Chesapeake Bay watershed; surficial processes of sediment and contaminant transport, deposition, sea-level rise, and sustainability of the Blackwater NWR; and biological monitoring associated with restoration projects. As part of the Fire Management Plan, the effects of the four fire prescriptions on selected wildlife will be evaluated. As part of the Integrated Wildlife Damage Management Plan, the use of goose repellants (FlightControl®) to reduce crop depredation will be tested. As part of a larger Region 5 initiative, Blackwater NWR will participate in a study of the effects of moist soil drawdown on shorebird use, benthic invertebrates, and vegetation. As part of the American Black Duck Initiative, funding will be sought to evaluate predator control and the use of floating nest platforms on the Chesapeake Island Refuges, and to develop cooperative research to determine the movements and nesting success of black duck hens Refuge Complex-wide.

Other research will be developed to fill information gaps. In particular, it will include studies of the genetics and continental movement the lesser snow goose population at Blackwater NWR, and the effects of Animal Feed Operations on Blackwater and Nanticoke protection area. Other contaminant assessments may be necessary in the Nanticoke watershed. Additionally, funding for research needs specifically identified in recovery plans for Federal-listed species will be more aggressively pursued.

Last, a Geographic Information System will be developed for the Refuge Complex. As base layers, that GIS will include DOQQs, DRGs, DLGs, vegetation classifications under the National Wetland Inventory and National Vegetation Classification System, and USDA soil types. Hyperspectral imagery will be used to delineate wetland communities (including invasive Phragmites and purple loosestrife distribution). LIDAR will be considered for the development of bathymetric and elevational contours, canopy height, or Digital Elevation Models. Geo-referenced data collected as part of the I&M program, and obtained from the MD DNR Heritage Program, will be maintained in the GIS.

L. Islands Management

Background

Erosion control and habitat restoration is a major component of this plan. The activities and management strategies will apply to the Chesapeake Island Refuges.

Erosion is the overriding environmental factor affecting the islands. Their shorelines, particularly the ones facing west, are receding at a rate of 8–12 feet per year. At that rate, most of the land and habitat types that compose the Island Refuges will be lost in the next 100 years. SAV beds, which are buffered by the islands against wave action, will also be lost. With the exception of aquatic resources (e.g., fish, benthics, and aquatic invertebrates), all other faunal species will be displaced.

Erosion control and habitat restoration are proposed in partnership with the U.S. Army Corps of Engineers, constructing stone segmented breakwaters and filling shallow waters to restore habitat such as wetlands, beaches, intertidal flats, uplands, and dunes. We will develop Environmental Impact Statements or Environmental Assessments on a project-by-project basis.

M. Hunting Management

Background

In the 1930s, most of Dorchester County was rural. Hunting was a means of providing food for the table, as well as an accepted, popular form of recreation. The local populace hunted on their own land, and allowed others to hunt on their land. Blackwater NWR was considered a sanctuary for wildlife, and protected from poachers. Few visitors came to the refuge.

A 1949 amendment to the Duck Stamp Act permitted hunting on 25 percent of the land purchased for the Refuge System with Duck Stamp funds, but Blackwater NWR remained closed to hunting. [Note: Later amendments authorized hunting on up to 40 percent of the land purchased.] After World War II, Americans traveled the Nation's back roads and discovered their national wildlife refuges. Interest developed in using refuges for recreation other than hunting. Although most wanted to share with their families the sights and sounds of wildlife and the wonders of the living world, many also wanted to use their refuges to sail, swim, camp, fish, hike, jog, water ski, ride horses, sunbathe, bicycle, and rock-climb. Guidance in the first Refuge Manual (1943) left the door open to public uses for the cause of building public support, but conflicts between wildlife and public uses could be foreseen. In the 1957 Refuge Manual, guidance on how to decide which public uses to allow hinted at a wildlife-first priority, but sent mixed signals.

The Refuge Recreation Act of 1962 and the Refuge Administration Act of 1966 placed into law the concept that refuges would be closed to all recreation uses, until the refuge managers could determine that a proposed use was compatible with the purpose for establishing the refuge, and that sufficient funds were available to administer those uses. Usually, these determinations were made locally and, in many cases, were based on local pressures and interests. The compatibility determination for hunting on Blackwater NWR was approved on August 26, 1994.

