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Chapter 4. Environmental Consequences

Biological Diversity, Biological Integrity, and Environmental Health

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.[1] 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

[1] Biodiversity Communications Handbook 2000

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].

In comparing the consequences of the alternatives on both Blackwater NWR and the Chesapeake Island Refuges, it is important to note that programs to benefit biological integrity, biological diversity, and environmental health are ongoing. The goals and objectives outlined in alternative A produce 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.

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.[2] 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.

The primary distinction among the alternatives is one of focus and effort. Alternative C takes a more bare-bones approach than alternative A. Alternative C will direct management only toward Federal trust resources where mandated by law or policy. As with alternative A, incidental benefits will accrue to biological integrity, biological diversity, and environmental health. The important distinction of alternative C is that it implements no programs to enhance other species, habitats, or processes that are not formal mandates of the Refuge System. Alternative C will allow natural and anthropogenic forces to act upon the ecosystem processes, communities, habitats, and species within the Refuge Complex. It makes no effort to control invasive, injurious, or exotic species or address sea-level rise and habitat loss. We would not intervene unless, in our best professional judgment, inaction would have catastrophic consequences.

In alternative B, we would 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 would 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. Alternative B assumes the funding and staffing capacity to carry out these

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

management programs and activities. Without sufficient personnel and resources, meeting the objectives for each refuge of the Refuge Complex will be problematic.

Table 1. Summary of consequences by alternative

Program Activity	Alternative A	Alternative B	Alternative C
Surveys, monitoring, and assessment	Very limited, opportunistic. Most dollars and effort provided by outside partners.	Comprehensive: build upon existing data and information. Operational capability ($ and FTE) on station.	Limited. Some capability on-station but not primary focus of Refuge Complex inventory plan. Other partners may initiate.
Restoration and other management actions	None specific, but collateral benefits from focus on Federal trust resources	Specific and systematic with the focus for those resources in mind.	None; collateral benefit only, from the focus on Federal trust resources.
Protection	Done primarily through land protection.	Comprehensive and specific programs for each identified element or incorporated into larger planning efforts.	Done primarily through land protection.
Step-Down Plans with specific management elements and programs	No	Yes	No

Alternative A. Species–specific Management

Physical Impacts

Generally, the consequences of the major habitat management programs in alternative A will likely be minimal, and will have collateral benefits for the biological integrity, biological diversity, and environmental health of the Refuge Complex. Alternative A maintains our intensively managed water and wetland management systems and the furbearer and exotic species management programs. The chemical control of invasive species will have some effects on water quality, previously discussed. All of these activities will involve some use of mechanized equipment and limited construction and restoration. We anticipate some temporary effects on water quality, soils, and topography, but most of those activities will not influence any features of biological integrity, biological diversity, and environmental health.

Biological Impacts

The preeminent strategy in alternative A is to apply land management and species management programs to conserve fish and wildlife and other biological resources on the landscape. However, it limits intensive management activities on the surrounding land base, unless our conservation partners initiate or support them. Although this alternative does not specifically address the

elements of biological integrity, biological diversity, and environmental health, the existing land protection of the Refuge Complex and our existing management programs for Federal trust species will result in some benefits. Our programs for managing populations of endangered and threatened species or other Federal trust resources and providing habitat for them will also help sustain the life history requirements of other sensitive species, and maintain ecosystem processes and environmental health. For example, crops grown for waterfowl would provide feeding and host habitat for several species of butterflies.

Attempts to manage the effects of invasive, injurious, and overabundant species will be minimal, compared to the programs outlined in alternative B. However, some control will occur, and any management of the impact of these species will commensurately improve biological integrity, biological diversity, and environmental health.

We do not expect significant conflicts to arise from managing for Federal trust species and habitat objectives and from conserving, at least on some level, biological integrity, biological diversity, and environmental health. For example, most of the species and communities listed in chapter 3, "Affected Environment," live in wetland and unique upland habitats that overlap, to some extent, Federal trust resources. We expect only limited opportunities to conduct additional inventorying and monitoring of those resources in alternative A, which would further hamper our ability to expand programs to address biological integrity, biological diversity, and environmental health.

Socioeconomic Impacts

Alternative A lacks specific opportunities to facilitate, restore, or enhance biological integrity, biological diversity, and environmental health, which may have some negative impacts on the socioeconomic environment. Opportunities for research and adaptive management may be limited or even unavailable, except through the generosity and support of conservation partners. Similarly, opportunities for compatible wildlife-dependent recreation may be limited, or may not develop at all. Cumulatively, alternative A would reduce the positive economic impacts that alternative B would produce on restaurants, hotels and the service and retail sectors from the visiting public, scientists, and researchers.

Cultural and Historical Resource Impacts

The lack of comprehensive biological integrity, biological diversity, and environmental health programs in alternative A will have no effect on cultural and historical resources.

Administration, staffing, infrastructure, law enforcement, and other needs

Since no management programs will be in place specifically for conserving biological integrity, biological diversity, and environmental health, we do not anticipate the need for additional staff,

administration, or logistical support for that purpose. We would integrate it into the overall operational needs of implementing alternative A.

Alternative B. Conservation Biology for Trust Species Diversity

Physical Impacts

Water Quality

Management programs to address biological integrity, biological diversity, and environmental health will positively benefit water quality. For example, protecting State heritage sites will preserve their vegetation communities, and draw attention to concerns about water quality from upstream sources. Programs will be implemented to elicit landowner support for improving water quality in the watershed generally, and for biological integrity, biological diversity, and environmental health, specifically. Service programs on the Refuge Complex will either meet or exceed existing agricultural and forestry best management practices. Strategies for restoring hydrology and reducing or eliminating island losses will also benefit water quality. We will work with our conservation partners to address long-term watershed restoration and eliminate sources of eutrophication.

Implementing the Fire Management Plan and the Habitat Management Plan will cause some temporary adverse impacts on water quality. Prescribed burning may temporarily produce conditions that introduce nutrients into surface waters. Timber stand improvements (TSI) may temporarily degrade water quality, through the construction of minor roads, the placement of culverts, and so forth. Using thin-layer deposition may result in turbidity and other adverse effects on ambient water quality conditions in surface water.

Topography and Soils

Management actions that involve construction, mechanized equipment, or fire, may cause some temporary impacts on soils, as discussed in our approved Fire Management Plan. The topography will not be impacted significantly; any construction will be designed to restore and redress historical hydrological modifications, and will provide long-term beneficial effects that exceed any short-term adverse effects.

Geology and Hydrology

The actions to restore surface water hydrology outlined in chapter 2, “Alternatives,” include, but are not limited to, restoring historical hydroperiods and stream flows or addressing unnatural flood or drought cycles. These will directly benefit biological integrity, biological diversity, and environmental health. Any impacts from construction to restore or redress historical hydrological modifications will provide long-term beneficial effects that will exceed any short-term adverse effects. We do not anticipate any consequences on the geology of the Refuge Complex.

Air Quality

Programs to enhance biological diversity, biological integrity, and environmental health will result in protecting habitats, thereby conserving the ability of forests and other natural lands to absorb heat and produce oxygen, positively affecting ambient air quality. Minor, temporary effects on air quality may result from prescribed burning for habitat management, as discussed in the Fire Management Plan. Management activities involving the placement or removal of water control structures, fish passage barriers, or the use of mechanized equipment to perform these and similar actions will produce temporary adverse effects on air quality; we do not expect these to be anything but insignificant and inconsequential.

Biological Impacts

Aquatic, Wetland, and Terrestrial Habitats

The consequences of applying actions designed to benefit biological integrity, biological diversity, and environmental health on the Refuge Complex will also ultimately benefit aquatic, wetland, and terrestrial habitats. Those actions will result in the protection, creation, and maintenance of riparian corridors, protecting these features of the landscape. Managing and protecting specific populations will provide collateral benefits to aquatic, wetland, and terrestrial habitats. Riparian buffer maintenance and creation will be targeted to optimize the breeding, feeding, and sheltering requirements of healthy populations of resident species and to restore overall ecosystem processes. Invertebrates and other basic food-chain organisms that live in aquatic areas should improve, thereby improving biological diversity, biological integrity, and environmental health. Forest fragmentation will be reversed, and overall forest health will improve, through the application of Timber Stand Improvement (TSI) methods, as explained in the Forest Management Plan, below. Efforts to address hydrological modifications and combat the effects of sea-level rise and marsh loss will also improve the condition, health, and acreage of aquatic, wetland, and terrestrial habitats within the Refuge Complex.