Waterfowl hunting in Dorchester County had been a major recreational activity, but when hunters discovered the abundance of deer, and especially the exotic sika deer that could not be found elsewhere, they swarmed to Dorchester County. Interest in hunting on Blackwater NWR increased. When the farming community complained

that the ever increasing population of deer on the refuge seriously depredated their crops, interest in promoting hunting on the refuge increased even more. To assist with the crop situation and provide recreation, the refuge deer hunting program began in 1985. Although the current program allows most of the hunters that apply to participate, during the CCP scoping meetings, hunters requested increased opportunities to hunt deer. They also requested a turkey hunt and a resident goose hunt. The resident Canada geese have become major competitors with native wildlife, and the public recommended hunting as a means of controlling the growing population.

Strategies for Blackwater NWR

The number of hunting days and types of hunts at Blackwater NWR will be increased, as will the acreage available for big game hunting (approximately 10,430 acres, and increasing with protection). Big game hunting for white-tailed and sika deer will be permitted for a minimum of 53 days (45 days of archery hunting generally beginning the last Saturday in September, continuing consecutively until mid-November, and ending with a late archery season beginning the first Saturday in January and ending the third Saturday in January; 2 days of muzzle-loading rifle or shotgun hunting the third Friday and Saturday in October; 2 days of youth only shotgun hunting the second and fourth Saturdays in November; and 4 days of shotgun hunting the first and second Mondays and Fridays of the statewide firearms season), all within State seasons, and consistent with State weapons, bag limits, and hunting hours.

During the archery seasons, all vehicle access will be prohibited, and hunters will walk in from existing designated parking areas. During the firearms seasons, vehicles will be restricted to designated refuge roadways. There will be no off-road vehicle or ATV use allowed during any hunting season. There will be no access allowed by boats during any of the big game hunting seasons. The first section of the Wildlife Drive will only be closed the first 2 days of the shotgun hunt, leaving the second part of the Wildlife Drive open for public use. Hunting opportunities will be provided to a minimum of 3,000 hunters annually on a first come, first served, mail in system (non-quota for the archery season, but with quotas for the firearms hunts). Hunters will be restricted to zoned areas for safe distribution, with a ratio of no more than one hunter per 20 acres, although some areas may have only one hunter per 40 acres.

Blackwater NWR will honor the commitments related to Blackwater NWR protections where the Service assured the public that the historical tradition of hunting deer will be permitted if compatible with the objectives of Blackwater NWR. With the protection of additional property, the refuge will open other areas suitable to hunting with the number of hunters per acre the same, and will increase the number of total hunters accordingly. Check stations will be operated by staff and volunteers during muzzle-loader and shotgun hunts to obtain age, sex, species, and weight data. Deer killed during the archery season will be required to be checked at a Maryland DNR certified checking station. An annual hunt program will be prepared and submitted for review prior to July 1. Summaries of the biological information will be published in the Annual Narrative Report. Administrative fees will be charged for the permits. Senior citizens and youth will receive a 50-percent discount on these fees. Fees will be utilized to hire a hunt program coordinator and maintain parking areas and signs.

One area of the refuge will be designated for certified wheelchair-bound big game hunters. Hunt leaflets, regulations, and maps will be prepared and published annually, and distributed to hunters. Refuge-specific regulations will be published annually in the Federal Register and codified in Title 50, Part 32. A hunter database will be maintained to facilitate mailings and distribution of information. Blackwater NWR will continue taking precautions to safeguard threatened or endangered species and migratory waterfowl. Hunting will be regulated in time and space to eliminate conflicts with endangered species and other public uses and to ensure compatibility with refuge purposes. Annual spotlight surveys, harvest data, herd health conditions, and available habitat will continue to ensure that the deer hunt remained biologically sound.

Deer hunting will continue to provide opportunities to use a renewable resource, while maintaining herd numbers within acceptable levels. Hunting seasons will be adjusted annually to take into consideration changes indicated in herd quality by biological monitoring (APCs, antler size, reproductive rates, etc.).