Fish and Wildlife Populations

Introduction and general discussion.—Generally, fish and wildlife populations should benefit or exhibit a benign effect from the implementation of programs to meet biological integrity, biological diversity, and environmental health goals for the Refuge Complex. We do not expect any conflicts among species and communities from the inventorying and monitoring program, efforts to restore hydrology, cropland management, or step-down plans for the major habitat types in the Refuge Complex. We expect that, using the results of the Refuge Complex-wide Resource Inventorying and Monitoring Plan, the development of Annual Work Plans will incorporate a variety of management tools to conserve, restore, and maintain biological integrity, biological diversity, and environmental health. Those may include, but are not limited to, using spatial or temporal zoning to manage potential or actual anthropogenic disturbances; restoring ecosystem processes; using prescribed burning; using nest boxes; restoring hydrological regimes; and developing species-specific population and habitat objectives that tier off existing plans and

initiatives and embody relevant conservation science and management issues, such as disease monitoring, population and trends monitoring, life history and management-related research.

Migratory waterfowl.—Habitat objectives and population goals for migratory waterfowl will be compatible with efforts to enhance or maintain biological integrity, biological diversity, and environmental health, since most efforts to provide intensively managed wetland and water management systems will occur in a small portion of the Refuge Complex to meet refuge purposes. The development of any new wetland and water management systems will focus on previously disturbed or farmed wetlands. Efforts to protect the island communities, other wetlands communities, and efforts to restore SAV beds should produce positive effects on migratory and wintering waterfowl.

Neotropical migrants and forest interior dwelling species (FIDs).—The protection or restoration of forested communities, including Atlantic white cedar and rich woods complexes, will result in a higher quality and larger forest within the Refuge Complex, benefitting Neotropical migrants and FIDS. Maintaining the health of these plants communities may also result in a better matrix of feeding, breeding, and sheltering habitats, which may enhance biological diversity at the forest stand and watershed scale.

Endangered and Threatened Species.—Conserving biological diversity, biological integrity, and environmental health will not affect habitat and population management programs for endangered and threatened species. In fact, we expect the restoration or conservation of the diverse species and plant communities within the Refuge Complex to benefit those species, or at worst, create only benign effects. The use of fire and other management programs for some of these species or plant communities could have both positive and negative effects. Although we do not expect the latter, the Refuge Complex will use the best conservation science available to ensure that the mechanics and logistics of prescribed fire or any other management tool will not adversely affect threatened or endangered species. Methods for redressing previous hydrological impacts and developing specific protocols to assist in meeting goals for biological diversity, biological integrity, and ecosystem health would also assist in meeting goals for endangered and threatened species.

Raptors, colonial waterbirds, and shore, marsh and wading birds.—Management programs for biological integrity, biological diversity, and environmental health will materially benefit these species. Efforts to create or maintain wetland habitats or restore hydrology will improve overall watershed- and landscape-level ecosystem processes.

Socioeconomic Impacts

We do not expect any impacts on land use and values or on economic or population growth from the implementation of actions to improve biological integrity, biological diversity, and environmental health. Some minor beneficial effects on the local economy would result from increases in the Refuge Complex operating and maintenance budget to address these resources. As people

travel to the Refuge Complex for wildlife-dependent recreational opportunities, income from ecotourism would increase, and Service-employed researchers or partners will contribute as well.

Cultural and Historical Resource Impacts

The effects on archeological and cultural resources will be positive, since Federal ownership of these areas triggers legal mandates that protect and conserve these features on the landscape, far beyond the requirements for non-Federal landowners.

Administration, staffing, infrastructure, law enforcement, and other needs

We would anticipate the need for additional staff and administrative and logistical support to implement biological integrity, biological diversity, and environmental health programs. Refuge and Refuge Complex operating needs, staffing, and equipment projections are outlined in the appendixes.

Alternative C. Maximum Public Use with No Habitat Management

Physical Impacts

We do not expect any physical impacts from management programs for biological integrity, biological diversity, and environmental health, because those programs will be minimal in alternative C. They generally consist of monitoring and status and trend analysis. The use of mechanized equipment to perform these surveys would produce temporary impacts on the physical environment.

Biological Impacts

The preeminent strategy to manage and conserve fish and wildlife and other biological resources in alternative C is land protection. We will not have programs that consist of active intervention in wildlife population management, nor will we create any new intensive wetland and water management or any new areas for high-quality winter forage. Alternative C maintains our existing programs for managing Service trust resources, but does not expand them into newly protected refuge lands or to the proposed Nanticoke protection area. Surveys and monitoring will continue, and expand across the Refuge Complex. Although this alternative lacks specific management programs to address biological integrity, biological diversity, and environmental health, existing programs will result in some benefits.

We will not attempt to manage the effects of invasive, injurious, and overabundant species, which may counteract the beneficial effects of placing additional lands under Service ownership.

Absent control of those species, we expect a slow degradation of biological integrity, biological diversity, and environmental health.

Socioeconomic Impacts

Alternative C lacks specific opportunities to facilitate, restore, or enhance biological integrity, biological diversity, and environmental health, which may have some negative impacts on the socioeconomic environment. Research and management opportunities will be limited or unavailable, except through the generosity and support of outside partners. Similarly, compatible wildlife-dependent recreation opportunities may be limited, or may not develop at all. Compared to alternative B, alternative C may cumulatively reduce the positive economic impacts produced by the visiting public, scientists, and researchers on restaurants, hotels, and other service and retail industries.

Cultural and Historical Resource Impacts

The lack of comprehensive biological integrity, biological diversity, and environmental health programs will have no effect on cultural and historical resources.

Administration, staffing, infrastructure, law enforcement, and other needs

Since no management programs will be in place that specifically conserve biological integrity, biological diversity, and environmental health, we would not anticipate the need for additional staff and administrative or logistical support specifically for that purpose. It would be integrated into the overall operating needs of implementing alternative A.

Habitat Management—Marsh

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 now 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.

We present three alternative solutions.

- Alternative A involves programs designed to reduce herbivory (the nutria rebate program and muskrat and nutria trapping), stimulate marsh growth (prescribed burning), and provide limited control of invasive plant species, for example, Phragmites (*Phragmites australis*).

- Alternative B involves developing a comprehensive marsh management plan, which 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.

- Alternative C will involve the implementation of monitoring programs, but no active wildlife population or habitat management. Strategic land protection is a component of all three alternatives. The consequences of these alternatives will be discussed in the context of Blackwater NWR, but that discussion will apply to lands protected for the proposed Nanticoke protection area. See "Erosion Control and Habitat Restoration" in "Islands Management," below, for a discussion of the marsh management alternatives for the Chesapeake Island Refuges.

Alternative(s) Considered But Dismissed

Given the prediction that seawater would inundate most of the existing refuge lands by the next century, we considered working with, rather than against, these geomorphological processes. That approach would 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 this alternative because marsh restoration was considered crucial to 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.

Alternative A. Species–specific Management

Physical Impacts

The impacts of alternative A on the existing physical environment would be severe, if not catastrophic. Blackwater NWR has lost marsh at the rate of 142 acres per year since 1938 (Stevenson, et al. 1985). The Blackwater River historically was more typical of tidal rivers on the Eastern Shore, with cattail (*Typha* sp.) marshes in the upper river turning to *Spartina alterniflora*-dominated saltmarsh at its mouth. Salinity levels likewise varied from 0 ppt at its headwaters to 20 ppt at its mouth. However, a breach in the marsh that separates the relatively high-saline Stewart's Canal and the historically freshwater upper Blackwater River has noticeably enlarged since it was first observed in 1989. In recent years, salinity in the upper Blackwater River has exceeded 20 ppt due to saltwater intrusion from Stewart's Canal, at times exceeding the salinity at the mouth of the river.

Shorter's Wharf Road clearly is impacting the existing marsh, and will continue to do so under alternative A. Some stretches of this road delineate a marsh dominated by *Spartina patens* on the east and by *Shoenoplectus americanus* on the west. Pendleton and Stevenson (1983) report that 99 percent of total suspended solids flushed out by the Blackwater River channel under the Shorter's Wharf bridge is from intertidal and subtidal (i.e., open water) sources. Concomitantly, Shorter's Wharf Road inhibits the inflow of fresh sediment during storms. These findings suggest that the system is attempting to flush out decaying substrates, but the sediment-damming effect of the road is limiting this natural process. Without the complete flushing of decayed matter and eventual replacement by new inorganic substrates, it is unlikely that the marsh ecosystem will recover its equilibrium.