By April 2007, Blackwater NWR will be open to spring turkey hunting in accordance with State season regulations. Spring turkey hunting on a quota basis will be open Tuesdays and Saturdays for 4 weeks (8 days) during the State season (April 18 to May 16). Turkey hunting will require a permit determined by a lottery system issued to

14 hunters per day (112 hunters) on approximately 7,485 acres in 10 areas (Areas B1, D, M2, N, R, S, T, U1, U2, and U3) located where public use will not occur as specified in the Annual Hunt Plan. Scout days will be authorized the day before each hunt day. New areas will be evaluated and considered as they are protected that will not conflict with public use areas or endangered and threatened species (bald eagle) and will not have a negative impact on other wildlife and habitat resources or public safety. A compatibility determination will be completed for the Blackwater NWR turkey hunt before it will be initiated.

By December 2008, Blackwater NWR will be open to spring hunting (March 15 through April 15) of resident Canada geese according to the Annual Hunt Plan based on the Integrated Wildlife Damage Management Plan for Control of Resident Canada Geese, if consistent with the Service EIS on managing these injurious resident waterfowl. Hunting will occur in areas that will not conflict with public use or endangered and threatened species (bald eagle) and will not have a negative impact on other wildlife and habitat resources or public safety. Boating access to the hunt areas will be closed to non-hunters during the hunting season. Resident goose hunting will require a permit determined by a lottery system issued for 30 blind sites constructed by the hunter within 100 yards of a numbered post. The blind sites will be located in areas B1, B2, G, F, J, K, L, and O on approximately 8,300 acres of marsh (3,731 acres), fields (70 acres), and open water (4,500 acres). Thirty permits per day for 27 days will be issued, providing 810 recreational waterfowl hunting opportunities. New areas will be evaluated and considered as they are protected that will not conflict with public use areas or endangered and threatened species (bald eagle), will not have a negative impact on other wildlife and habitat resources, or adversely affect public safety. Retrievers will be permitted.

Waterfowl hunting, in accordance with state seasons, species, bag limits, and hunting methods, will be permitted on 40 percent of all newly protected land. We will continue to maintain approximately 23,000 acres as an inviolate sanctuary for wintering and migrating waterfowl.

The number of employees who also have law enforcement authority has decreased from six to one since 1989. Having only one collateral duty law enforcement officer could make it difficult to conduct the increased programs and activities. Therefore, new Law Enforcement Officers will be hired to enforce hunting regulations in addition to their other duties.

A Hunt Coordinator will be hired using revenues from user fees to prepare updated mailing lists, regulations, maps, and applications, mail out information, process applications, collect and record money, maintain the hunt areas, conduct the hunts, and collect and record hunt statistics. With the increased deer hunts, a spring turkey hunt, a spring resident Canada goose hunt, a new waterfowl hunting program and an expansion of hunting in newly protected property, a full-time Park Ranger will be required to fulfill all the duties necessary for the Hunt Program.

Strategies for the Chesapeake Island Refuges

On the more than 5,000 acres available on the Island Refuges, waterfowl and rail hunting will be proposed, where compatible, in areas not affected by Secretarial Closing Order. Quotas in accordance with state seasons and bag limits will be permitted on Spring Island, Watts Island, and on South Marsh Island, should Maryland DNR enter into an MOU with the Service for its management or decide to sell the island to the Service. There will be no hunting on Martin NWR, as stated in the Secretarial Closing Order. There will be no hunting on Bloodsworth Island for human safety.

N. Fishing and Boating Management

Background

Fishing and crabbing have been sources of food and recreation in this area since Native Americans were its only inhabitants. When Blackwater NWR was established, it was considered an inviolate sanctuary for wildlife. The refuge owned and regulated all the waters within its original protection boundary. For the sake of protecting migratory bird resources, all of its interior waterways were closed from October 1 to March 31 to prevent disturbances during the peak waterfowl migration and wintering seasons. The waters on the refuge are unmarked, shallow, and often revert to tidal mud flats at low tide, making fishing very difficult. Because of the shallow waterways, increasing salinities, and excessive turbidity resulting from marsh loss, fish populations are very low,

and the sizes of most fish very small. Thus, with the many other opportunities available for fishing in Dorchester County, fishing and crabbing historically have not been recreational opportunities for refuge visitors, except at the Blackwater River and Little Blackwater River bridges, in areas not regulated by the refuge.