Alternative A would not address sea-level sea rise or the modified hydrology induced by Stewart's Canal and Shorter's Wharf Road. Marshland fire would be prescribed to increase the growth of the existing marsh and to sustain a marsh dominated by Olney's three-square bulrush. Nutria, muskrat, and mute swan populations would be controlled to decrease herbivory and its

effects exacerbating marsh loss. However, in the absence of efforts to restore marsh hydrology and to mitigate the current loss, the existing marsh would continue to be degraded and lost over the foreseeable future. The breach between Stewart's Canal and the upper Blackwater River is already to the point that an almost continuous flow of brackish water separates southern Dorchester from the rest of the county, connected only by the bridges on Route 16, Route 335, and Shorter's Wharf Road. With only a 2.5-m range in elevation over the entire refuge, and a sea-level rise of 30–65 cm projected over the next century, one scenario is that southern Dorchester County will become an island, much like nearby Taylors Island, with most of the existing emergent marsh on the Blackwater River becoming a tidal gut on the Chesapeake Bay. Similarly, Stevenson, et al. (2000) paint a scenario in which this extensive marshland would become open water embayments. They further suggest that because of excessive organic debris, excessive turbidity, and sporadic anoxia, "it could take decades to centuries for these embayments to become productive environments." In either event, it is not unreasonable to assume that most of the remaining 8,000 acres of estuarine emergent marsh would be severely degraded, if not lost, under alternative A.

Biological Impacts

We expect the impacts on existing biota to be severe and dynamic. The loss of tidal marsh and the landward migration of the forest-marsh transition zone are expected results of global sea-level rise and land subsidence. One could argue that this is a natural process and that the system will reach some kind of equilibrium without human intervention. However, the current rate of marsh loss is exceeding the rate of natural succession within the forest-marsh transition zone. At lower rates, species composition within this ecotone would vary through several seral stages; e.g., from low marsh to high marsh to a saltbush community to stunted loblolly pine and finally to a more upland forest community. However, the marsh at Blackwater NWR is being flushed faster than these communities can become established, typically resulting in open water lapping against Phragmites-buffered, salt-stressed loblolly pine. This system is vulnerable to erosion, and has few of the ecological values associated with more classical tidal wetlands.

The continued loss of estuarine emergent marsh can only negatively impact breeding and wintering waterfowl. Historically, the marsh has provided significant wintering habitat, particularly, Olney's three-square bulrush, for Canada geese, lesser snow geese, American black ducks, and other dabbling waterfowl. Similarly, the refuge was noted for its extensive breeding habitat for American black ducks and blue-winged teal (*Anas discors orphana*). During his testimony to the Migratory Bird Conservation Commission in 1931, Dr. Oliver L. Austin of the U.S. Biological Survey described Blackwater NWR as "the most important waterfowl breeding area on the Atlantic coast south of Labrador."

However, aerial surveys suggest that most of the waterfowl wintering on Blackwater NWR in the past decade use the freshwater impoundments, croplands, and adjacent off-shore areas on the Blackwater and Little Blackwater Rivers. Relatively high counts of American black ducks still can be found in the areas that sustain healthy emergent marsh. On the other hand, the open water that has displaced wetlands is now used 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 its use by shorebirds other than pelagic phalaropes, and few diving duck species use this habitat due to its lack of SAV (see below). Under this alternative, both breeding and wintering waterfowl populations on Blackwater would continue to decline as emergent marsh is lost. Other marsh-dependent fauna, such as the saltmarsh sharp-tailed sparrow, coastal plain swamp sparrow, black rail, muskrat, and rare skippers, would be expected to decline as well.

At least 44 fish species in Dorchester County use the marshes for spawning, nursery, and feeding (Metzgar 1973). However, marsh loss and frequent saltwater intrusion in recent years has greatly reduced the quality of aquatic habitats due to turbidity. With the continued loss of emergent marsh and the inability of the system to flush flocculent detritus, it is very likely that the bottom of the expanding open water will not stabilize for some time. This has resulted in the degradation of existing SAV (primarily, wigeongrass), and has inhibited the establishment of new SAV beds as open water has expanded. The waters of the upper Blackwater River, historically significant for spawning anadromous fish (e.g., striped bass, river herring, shad), are now too salty and degraded, due to the breach in the marsh that now joins the Blackwater River with the Little Choptank. Catadromous American eels have declined in numbers, although they were once commercially harvested on the Blackwater River. Similarly, freshwater species that can tolerate low levels of salinity, such as yellow perch, bluegill, black crappie, and largemouth bass, can only decline in numbers in the upper Blackwater and Little Blackwater Rivers as those waters become more brackish.

Increasing salinity would certainly threaten the Upper Blackwater River Natural Heritage Area, an area identified as significant by the Maryland Heritage Program. This area represents one of the best examples of a complex of tidal saltwater wetlands, tidal freshwater wetlands, contiguous non-tidal wetlands, upland islands, and Delmarva Bays in Maryland. Wetland communities extending from the Ewing (Madison) Tract at the headwaters of the Little Choptank River, east to the Seward Tract, include 10 different types of tidal wetland and approximately 15 types of non-tidal wetland, which support a number of rare, threatened, or endangered species, including the rare skipper and bald eagle. Both estuarine and palustrine wetlands are well represented. Tidal wetland communities within these parcels (Salt Marsh Cordgrass, Saltmeadow, Saltbush, Black Needlerush, Freshwater Mixed, Arrow Arum-Pickerel Weed, Cattail, Narrowleaf Cattail, Yellow Pond Lily, and Tidal Mudflat) make this extremely diverse complex important to preserve and protect.

Increasing salinity would almost certainly cause the expansion of the forest type classified as “Stunted.” This forest type usually grows on soils classified as “Sunken,” most often in the transition zone between marsh and upland. It is generally represented by sparsely distributed loblolly pine with an understory of switch grass (*Panicum virgatum*), *Spartina patens*, wax myrtle, and greenbriar. The trees are stunted and small in diameter, and seedling mortality rates are elevated (USDA 1998) due to the sodium salts in the upper layers of the soils. Many of these salt-stressed areas ultimately will be converted to marsh as the loblolly pine dies, unless sea levels rise at rates that exceed normal floral succession.

Socioeconomic Impacts

Blackwater NWR is the largest tourist attraction in Dorchester County. Refuge visitation and associated ecotourism revenue contribute a reported $15 million annually to the local economy. More than 100,000 visitors register annually at the Visitor Center, and most come here to view wildlife, particularly waterfowl. Waterfowl populations seeking sanctuary and forage at the refuge also directly affect the leasing of hunting rights on nearby private lands. More than 4,500 jobs and $31 million in state and Federal tax revenues are directly related to hunting or non-consumptive activities associated with migratory waterfowl and bird use in Maryland (Southwick Associates 1995). The overall economic benefits to Maryland from hunting waterfowl and other wildlife species that depend upon the Chesapeake Bay marshes are estimated at more than $300 million annually (USFWS 1995). In alternative A, waterfowl use of the refuge would be expected to decline as the marsh degrades. Consequently, visitation and its contribution to the local economy can be expected to decline, as well.

Shellfish and finfish in the surrounding waters and furbearers in the marshes have provided a source of livelihood since the time of the earliest settlers. The Blackwater NWR and the Fishing Bay estuary support one of the most important blue crab nurseries in the Chesapeake Bay, and the surrounding marshes serve as important habitat for at least 44 fish species (Metzgar 1973). The most significant sport fish in the Blackwater and Little Blackwater Rivers, the largemouth bass, will almost certainly decline in abundance as the rivers become more brackish.

Similarly, fur trapping is a major source of supplemental income to many Dorchester County residents, particularly watermen and farmers. To control nutria and muskrat populations on the refuge, trapping is conducted on 18 units by permits, which are awarded by sealed bids. Bids for 1997 trapping rights exceeded $9,400. Trapping income from the refuge in 1997 contributed approximately $53,000 to the local economy. That supplemental income would decline sharply in alternative A as the marshes continue to disappear.