The navigable waters of the Nanticoke River will not be subject to refuge regulations, should a national wildlife refuge be established there. Fishing and its associated boating activities will fall under the sole jurisdiction of the State of Maryland. Similarly, the State has jurisdiction in regulating those activities on the Island Refuges, since the Service owns only to mean high water. The Service could only regulate access from the refuge to the river or to the waters of the Chesapeake Bay. However, despite limited opportunities, limited fish populations, and problems with access, the public requested more boat ramps and fishing opportunities during our scoping process.

Strategies for Blackwater NWR

To increase fishing opportunities, we will construct a canoe ramp on Route 335 with a parking area, an accessible boardwalk, a pier along Key Wallace Drive on the Little Blackwater River, and improved mapping and marking of the Blackwater River channel. The historical, seasonally closed area (October 1 through March 31) will be expanded from 5,788 acres to 6,223 acres, in accordance with new Maryland legislation. Signs and printed materials explaining Blackwater NWR rules and regulations will be made available to visitors. Canoeing and boating activities will be monitored and, if necessary, restricted to reduce disturbance of wildlife and impacts on habitat.

Additional staff will provide fishing, crabbing, and boat safety interpretation programs; National Fishing and Boating Week activities; preparation of canoe trails, maps, kiosk information, and signs; posting of navigation signs and boundary signs; and law enforcement of fishing, boating, and crabbing regulations within Blackwater NWR.

Strategies for the Nanticoke protection area

Fishing access will be by boat only. There are adequate public boat ramps at many locations along the Nanticoke River within the protection area. According to the Nanticoke River Watershed Boating Assessment Study in August 1997 (Nanticoke Boating Study), fishing and cruising (sightseeing) dominate the boating activities on the Nanticoke River. The Nanticoke protection area will have no jurisdiction over the waters of the Nanticoke River. The refuge is not authorized to regulate fishing or other waterborne activities within the navigable waters of the State or within areas where water bottoms are State-owned.

Strategies for the Chesapeake Island Refuges

Fishing access will continue to be by boat only from the various public ramps available along the mainland. The refuge maintains jurisdiction only on lands above mean high water level. Tour boats, cruising, commercial and recreational fishing dominate the island boating activities. The Island Refuges are not authorized to regulate fishing or other waterborne activities within the navigable waters of the State or within areas where water bottoms are State-owned.

O. Environmental Education and Interpretation and Wildlife Observation and Photography Management

Background

In the 1930s, when Blackwater NWR was first established as a refuge for migratory birds, it was considered a sanctuary for wildlife. Few visitors came. By the 1960s, people began to take an interest in the refuge for recreation. Schools began to bring students to see wildlife; visitors interrupted working employees to ask questions; and people wanted a place to picnic in a natural setting. In 1963, a recreational area was constructed, consisting of a shelter, rest room, picnic area with tables, charcoal cookers, walkways, and parking area. The area was highly appreciated and sought after by local residents, as it was the only such facility in Dorchester County. It remains one of the few public picnic areas available in the county. Photographers, bird watchers, and picnickers continued to increase, with the pressure of their use being felt by the refuge staff.

A Visitor Center was constructed in 1967. Locally, the new Center was called the Community Center, where the people of the surrounding area could go to ask questions and learn about their renewable resource, wildlife. With the continued demand for wildlife-oriented recreation, an observation tower, Wildlife Drive, and two walking trails were constructed for public use in the late 1960s and early 1970s.. A self-service entrance fee program, begun in 1987, caused an initial drop in visitation but was gradually accepted, continuing the increase in visitation. Four kiosks with interpretive panels were completed in 1999.

Public demand for information prompted the refuge to produce a general leaflet; a birding check list; leaflets on mammals, reptiles and amphibians, and Canada geese; a Wildlife Drive guide; and a Marsh Edge Trail guide. Blackwater NWR became a showcase for wildlife. It also became a place for children to learn firsthand nature's lessons of adaptation and diversity, for adults to see birds and wildlife in their natural environment, and a place to pass on to a new generation a love for America's wildlife. Visitation peaked in 1999, with almost 500,000 visitors using refuge facilities.

In the 1960s, the entire staff participated in refuge environmental interpretation programs. Although well trained and equipped to manage habitat and wildlife, the staff faced new challenges in managing an eager and active public. The idea took hold that a better informed public could be a positive force in shaping conservation awareness, and thus policy and practice. A Public Use Specialist was hired in 1968, increasing the number of environmental and interpretation programs. Visitation continued to increase and required a permanent full-time Outdoor Recreation Planner (ORP), a permanent full-time Recreation Assistant, and as many as two temporary and two seasonal Recreation Assistants.