Cultural and Historical Resource Impacts

The marsh management program in alternative A would not adversely impact cultural and historical resources. However, the continued loss of a significant estuarine marsh on the Chesapeake Bay would have impacts that go beyond tangible biological, physical, or economic concerns. Coastal intertidal marshes, like all wetlands, have figured prominently in human artistic and aesthetic considerations for ages. The relatively pristine tidal marsh system is the underpinning of the unique character of the Eastern Shore and the waterman and trapper traditions. Wiegert and Freeman (1990) point out that tidal marshes are wilderness by many definitions, despite their use by people in search of recreation and commercial return. Unlike most terrestrial systems, intertidal marshes have retained relatively pristine processes because (1) they were largely undisturbed by agriculture, (2) the dominant vegetation responsible for the productivity of the system is continually renewed, and (3) the trophic web essentially has been retained. Furthermore, the intertidal system, because of the stress imposed by high salinity, is not an easy system for non-native plants or animals to invade.

Administration, staffing, infrastructure, law enforcement, and other needs

As alternative A does not change the existing management regime on either Blackwater NWR or the Chesapeake Island Refuges, we do not anticipate additional staff or administrative support specifically for this purpose.

Alternative B. Conservation Biology for Trust Species Diversity

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 would 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 would 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 would also include a significant monitoring component, due to the dynamic history of the marsh and the planned restoration strategies.

Physical Impacts

The restoration of hydrological and geomorphological processes proposed in alternative B would be dramatic, but beneficial. Its overarching goal is to restore the Blackwater marsh to 1938 coverage. To accomplish this, the proposed strategies involve reversing the changes that have occurred as a result of constructing Stewart's Canal in the 1850s and Shorter's Wharf Road in the early 1900s. Plugging Stewart's Canal would restore the natural salinity gradient to the upper Blackwater River, and should reduce the input of organic detritus from decaying marsh plants. Constructing culverts under Shorter's Wharf Road or elevating the entire roadbed above the marsh (i.e., a causeway) would increase tidal sheet flow, which can lead to both increased sediment deposition and reduced anoxia (Stevenson, et al. 2000). Riprapping the shorelines of existing pine islands that have been exposed as a result of the degradation of the surrounding marsh would abate further erosion from wave action and river flow. Depositing thin-layer dredge material to restore elevations in degraded and subsiding marshes would accelerate their vertical

accretion (Ford, et al. 1999). These proposed projects will have mostly short-term negative physical impacts associated with construction activities; these will be covered under a separate but comprehensive EIS.

Management programs to reduce herbivory and promote marsh vigor also have short-term negative physical impacts associated with their implementation. Please note, EAs have been approved for the existing Fire Management Plan (Sep 2000), the Integrated Wildlife Damage Management Plan (Dec 1999), and the Nutria Damage Reduction Pilot Program (Dec 2001).

Biological Impacts

In alternative B, the full restoration of the marsh should dramatically but beneficially impact aquatic and marsh-dependent organisms. The reestablishment of 7,000 acres of brackish emergent marsh, mostly Olney three-square, would directly benefit breeding and wintering waterfowl (particularly American black ducks), muskrats, black rails and other waterbirds, rare skippers, and marsh-obligate passerines such as the coastal saltmarsh sharp-tailed sparrow and coastal plain swamp sparrow. Increased tidal flow as a result of modifying Shorter's Wharf Road should reduce anoxic conditions, thereby increasing the decomposition rate of organic debris and improve conditions for SAV growth. Restoring the salinity gradient should minimize further degradation of oligohaline marsh on the upper Blackwater River, improve the nursery and spawning habitat for anadromous and catadromous fish, and help minimize the frequency of storm-induced intrusions of saltwater.

Stevenson, et al. (2000) express some concern about the efficacy of restoring the natural marsh plug above Stewart's Canal. They suggest that blocking the canal will reduce tidal action, which could create even more anoxic conditions in the upper Blackwater River, and displace polyhaline species such as *Spartina alterniflora*, which have become established along some previously degraded sections of Stewart's Canal. They also question the capability of whatever structure is installed to withstand hurricane force winds and, in the event of a catastrophic breach, the impacts on the marsh system. However, restoring the natural salinity gradient in the Blackwater River and, in particular, protecting the freshwater environment in the upper watershed is crucial in reversing the current process of marsh degradation. The completed EIS for the restoration component of the proposed Habitat Management Plan must include intensive monitoring to evaluate these concerns.

In alternative B, floral composition would be maintained and enhanced by prescribed burning; controlling Phragmites and purple loosestrife; controlling populations of nutria, muskrat, resident Canada geese, and mute swans; and replanting marsh vegetation in conjunction with thin-layer deposition of dredged material. EAs have been approved for the existing Fire Management Plan (Sep 2000), the Integrated Wildlife Damage Management Plan (Dec 1999), and the Nutria Damage Reduction Pilot Program (Dec 2001). All three of these management plans emphasize biological monitoring and adaptive management. The Fire Management Program includes a multi-year study to evaluate the effects of different fire rotations (no burn, annual, 3- to 5-year, and 7- to 10-year) on aboveground biomass and species composition. Based on field testing this

year, the IWDMP for resident Canada geese may be modified to include the use of anthraquinone, a naturally occurring goose repellent, to reduce crop depredation. The Nutria Damage Reduction Pilot Program ultimately may be expanded to evaluate the use of thin-layer deposition and supplemental planting for restoring marshes with and without nutria control. All of these components of the proposed Habitat Management Plan will be subject to annual review and possible modification as new data are protected.

Socioeconomic Impacts

In alternative B, restoring and enhancing the tidal marsh would positively impact State and local economies. Restoring the marsh to its 1933 composition would promote fur trapping, waterfowl hunting, commercial and recreational fishing for both finfish and shellfish, and nonconsumptive recreational pursuits. However, some controversy is associated with restoring the salinity gradient in the upper Blackwater River. The NEPA process for the proposed Habitat Management Program will need to address this issue.

Cultural and Historical Resource Impacts

Alternative B would not significantly impact cultural or historical resources. However, as discussed under alternative A, perpetuating one of the most complete and complex watersheds that remain on the Chesapeake Bay has a value that goes beyond socioeconomic concerns. The recognition of the Nanticoke and Blackwater watershed as such a place prompted The Nature Conservancy to designate it a “Last Great Place” in 1991.

Administration, staffing, infrastructure, law enforcement, and other needs

Alternative B proposes we develop a comprehensive Habitat Management Plan with intensive nutria control, prescribed burns, erosion control, marsh restoration, shoreline protection, and the restoration of key hydrological processes. This is an enormous vision, which can only be accomplished with multiple partnerships, particularly, with the U.S. Army Corps of Engineers and Maryland DNR, and through cost-sharing. The Corps recently estimated that full restoration of the marsh at Blackwater Refuge to 1933 coverage could cost as much as $500 million. It is expected that the actual restoration strategies would be implemented by the Corps, long-term nutria control and possibly eradication would be implemented by the USDA Wildlife Services, and prescribed burns by the Fire Management staff maintained at Blackwater NWR. The Refuge Complex would primarily provide the FTEs to assist with planning, development, and maintenance of GIS and remote-sensing data, and long-term biological monitoring. This alternative would best be served by fully staffing the Biological Program proposed under “Inventory, Monitoring and Research.” That program includes the positions below.

Supervisory Wildlife Biologist (GS-12/13) for Refuge Complex . . . . . 1 FTE
GIS/Database Manager (GS-9/11) for Refuge Complex . . . . . 1 FTE
Wildlife Biologists (GS-7/9) for Blackwater, Nanticoke, Chesapeake Islands . . . . . 3 FTEs
Biological Technicians (GS-5) for Blackwater, Nanticoke, Chesapeake Islands . . . . . 3 FTEs

Alternative C. Maximum Public Use with No Habitat Management

Management Strategies

Marsh loss would be monitored with remote sensing (hyperspectral, aerial photos) and GIS. Strategic land protection would continue to mitigate marsh loss. Alternative C would not continue or initiate active wildlife population or land management programs: specifically, marsh restoration initiatives, the Nutria Damage Reduction Pilot Program, any prescribed burning under the Fire Management Program, the Integrated Wildlife Damage Management Program for resident Canada geese, muskrat trapping and nutria rebate program, and control of exotic, invasive, or injurious species. However, wildfire control would continue under this alternative.

Physical Impacts

The impacts on the existing physical environment would be even more severe than those in alternative A. In the absence of any efforts to restore marsh hydrology, control excessive herbivory, promote marsh vigor, or control invasive flora, the rate of marsh loss would likely increase. The breach between Stewart's Canal and the upper Blackwater River is already an almost continuous flow of brackish water that separates southern Dorchester County from the rest of the county, which is connected only by the bridges on Route 16, Route 335, and Shorter's Wharf Road. With only a 2.5-m range in elevation over the entire refuge and a projected sea-level rise of 30–65 cm over the next century, one scenario is that southern Dorchester County will become an island, much like nearby Taylors Island, and most of the existing emergent marsh on the Blackwater River will become a tidal gut on the Chesapeake Bay. Similarly, Stevenson, et al. (2000) paint a scenario in which this extensive marshland would become open water embayments. They further suggest that, because of excessive organic debris, excessive turbidity, and sporadic anoxia, "it could take decades to centuries for these embayments to become productive environments." In either event, it is not unreasonable to assume that most of the remaining 8,000 acres of estuarine emergent marsh would be severely degraded, if not lost, in alternative C.

Biological Impacts

The impacts of alternative C on the biological environment would be greater than those described in alternative A. Without programs to reduce muskrat, nutria, mute swan, and resident Canada goose populations, "eatouts" would almost certainly become more frequent and more extensive. These areas would be denuded of vegetation, and the subsequent ponding of stagnant, periodically anoxic water can have adverse physiological effects in the rhizosphere of the remaining plants (Stevenson, et al. 1985). Without programs to control the spread of Phragmites and purple loosestrife, the former would expand and the latter would become established. The spread of monotypic stands of Phragmites might help to slow erosion rates and entrap sediment

in the marsh (Stevenson, et al. 2000), but would reduce floral and faunal diversity in the remaining marsh.

Without prescribed burning, the remaining mesohaline marsh likely would revert from one dominated by Olney three-square to one dominated by *Spartina alterniflora* at lower elevations and by black needlerush, groundsel tree, or marsh elder at higher elevations (Stevenson, et al. 2000). Even in the absence of additional marsh loss, the value of the marsh to most species of waterfowl would be reduced because dabbling ducks and Canada geese prefer the seeds of Olney's three-square. Also, one of the objectives of the Fire Management Program is to reduce fuel loading around bald eagle nest trees; certainly, the absence of prescribed burning would increase their vulnerability to wildfire.

Socioeconomic Impacts

The socioeconomic impacts of alternative C would be similar to, but more severe, than those in alternative A. In particular, the loss of the muskrat trapping program would result in the loss of income for local trappers.

Cultural and Historical Resource Impacts

Same as alternative A.

Administration, staffing, infrastructure, law enforcement, and other needs

Alternative C involves the implementation of monitoring programs but no active population or habitat management. This alternative would best be served by fully staffing the Biological Program proposed under "Inventory, Monitoring and Research." That program includes the positions below.

Supervisory Wildlife Biologist (GS-12/13) for Refuge Complex . . . . . 1 FTE
GIS/Database Manager (GS-9/11) for Refuge Complex . . . . . 1 FTE
Wildlife Biologists (GS-7/9) for Nanticoke, Chesapeake Islands, Blackwater . . . . . 3 FTEs
Biological Technicians (GS-5) for Nanticoke, Chesapeake Islands, Blackwater . . . . . 3 FTEs

Habitat Management—Islands

Erosion Control and Habitat Restoration

The activities and management strategies proposed would apply to the Chesapeake Island Refuges. Alternatives A and C do not propose erosion control or habitat restoration. Erosion control and habitat restoration is a major component of alternative B.

Physical Impacts

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 would be lost within the next 100 years. SAV beds, which are buffered by the islands against wave action, would also be lost. With the exception of aquatic resources (e.g., fish, benthics, and aquatic invertebrates), all other faunal species would be displaced.

Erosion control and habitat restoration are proposed in partnership with the U.S. Army Corps of Engineers, using stone segmented breakwaters constructed in conjunction with filling shallow waters to restore habitat, such as wetlands, beaches, intertidal flats, uplands, and dunes. Environmental Impact Statements or Environmental Assessments would be developed on a project-by-project basis. The following discussion compares the conceptual impacts and habitat tradeoffs of habitat manipulation with those of no habitat manipulation to address environmental and anthropogenic processes affecting the Island Refuges.

Water Quality

Alternative A lets stand existing conditions, which include significant erosion-induced sediment loading and associated nutrient loading and turbidity, all of which negatively impact SAV, aquatic resources, and terrestrial resources. These conditions will continue unabated until the islands disappear. With the complete demise of the islands, the sediment load would be reduced; however, so too will the vast SAV beds, which owe their existence to the wave-buffering effect of the islands. Since SAV benefits water clarity through nutrient uptake and anchoring bottom sediments, water quality would be negatively affected.

Alternative B would be expected to have long-term beneficial impacts on water quality, although the exact amount is difficult to measure. By reducing marsh erosion, this alternative would help anchor fine grained, nutrient-rich marsh sediment, and prevent it from entering the local water column. The expected result would be an increase in water clarity, resulting from a decline in nutrient levels and total suspended solids, allowing more light to reach the bottom. More light would encourage SAV germination, which would further help anchor bottom sediments and act as a nutrient sink, absorbing nitrogen and phosphorous from the Chesapeake Bay. Increasing the size and quality of SAV beds would have long-term consequences for water quality and the overall quality of the Chesapeake Bay ecosystem.

The environmental consequences of alternative C would be the same as alternative A.

Hydrology and Hydrodynamics

In alternative A, we would expect changes to hydrology and hydrodynamics as the islands decrease in size, and currently protected areas become exposed to large fetches. Most of the effects would be felt on the present leeward side of the islands, affecting wind, wave, and tidal current conditions. In general, the energies associated with hydrology and hydrodynamics would increase. In some situations (e.g., the loss of the Barren Island Division), the effects would be felt on the mainland and adjoining populated islands, and the erosion of mainland habitats and populated island shoreline communities would increase.

We expect that hydrology and hydrodynamics would also be altered in alternative B, but in the opposite fashion compared to alternative A. Breakwaters would alter the prevailing wave energy, reducing the force of waves against the marsh. Breakwaters would also create large areas of quiescent shallow water, effectively increasing the leeward effect over the existing conditions. Breakwater and habitat restoration would be expected to prevent tidal breaching of marshes and protect interior coves and waterways from scour and sedimentation. Tidal currents would be restored to their pre-breach condition, reducing the energy within the coves and interior waterways, and thereby promoting the conditions favorable for SAV colonization and growth.

The environmental consequences of alternative C would be the same as alternative A.

Biological Impacts

Rare, Threatened, and Endangered Species (RTE)

In alternative A, all endangered species nesting habitats and some vegetated foraging habitats (e.g., SAV beds) would be lost over time. The Island Refuges support the Federal-listed endangered northeastern beach tiger beetle (potential habitat), the Federal-listed endangered bald eagle, several plant and animal species State-listed as rare or as species of concern (e.g., diamondback terrapins, black skimmers, least terns, and rare plants), and, occasionally, transient Federal-listed sea turtles. While the islands persist, we would continue management activities to avoid or minimize human disturbance of RTE species habitats.

Alternative B would protect and enhance RTE species habitats, and, in particular, offer restoration and research opportunities associated with constructing beach habitat for tiger beetles and nesting diamondback terrapins. Construction activities would include time-of-year restrictions to prevent disturbance to RTE species, and coordination with the appropriate agencies. Improved visitor facilities and habitat restoration would provide additional RTE education opportunities for the public.

The environmental consequences of alternative C would be the same as alternative A.

Emergent Wetlands

In alternative A, the loss of wetlands to erosion would continue unabated. Associated wetland values, such as habitat, detrital production and export, and wave buffering would continue to decline as wetland acres decrease. Alternative A includes Phragmites control, and, where implemented, wetland habitats would be improved as long as the islands persist.

Alternative B would include the construction of segmented breakwaters offshore for erosion control, and the placement of fill material behind the breakwaters to provide elevations suitable for the establishment of estuarine emergent wetland habitats. Breakwater systems would avoid impacts on the existing marsh, as they would be sited 30 to 100 feet offshore. Gaps between the breakwaters would allow for the development of a natural shoreline, maintain the existing marsh hydrology, and maintain fish and wildlife species' access to the existing and created shorelines. The quality of the marsh edge, now a shallow vertical escarpment, would improve, allowing terrapin access for nesting. Breakwaters in conjunction with created wetland habitats would effectively stop or minimize wave-generated erosion, and thereby maintain and increase the Island Refuges wetland acreage and associated fish, wildlife, and ecological values. Phragmites control and conversion to more desirable native vegetation would also be proposed.

The consequences of alternative C would be the same as alternative A, with the exception of Phragmites control. Alternative C would not include Phragmites control, and the continued expansion of this invasive plant species would be expected.