Since1990, when both the ORP and Recreation Assistant took other positions, Blackwater NWR has had only one ORP and numerous temporary Recreation Assistants, volunteer interns, or Student Conservation Association Volunteers, usually only one at a time for 3-month periods, requiring a great deal of time for recruiting and training. There were also periods as long as 6 months when the ORP tried to cope with the increasing demand with only the assistance of volunteers. It is no longer possible for the refuge to keep up with the expectations and requests of the public without additional staff.

Although a few citizens began to volunteer in 1981, volunteer workshops were not started until 1985. The program reached 104 volunteers in 1994, and has remained consistent, with approximately 100 volunteers providing more than 11,500 hours per year. The Visitor Center is staffed mainly by volunteers, who are at times the only ones on the refuge because of the staff shortage. The Friends of Blackwater (FOB), a cooperative association that established a book store in the Visitor Center in 1988, has since grown to more than 700 members. Sales grossed more than $61,000 in 1999. FOB has procured several grants to assist in refuge projects, and has become nationally known for their mentoring and assistance in developing other "friends" groups. FOB involvement has helped offset staff shortages and inadequate funding.

During our scoping meetings, the public requested more facilities and increased opportunities for public use. In particular, they want increased opportunities for wildlife-oriented education and interpretation, better auto tour routes, more hiking trails, canoe trials and maps, boat ramps, bike trails, an observation tower, increased hunting and fishing, and a remodeled or new Visitor Center. Although the Visitor Center exhibits were upgraded in 1982, they need to be updated to better inform the public of Service and refuge policies, wildlife needs, and the benefits of wildlife conservation.

In response to those concerns, this plan will increase environmental education programs (including the publication of an environmental education manual), increase the number and types of interpretation and outreach programs, photographing facilities, and wildlife observation facilities; construct an environmental education facility; update exhibits and remodel and enlarge the existing Visitor Center; and hire more staff to plan, manage, and conduct the public use program.

Strategies for Blackwater NWR

This plan will increase opportunities for environmental education and interpretation, outreach, and wildlife observation and photography. In addition to the supervisory ORP for the Public Use Program, three permanent full-time ORPs and a permanent full-time Park Ranger (vacancy since 1989) will be hired to help conduct the

Entrance Fee Program, the Volunteer Program, the Interpretation Program, and the Environmental Education Program. Temporary and seasonal employees may become necessary as the environmental education and interpretation programs develop. Three full-time law enforcement personnel also will be hired for the Complex: two at Blackwater and one for the Island Refuges, to do compliance checks, keep visitors informed, and enforce refuge regulations. Not only will that prevent the public from causing a negative impact on the wildlife and habitat by making them aware of refuge regulations and closed areas, it will also increase refuge entrance fees and provide more accurate information on visitation by requiring all visitors to fill out entrance fee envelopes.

Two hundred volunteers will be recruited and trained for the Public Use Program for interpretation, environmental education, outreach, and staffing the Visitor Center, Nanticoke Contact Station, and Environmental Outdoor Classrooms. Environmental education and interpretation are critical tools for the protection of our Nation's wildlife and habitat resources. By placing additional emphasis on environmental education and interpretation at Blackwater NWR, we anticipate that the number of students reached through on-Refuge visits will increase from 2,000 to 20,000 annually. These students will also receive a richer environmental education experience because of the expanded curriculum and additional contact with Blackwater NWR staff.

The increased public use staff will plan, organize and conduct environmental education programs; recruit and train at least 30 volunteers and interns to assist in the environmental education program; manage the environmental education outdoor classrooms; organize two teacher workshops each year; develop environmental education programs that can meet requirements of school curriculums, boy scout, girl scout, 4–H clubs, home school groups, college programs, programs for adults, and special event programs to be available when needed by 2012; develop refuge activities for elementary age visiting groups by January 2009, for middle school groups by October 2010, and high school groups by October 2012; develop an MOU with Henson Scout camp and the 4–H Camp Thendera to work together on environmental education and interpretive programs by 2011; develop an Envirothon for middle and elementary schools by 2017; develop three changeable environmental education activities for the refuge web page by January 2010, alternating programs every 6 months; and, implement an environmental education manual (printing section1 by October 2009, section 2 by October 2010, and section 3 by October 2012).