Submerged Aquatic Vegetation

Most SAV beds associated with the Island Refuges occur either in the interior waterways, or on the leeward side of the islands, where wave energy is reduced. Because alternative A lacks an erosion control component, no benefits to SAV would be expected. As the islands continue to erode, sediment loads would continue to increase, further negatively impacting existing SAV beds through increased turbidity and decreases to the photic zone. SAV beds exposed to higher wave energies as the islands recede would be lost.

The breakwaters proposed in alternative B would have a positive impact on SAV beds and increase potential SAV habitat. Breakwaters would repair and prevent marsh breaching, preventing eroded sediment from choking existing interior beds. Breakwaters would be sited to avoid building on top of existing SAV. These structures would reduce wave energy and the rate of marsh loss, effectively reducing the amount of total suspended solids (TSS) and nutrients entering the estuarine system. Lastly, breakwaters would reduce wave energy in existing cove areas, creating the more quiescent water requisite for SAV colonization. The breakwaters (approximately 15' X 150') would permanently prevent growth of SAV within the footprint of the structures. Structure footprint acreage would be minuscule, compared to the acreage of existing SAV protected and the acreage of potential SAV habitat created.

The environmental consequences of alternative C would be the same as alternative A.

Benthics

As the islands continue to erode under alternative A, former uplands and marshlands converted to shallow water would result in a net increase in potential benthic habitat. However, the bottom type of these former lands would be a hard, laminar mud clay, which would have lower value than bottom types outside of the historic island footprint. Continuing erosion and associated sediment load would negatively impact adjacent benthic habitats. Benthic organisms associated with SAV beds would suffer as beds are reduced in size.

Alternative B would result in the conversion of benthic habitat to other habitat types. In addition, benthic organisms occurring under proposed breakwater structures would be displaced, and construction activities would have temporary impacts associated with turbidity. If fill material is supplied via shallow excavation of borrow sources in the Bay, benthic communities would be temporarily impacted. Communities would be expected to recolonize within 1 to 2 years of excavation. Borrow areas would be sited outside of existing SAV beds. Shoaling would be expected to refill borrow sites within several years of project construction, returning the bottom to its natural condition and benthic assemblage. Because of the benefits to SAV, decreases in erosion-generated turbidity, and the reduction in marsh loss and maintenance of detrital production, overall positive impacts on the benthic community would be expected.

The environmental consequences of alternative C would be the same as alternative A.

Aquatic Resources. Phytoplankton and Zooplankton, Fish, and Commercially Important Species

As with the consequences for the benthic community in alternative A, former uplands and marshlands converted to shallow water through erosion would result in a net increase in aquatic resource habitat. However, the habitat would be of lower value than the subaqueous habitats that now surround the islands. While the islands persist, erosion and the associated sediment load would continue to negatively affect aquatic resources and the habitats they depend upon. With the islands' demise, the major predicted environmental consequence to aquatic resources would be the loss of the most extensive SAV beds in the tidal portion of the Chesapeake Bay. Of particular concern are the extensive waterfowl resources and commercial blue crab fishery, in particular soft crab fishery, which depend upon these beds. Because shallow water is common throughout the Island Refuges and increasing all the time, the net gains to plentiful habitat types would come at the expense of limiting habitat types to aquatic resources.

In alternative B, habitat tradeoffs would be a consequence of converting shallow water to emergent wetland, beach, and dune habitat. During construction activities, temporary adverse impacts associated with additional turbidity would be expected. Long-term turbidity would be significantly reduced, benefitting aquatic resources and aquatic habitats. Construction and its resulting disturbance would cause the temporary relocation of aquatic resources and the permanent displacement of some species within the footprint of fill material and structures. The use of stone breakwaters would provide hard surfaces as an additional habitat type for epiphytic attachment. Because projects would be designed to protect and restore SAV, we expect overall beneficial consequences for aquatic resources in alternative B.

The environmental consequences of alternative C would be the same as alternative A.

Terrestrial Resources. Mammals, Reptiles and Amphibians, and Avian Species

Terrestrial faunal species use various island habitat types, including wetlands, hammocks, beaches, intertidal flats, forests, and dunes. In alternative A, all of these habitat types would exhibit declining acreage and ultimately disappear. Therefore, all terrestrial resources would be displaced as the islands disappear. Some species may be able to relocate; for example, nesting diamondback terrapins. Those species requiring isolation, few predators, and little human disturbance (e.g., colonial nesting waterbirds) would be most negatively affected, in that similar vegetative communities on the mainland do not supply the same habitat juxtaposition as the islands. As the islands shrink in size, mammalian and avian predators of nesting species would become more problematic, being able to more efficiently find nests and prey. It is unknown whether Neotropical migrant species that now use the islands as resting stops during migration would adapt to using the remaining mainland habitats without negative effects. The continuing decline in the SAV resource would negatively affect the availability of food and prey for many terrestrial species. Phragmites control would be used to enhance terrestrial faunal species' use of hammocks while the islands persist, and short-term increases in some populations would be expected.

In alternative B, terrestrial faunal species habitats would be protected and enhanced, and the acreage of these habitats types would be increased. Populations of some species are expected to increase (e.g., terrapins and colonial waterbirds), while others would be unaffected. Construction would cause only temporary, localized relocation of some species; however, time-of-year restrictions on construction would be used to avoid impacts on sensitive species (e.g., colonial waterbird rookeries). Alternative B includes creating additional hammocks on the island, at present a limiting habitat type for many migratory bird upland nesting species. Phragmites control and conversion to more desirable vegetative communities would be used to further enhance the limited upland habitats occurring on the Island Refuges, with a subsequent increase in nesting habitat availability and use. If research determines that predator control is warranted, it would be used, and terrestrial species production should increase. By reducing erosion and favoring the formation of beaches and dunes, diamondback terrapin nesting and recruitment would be expected to increase. Protecting and expanding the SAV beds would positively affect the availability of food and prey items for many terrestrial species. The islands' habitat value as stop-over sites for Neotropical migrants would be protected and enhanced.

Consequences in alternative C would be the same as alternative A, with the exception of Phragmites control; the continued expansion of this species would negatively affect terrestrial fauna.

Cultural and Historical Resource Impacts

In alternative A, all cultural resources would be lost to erosion over time.

In alternative B, where erosion control can be provided, we would predict no impact on cultural resources. Where erosion control cannot be provided due to cost, logistics, or environmental concerns, cultural resources would be lost.

The consequences of alternative C would be the same as alternative A.

Socioeconomic Resource Impacts

In alternative A, the islands would continue to erode. Commercial fisheries that depend upon SAV beds (e.g., soft-crabs, and nursery areas for juvenile, commercially valuable fish species) would continue to decline. As evinced by other formerly inhabited islands, communities at Smith Island and Hoopers Island ultimately would be forced to relocate to the mainland. Tourism targeting the unique culture of the Smith Island communities would disappear. While the islands remain, wildlife-dependent recreation would continue, where compatible with the Island Refuges mission.

In alternative B, we expect no negative impacts on the socioeconomic environment. Positive benefits would result from maintaining the island communities, maintaining and enhancing natural resources, and increasing tourism and revenues as the refuges, as well as the Smith Island community, become well-known destinations. The habitats commercially valuable species depend upon would be maintained and expanded. Alternative B would provide more opportunities for public use, education, and interaction with the refuges. Habitat restoration projects and improved visitor facilities would provide more opportunities for educating the public about the Chesapeake Bay environmental issues.

The environmental consequences of alternative C would be the same as alternative A.

Habitat Management—Forest

Introduction

The consequences of this type of management program are evaluated for Blackwater NWR and the land proposed for protection in the Nanticoke River watershed. Forest management would not be practiced on other units of the Refuge Complex. As with any management program, forest management offers various options for managing certain habitat types. We expect that, although some of the objectives may vary between the refuge and the division, the same strategies will be used to achieve all objectives, and, therefore, their subsequent consequences will be similar. The CCP alternatives consider three different realistic options for managing the forested habitats: no forest management or status quo (alternatives A and C); and the full implementation of the forest management plan (alternative B), which is our preferred alternative, in relationship to the objectives and strategies necessary to fulfill the primary purpose(s) for which Blackwater NWR was established. We based our proposed forest management techniques, or silvicultural

prescriptions, on the principle of "Wildlife First," rather than on primarily economic, historic, or sociological principles.

Alternative(s) Considered But Dismissed

We considered but dismissed a couple of additional alternatives, due to their incompatibility with the mission of the Refuge System and the Refuge Complex: the proposal to manage our forests based primarily on economic, historic, or sociological principles, rather than on the principle of "Wildlife First"; and, the proposal to restore hydrologic conditions on Blackwater NWR to mimic natural conditions.

The first alternative dismissed was the proposal to intensively manage all forested lands on Blackwater NWR for loblolly pine production and commercial sale of saw timber, pulpwood, and pole products. Existing pine stands would be managed to optimize height and diameter growth of pines. Hardwood and mixed pine–hardwood stands would be harvested and converted to pine monocultures where applicable. All pine stands would be harvested for commercial products on a 60- to 80-year rotation with at least one precommercial and one commercial thinning per rotation. The impacts of such activities, although widely accepted by the timber industries, would be severely detrimental to many of the wildlife species that depend on the diversity of forested habitats. Those species or species groups, such as the endangered Delmarva fox squirrel and many forest interior dwelling songbirds that depend on a variety of mature hardwood tree species, would undoubtably experience significant declines as a result of converting all forest habitats to pine monocultures.

The second alternative proposed to restore hydrologic conditions on Blackwater NWR to mimic natural conditions. Throughout history, the forested wetlands of the Eastern Shore have been drained and cleared primarily for agriculture and development and, to a lesser extent, forestry. Years of unregulated ditching have dramatically altered their natural hydrologic regimes and have caused equally dramatic shifts in the species composition of the forests. Most of the historically hardwood-dominated forests or swamps have been replaced with a mix of pine and hardwoods typical of more dryer soils.

Today, large patches of pine-dominated largely second-growth woods result from that extensive draining and clearing. However, hydrology largely dictates the species that occupy any site, which most likely do not match the species that occupied the site historically. The forest that covered the Eastern Shore in Native American times is believed to have been predominantly hardwood, increasingly mixed with pine to the southward. In aboriginal times, the woods of the Eastern Shore were likely to be oak-hickory, oak-gum, or oak-pine types. These still exist in second-growth form (Carter 2000), with the exception of hickory, which is no longer a component of the forests on Blackwater NWR.

Although drainage has altered the species composition of the forest, we would not attempt to recreate the historical forest composition. Nature would be left to take its course under current conditions. The general effect of the intricate network of drainage ditches throughout the Refuge Complex and surrounding lands has been to convert wet wetlands to much drier wetlands. In

most cases, the soil conditions remain hydric, yet surface and soil water are leached from the system at much higher rates. Therefore, these drained systems are able to support a wide range of wetland as well as upland tree species that prefer well-drained soils, such as American beech, white oak, and loblolly pine.

Restoring the historical hydrology on these sites would most likely result in heavy mortality of those species, which cannot survive long periods of inundation. These sites would also be completely inundated by water for significant periods throughout the year.

Loblolly pine seedlings or saplings cannot withstand prolonged flooding. Complete inundation for more than 2 weeks during the growing season often results in significant mortality. Larger trees are classed as moderately tolerant of flooding; typically they can survive one season but usually succumb during the second growing season if continuously in 0.3 m (1 ft) or more of water (Baker and Langdon 1990). White oak germination is severely limited after 15 days of exposure to flooded conditions (Rogers 1990). The resulting cover type would be significantly less diverse, and primarily be comprised only of wetland species, such as red maple, sweet gum, black gum, willow oak, and water oak.

A critical factor in flood-stressed trees' survival is whether they are invaded by insects or disease. Flood-stressed trees are prime targets for attack by "secondary organisms," a wide variety of opportunistic fungi and insects that selectively invade their hosts only after they have been weakened or predisposed by stress. Stresses, such as flooding, drought, and defoliation, are believed to impair host resistance mechanisms, and to trigger biochemical responses that release carbohydrates, glucose, and other nutrients that stimulate secondary insects and diseases. Further, certain root and collar rot diseases are favored by waterlogged, oxygen-deficient soil conditions, most notably those caused by the water mold fungi, *Phytophthora* spp. and *Pythium* spp. Flooded soil conditions not only promote the reproduction and dispersal of those fungi, but also promote the susceptibility of plant roots to infection.

Finally, wood-boring insects and blue staining and decay fungi will also quickly attack the wood of trees that have died as a result of flooding. Where landowners wish to salvage and sell dead or severely declining trees, they will need to be aware of the decline in wood quality that can quickly result from insect and disease attack, significantly reducing the value of wood products (Bratkovich, et al. 1993).

An exception to our dismissal of this proposal is the need to restore hydrologic conditions for Atlantic white cedar. One of the most significant forest management issues in the Nanticoke River watershed is the conversion of the Atlantic white cedar swamps to mixed hardwood and pine forests. The ditching and draining of the cedar swamps and surrounding lands for agriculture, forestry, and development resulted in a conversion to hardwood, pine-hardwood and pine monocultures (plantations). As a result, and because of severe over-harvesting, The Nature Conservancy has classified Atlantic white cedar as globally rare or threatened throughout its historic range, and has assigned it a G-3 ranking. Therefore, the restoration and management of this vegetative alliance are high priorities for the Service and other land management agencies. We will restore the hydrology on sites that previously supported Atlantic white cedar, if necessary for its successful regeneration.

Background

The previous Forest Management Plan (1984) for Blackwater NWR was highly species-specific, and focused on improving habitats for Delmarva fox squirrels and bald eagles. Very little forest management had been performed since the establishment of Blackwater NWR, due to the lack of forestry staff and lack of knowledge about refuge forest resources. Since the development of the Forest Management Plan (1984) and the Station Management Plan (1991), 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 represented our current situation, did not provide sufficient information for accomplishing refuge objectives, and did not conform to new Departmental or Service policies and directives.

Blackwater NWR is now more than 36 percent forest, and 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*), and sensitive joint-vetch (*Aeschynomene virginica*), as well as 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 continue to be cleared and converted to residential areas, agriculture, or pine monocultures. Therefore, it is essential that these habitat types 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 (see alternatives A and C). 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).

With the 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 proposed 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 1.5–4.5ºC 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).

Alternative A. Species–specific Management

Management Strategy

In this alternative, and in alternative C as well, virtually no forest management practices would be performed to restore mismanaged land or enhance wildlife habitats on refuge land. The status quo or "no management" alternative would simply use the existing station management plan and its respective goals and objectives, which are key-species oriented. Forest age class, species composition, and long-term health would be left to natural processes. The reforestation of prior converted wetlands would not occur. Prescribed burning would be used only as a fuel reduction tool in areas of high fire danger.

Physical Impacts

There would be virtually no impacts on air and water quality, soils, and hydrology. No herbicides would be used. No heavy machinery would be operated in forested habitats. As old and unhealthy stands of trees begin to die, the loss of these trees and subsequent rotting would have some minimal impacts on air quality. Forests are especially crucial for urban areas due to their ability to absorb carbon dioxide. One acre of young healthy trees absorbs 2.5 tons of carbon dioxide and gives off 2 tons of oxygen each year. However, when trees become unhealthy or reach the end of their life span and begin to rot, this process is reversed. Oxygen is then consumed and carbon dioxide is released (Miller 1998). The degradation of air quality related to smoke management would only be a factor when burning would be required to minimize the potential of wildfire or threats to human health and safety.

Biological Impacts

Impacts on aquatic, wetland, and terrestrial habitats that may result from forest management activities would not occur under this alternative. However, by choosing not to implement forest management on the Refuge Complex forest lands, a significant decline in forest health would result, which, ultimately, would impact biological communities. The historical lack of forest management on the Refuge Complex would continue to have significant negative impacts on forest health and species composition. As mentioned above, oak decline will continue to occur, and will have severe and long-lasting effects on all wildlife species that depend on oak species for food. The resulting dramatic shifts in species composition and declines in health, vigor, and mast production may cause significant declines in the Delmarva fox squirrel population as well as other woodland species. The lack of forest stewardship has perpetuated and, in some cases, compounded the forest health and other management issues we face today.

Choosing not to establish and maintain large contiguous tracts of mature forest would only add to the growing local, regional, and global issues concerning Neotropical migratory songbirds, particularly FIDs. Blackwater NWR has been identified as containing some of the largest patches of mature forest on the Delmarva Peninsula. If Blackwater NWR chooses not to manage its

forested habitats for the previously mentioned species of management concern, it is very unlikely that they will be managed for at all. Due to the current rates of development, the forest land base continues to not only shrink but become highly fragmented. It is possible, however, that large contiguous forest patches would be established solely through land protection and, to a lesser extent, through natural succession. However, without the benefits of forest management, their species composition, age structure, and health would suffer. The protection of large contiguous tracts of forest land alone may have positive impacts on existing FID populations. However, there would be no direct efforts to enhance these areas for endangered species, area-sensitive birds or other wildlife species.