The manual will be distributed to schools, and feedback gathered one year after each section is published. The environmental education manual will provide teachers with the information to conduct programs meeting their curriculum requirements, beginning with reading, math, social studies, and science activities in their classrooms, bringing students to participate in a hands-on activity on Blackwater NWR, and returning to their classroom to complete the project, meeting the Maryland State School Performance (MSSP) curriculum standards. Steps will be taken to restore the cemetery before it will be used as a learning tool.

Programs will be conducted in small groups, limited to non-sensitive areas having pavement or decking, limited by how often the programs are conducted, and monitored for signs that carrying capacity is being exceeded. Many environmental education and interpretation activities will occur at the newly constructed Environmental Education Outdoor Classrooms, the remodeled Visitor Center, or inside vehicles where there will be little or no physical impact on the environment.

Five shared educational programs and activities with other environmental education centers (Horn Point Environmental Education Center, Karen Noonan Environmental Education Center, Pickering Creek Environmental Education Center, Chesapeake College, Salisbury University, and University of Maryland Eastern Shore) will be developed by October 2014; fostering opportunities for participation of students, co-ops, SCEPS, interns, and SCAs; participation in community and other government agency events with children's environmental education activities; and the development of communication, workshops, and meetings with other environmental education interests (educational community, non-government organizations, and other agencies) to share information, ideas, and assistance with environmental education activities.

The Robbins property, approximately 19 acres located east of Key Wallace Drive near the Visitor Center, where a house recently burned to the ground, will be protected as a site for an Environmental Education Outdoor Classroom. Another Environmental Education Outdoor Classroom will be constructed near the Visitor Contact Station on the Nanticoke protection area by 2017. Equipment and materials will be purchased for environmental education activities. The Environmental Education Outdoor Classrooms will be designed and located in areas that will minimize physical and biological impacts on the environment. The Service will carry out the section 106 process

under the National Historic Preservation Act to ensure that cultural resources were considered in project planning and avoided or treated appropriately before construction is approved. Blackwater NWR will train professionals by providing the opportunity for Outdoor Recreation Planners and selected volunteers to attend appropriate environmental education training.

The staff will manage the interpretation programs, update kiosk information, order and install signs, and design, update, and order refuge leaflets. Projects will include updating present kiosk information panels and providing a kiosk at the entrance to the new Wildlife Drive location, and at the Nanticoke Visitor Contact Station by 2014; developing and constructing trail heads with kiosks at new hiking, canoeing, and biking trails by October 2014; installing interpretive signs in new hiking, biking, and canoeing areas and other areas as needed; producing new Refuge film by 2012, and a Nanticoke protection area film by 2014; purchasing new videos that are applicable to the refuge for use in the Visitor Center as they are produced; revising Mammals and Wildlife Drive Guide leaflets to FWS standard format; and producing a self-guided Woods Trail leaflet, volunteer leaflet, and exotic species leaflet by October 2012; endangered species leaflet and entrance fee leaflet by October 2014; self-guided trail leaflets as trails are developed, and other leaflets as needed.

Most of the interpretation programs will be held inside or outside of the Visitor Center, Environmental Education Center, in vehicles that serve as photo blinds for wildlife, or in designated areas of public use where wildlife can anticipate human visitors and be less likely to have a defensive response. Environmental education and interpretation programs should help lessen impacts by informing visitors about the needs of wildlife and wildlife habitat. This extensive education of the public on natural processes and cultural resources will result in satisfying the curiosity of the public who will otherwise unwittingly cause much damage by their explorations. A sign in the Woods Trail kiosk will explain the history of the steam engine. All items used in displays or held in storage will be properly accounted for and cataloged. Historical items will be placed in a fire-safe storage area. Increased staff and trained Visitor Center volunteers will dispense information concerning cultural and historical resources as appropriate. Interpretive canoe trips on the Blackwater and Nanticoke rivers in the late spring will generate public support and increase public awareness of Blackwater NWR programs and mission.

An upgraded and remodeled Visitor Center with new exhibits will provide increased benefits to the environmental education and interpretation aspects of the program with more space for exhibits, programs, and an accessible second level observation platform. The Visitor Center will be remodeled and expanded by 2008 to include a multipurpose room for 150 people; second floor observation area with scopes; environmental education area; new office space for three ORPs and one Park Ranger, interns, and the volunteer program; sales outlet space for FOB; and a larger exhibit area.

New updated Visitor Center exhibits will be developed. A live action monitor of an eagle nest will be installed in the Visitor Center with educational exhibit on eagles by January 2009; an indoor interactive computer console installed by October 2008; an outdoor interactive computer console installed by 2014; a butterfly garden constructed by October 2008; a habitat demonstration area established by October 2009; and two travelers information stations installed on Route 50: one near Cambridge by January 2008, and one near the Nanticoke River in Vienna by 2012.

A Visitor Contact Station and Office will be constructed along Route 50, where more than 6 million people a year will have the opportunity to stop and visit the refuge and learn more about the Nanticoke River, the Refuge Complex, the Service, and the Eastern Shore. The contact station will be sited where the fewest physical impacts will occur, on a site yet to be determined. The facility will include administrative offices, a visitor contact station with interpretation exhibits, and a maintenance shop capable of housing refuge maintenance vehicles and boats.

Blackwater NWR will participate in local events, such as the Bay Country Festival, 4–H Fairs, Waterfowl Festival, Shad Festival, and other events as they develop; work with Dorchester County Tourism, South Dorchester Folk Museum, Harriet Tubman Organization, and community organizations in events and activities as they are developed; develop ecotourism programs with the new Cambridge conference center at the Hyatt by October 2012; develop better personal relationship with the media; develop a refuge monthly or weekly activity report for the local newspapers and radio stations; involve more people from the community in the Volunteer Program; and participate in the development of watershed-wide cooperative outreach groups of Caroline, Dorchester, Somerset, and Wicomico Counties; and continue to participate in the Nanticoke Watershed Alliance and Lower Shore Tributary Strategies Team.

Increasing Blackwater NWR participation in off-site events and activities will increase public understanding of the importance of wildlife habitats essential to wildlife's survival. When they understand the connection between wildlife's survival and man's survival, they will help protect the habitat and produce minimal impact on the physical habitat of Blackwater NWR and elsewhere. The refuge will continue to work with FOB to seek funding, develop programs, produce projects, expand the cooperative sales outlet, plan and conduct public events, and promote national projects and other activities as they develop.

A Friends group will be established specifically to support outreach and advocacy for the Nanticoke protections and the Nanticoke River watershed. The Friends group will be members of the Nanticoke Watershed Alliance. The group will also support the development of an outreach plan, a volunteer program, interpretation programs, signage, kiosks, a general leaflet and other self-guided leaflets and brochures, the Nanticoke protection area film, and the purchase of other videos applicable to the Nanticoke protection area, the refuge website, interpretive canoe trail, and special events.

By October 2009, the Wildlife Drive will be restructured to enter from the Visitor Center area and exit at the present entrance giving visitors a better view of wildlife along the drive. That change will enable visitors to first get information and assistance from staff and volunteers at the Visitor Center before entering the Wildlife Drive. The second part of the Wildlife Drive will be converted to a bike trail to connect with a bike trail to be constructed by the Maryland Highway Department and Dorchester County along Route 335 to Hip Roof Road, providing a 4- to 5-mile bike trail. That trail will allow a separate area for wildlife observation for hikers and bikers that will not conflict with motorists. Physically separating motorized and non-motorized traffic on the Wildlife Drive will not only improve the safety of the visitor, but also limit the impact on wildlife to only one section of the drive (motorized vehicles will serve as a blind for visitors). Parking areas for visitors wishing to bike will be constructed.

By October 2017, a trail at the Nanticoke River, a demonstration forest trail, and an observation walking trail on the Newcomb tract will be constructed with associated parking areas for visitors. The wildlife observation trails will be constructed mostly in existing roadway, in a areas presently closed to visitors that will have minor physical impact on the surrounding forested habitat. Benches will be installed along the existing and new observation trails to allow visitors to rest and enjoy observing wildlife.

By January 2012, the observation tower that was removed in 1990 because of structural deficiencies and other safety hazards will be replaced with an accessible deck and elevated observation platform over wetlands to the water's edge at the junction of Little Blackwater River and Blackwater River, to be used for environmental education programs as well as for visitors to view the wetlands. An observation tower, canoe access ramp and controlled parking area, and an accessible boardwalk and pier on or adjacent to the Nanticoke River will be constructed.

By January 2010, three observation and photography blinds will be installed. They will be designed and constructed with natural visual and noise screen and buffer zones to minimize impacts on Blackwater NWR resources or wildlife. The first will be along the Wildlife Drive with a deck over the marsh and enclosed photo blind. The second will be near the entrance to the second half of the Wildlife Drive, and the third along the 4-mile Gum Swamp observation trail. Photography programs will be provided for the public for each of the four seasons of the year. The construction of all new observation and photographic facilities will be located and designed to minimize impact on wildlife and habitat. Before increasing wildlife observation and photographic opportunities, a thorough examination of the new activity or facility addition will occur to insure that the change will not negatively impact the resource.

By January 2012, six observation and photography blinds will be installed. They will be designed and constructed with natural visual and noise screen and buffer zones to minimize impacts on Blackwater NWR resources or wildlife. The first will be along the Wildlife Drive with a deck over the marsh and enclosed photo blind. The others will be near the entrance to the second half of the Wildlife Drive, along the 4-mile Gum Swamp observation trail, the demonstration forest trail, and near the Nanticoke River. Photography programs will be provided for the public for each of the four seasons of the year. The construction of all new observation and photographic facilities will be located and designed to minimize impact on wildlife and habitat. Prior to increasing wildlife observation and photographic opportunities, a thorough examination of the new activity or facility addition will occur to insure that the change will not negatively impact the resource.

Strategies for the Chesapeake Island Refuges

This plan will increase environmental education and interpretation activities. The visitor contact station at the Middleton House on Smith Island will be upgraded to provide new displays and updated material on the Island Refuges; provide office space with telephone, fax machine, computer, and copy machine; suitable furniture for second floor lodging of interns and researchers; and upgraded plumbing and electrical systems. In the town of Ewell, lands will be purchased to construct an Environmental Educational Center highlighting Island Refuge ecology in partnership with the Chesapeake Bay Foundation. Protection will focus on suitable properties nearby to the Middleton House.

A kiosk will be constructed at the Ewell ferry dock to provide information and direction to the Middleton House and the environmental education and interpretation center. Exhibits and habitat restoration projects will be developed for the environmental education center. A professional video on the Island Refuge, other applicable videos, a video projector, and screen will be purchased to show films on Island Refuges, wildlife, and wildlife habitat to the public. A general leaflet and other self-guided leaflets and brochures, and additional outdoor displays will be developed. An outdoor spotting scope will be installed. Signs will be installed where needed.

In association with the new Environmental Education Center, a wildlife observation trail or boardwalk will be constructed on Martin NWR. Resources profiled will include waterfowl, waterbirds, and saltmarsh ecology. In addition, an observation tower and viewing and photography blinds will be constructed in suitable locations. A needs assessment will be conducted in cooperation with partners to determine the scope, extent, and compatibility of proposed and additional facilities and programs.

An Outdoor Recreation Planner will be hired to provide the increased public use program activities, supervise interns, and conduct education, interpretation, and outreach programs for the Island Refuges. One law enforcement officer will be hired to be a preventive presence on the islands and assist with outreach programs and daily maintenance of equipment and facilities. A volunteer program will be developed for monitoring, interpretation, education programs and outreach, and maintenance of the Island Refuges.

Partnerships with The Chesapeake Bay Foundation, U.S. Army Corps of Engineers, National Fish and Wildlife Foundation, National Aquarium in Baltimore, National Oceanic and Atmospheric Association, and the local Waterman Museum will be established to provide additional programing and educational opportunities for visitors. An MOU with The Chesapeake Bay Foundation will be maintained to work together on environmental education and interpretation programs and events. Outreach programs will be expanded to reach an additional 15,000 visitors by incorporating summer programs that coincide with tour boats visiting the Island Refuges. A Friends group to create a small cooperative sales outlet, to provide Federal passes, educational books, and other educational items; seek funding; develop programs; and produce projects will be established. Upon completion of a compatibility determination, an interpretive canoe or kayak trail will be developed between Island Refuges. Guided estuarine interpretation tours will be provided for educational groups during the spring and fall months.