Without management on much of the refuge's forests, the forest health, composition or structure would continue to deteriorate. As previously stated, no virgin forests remain in Dorchester County. Most of the forested lands were cleared for agriculture or development and were never replaced. The remaining stands were not likely to have been properly managed to ensure future health and species composition, unless the lands ended up in the hands of a timber company. However, unless a timber company had plans on additional harvests, minimal management was performed. Since the establishment of the refuge, its management has proven to be just as neglectful of the stewardship of its forested habitats.

Of the 8,374 acres of forested land, 64 percent, or 5,292 acres, could be classified as "potentially occupied" DFS habitat. That assumption is based on the definition of DFS habitat, which states that potential habitat "has a prevalence of large mast producing trees of both pine and hardwood species." (Moncrief, et al. 1993) However, the occupancy of many of these areas has not been well documented. It is also true that a significant portion of occupied or potentially occupied stands cannot be considered optimal DFS habitat. Many stands have dense understories or midstories as a result of past timber removal operations, mortality due to gypsy moths, and a general lack of management. Others are nearly pure loblolly pine, and contain little in the way of hard mast or cavities.

The lack of forest management would continue to perpetuate tree stress, decreased forest health, decreased mast production, and create undesirable shifts in composition and structure, which would most likely not be suitable for sustaining healthy and viable populations of Delmarva fox squirrels, FIDs, or the diversity of other wildlife. Not managing or restoring mismanaged stands would dramatically shift the future composition of the forest. For example, the residual canopy left after "high-grading" is detrimental to the regeneration of new trees, especially pines, depending on the percentage of pine removed during harvest. If the residual canopy is sparse enough to allow regeneration, the newly developed seedlings must continue to compete with these mature trees for light and nutrients. The growth of loblolly pine seedlings in a natural stand is inversely related to overstory stocking of pine and hardwoods. As the proportion of hardwoods increase for a given pine stocking, loblolly pine seedling growth decreases. The size and shape of openings affect seedling growth up to 9 m (30 ft) from the edges of openings. Therefore, under this alternative, seedlings growing beneath overstory hardwoods likely would not survive more than a few years, or if they did survive, their growth would be slow.

Additionally, these residual trees most likely were suppressed their entire life, were stressed prior to the harvest operation, and were too weak to respond to the increase in available resources.

Therefore, they represent the most stressed and unhealthy trees in the stand. These residual trees also complicate and impede future management. Increased stress and decreased vigor due to overcrowding, poor drainage, and the poor management associated with this alternative would significantly increase the forests' susceptibility to insect and disease outbreaks. In most cases, unmanaged forests are more stressed and less healthy than properly managed forests.

The natural and man-induced processes now occurring on and around Blackwater NWR that are negatively affecting forest health would continue. These processes, which include past mismanagement, the current lack of management, succession, overcrowding, alterations in drainage, and accelerated sea-level rise would result in significant health declines. The forest may then succumb to cover type conversions, invasions of exotic species, insect and disease outbreaks, large scale tree mortality and, ultimately, habitat loss. The susceptibility to both insects and disease is directly related to stand conditions and forest health. Forest insect pests in particular have the ability to key in on tree stress and therefore targets stressed or unhealthy forests first. Once established, these pests can reach epidemic levels and spread to healthy forests. Several natural processes occurring on and around Blackwater NWR are negatively affecting forest health: accelerated sea-level rise, alterations in drainage, overcrowding, past mismanagement, and the current lack of management. 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. Without management, there would be a greater potential for outbreaks of exotic and invasive species. The result would have devastating impacts on the wildlife depending on these forests, especially threatened and endangered species whose populations already are stressed.

As far as natural processes are concerned, the most significant impact as a result of no management would be the conversion of all the nearly pure pine and pine–hardwood stands to a predominantly mixed hardwood type through succession. As previously stated, pines in this region rarely survive past the age of 80 years without being afflicted by disease or insects. As these pines drop out of the canopy, the gaps would be filled by a mix of more vigorous hardwoods and, to a much lesser extent, pine. Pine seedlings growing beneath a canopy of hardwoods would not likely survive more than a few years. If they did survive, their growth would be slow. To most people, a mixed hardwood-dominated forest system would not only be acceptable, but preferred.

However, without proper management, the species richness and health of the forests will continue to decline. As mature and over mature pines and hardwoods die and create gaps in the canopy, they are quickly replaced by less desirable red maple and sweet gum. The gaps will also quickly develop a dense shrub layer that will shade out those species that require large quantities of sunlight for germination and seedling establishment. Due to the ingrowth of fast-growing shade tolerant hardwoods, coupled with the many problems associated with oak regeneration and the presence of gypsy moths, oaks would be extremely sparse, if not nonexistent, in many of these mixed hardwood stands. The decline in hard mast would have severe impacts on DFS stocks and many additional wildlife species. The predicted dominant canopy species would be sweet gum and red maple. Without proper forest management, which includes performing a wide array of silvicultural prescriptions, seedlings of desired species such as oaks and pines would be dominated and suppressed by denser more vigorous hardwood tree and shrub species. Although

most of these species are considered to be early successional and are generally replaced by later successional species, such as oak and beech, their regeneration success and the vigorous growth will enable these species to continue to fill in their own gaps and shade most oak and pine regeneration or keep these trees suppressed for the majority of their lives.

Overstocking of vegetation at all canopy levels from understory to overstory would occur, and cause stress, decreased growth rates, reduced mast production, and tree mortality. Another problem resulting from overcrowding would be the lack of sunlight reaching the forest floor. When this happens, it would make it impossible for young trees and other wildlife beneficial food plants to become established. These conditions would therefore threaten the future of the forest stand to properly regenerate, and would adversely affect wildlife that depends on the forest floor plants for food (Jastrzembski 2000).

We developed the following information, which is specific to the current forested land base on Blackwater NWR, to demonstrate the long-term impacts of the no management alternative. Projections for the end of 40- and 80-year periods were based primarily on current forest conditions, past management, juxtaposition, and soil type, as well as the suspected effects of natural, uncontrollable processes. The most significant processes considered while developing these projections were forest succession and sea-level rises. Despite the fact that the effects of sea-level rise are out of our control, it is the primary process that will significantly impact the overall acreage of forested habitat in the future. The effects of insects and diseases, which will undoubtably have significant impacts, were not factored in, since it is impossible to predict where and when these epidemics will occur. They are, however, reflected in the changes in overall forest health, which certainly would decline in the absence of forest management

The most dramatic change in forest condition over time would be the conversion of low-lying loblolly pine stands to stunted dying forests and then to marsh in a relatively short period of time. Within the 40-year projection, the acres of stunted forest would increase by nearly 300 acres, while at the same time much of the originally stunted stands and some of the low-lying mature pine stands would convert to marsh or open water (non-forest). The acreage of stunted forest type would decrease significantly by 80 years since most of the susceptible lands would already have converted to non-forest types (i.e., marsh or water). In fact, these projections, which were based on soil type and proximity to tidal marsh or water, may be greatly underestimated, based on the forecast for the Chesapeake Bay region of rates of sea-level rise of nearly 70 centimeters by the year 2100 (Kearney 2000). If this holds true, nearly all of Blackwater NWR’s palustrine forested wetlands would be significantly impacted by permanent inundation and saltwater intrusion within the 80-year window.

Also demonstrated is a significant lack of natural regeneration and stand replacement. Not only the species composition, but also the age classes of the forests become undiversified. All pine-dominated stands would be replaced by hardwood-dominated stands, which would contain very little hard mast producing species. Secondly, instead of having all age classes represented as individual stands with occasional uneven- or two-aged stands, the forest would consist primarily of all-aged stands in which all age classes may be represented sporadically throughout much of the forested area. While uneven-aged stands contain trees of three or more distinct age classes, all-aged stands contain trees of all or almost all age classes, including those that are mature or over-mature and, therefore, more difficult to manage. At the end of the 40- and 80-year periods, the forests on Blackwater NWR would consist of 55 percent and 86 percent all-aged stands, respectively.

Table 2. Forest conditions[1]

Cover Type and Age Class	Acres		
	Now	40 Yrs	80 Yrs.
Regeneration (0–15)	1,270.26	0.00	0.00
LP_immature (16–40)	84.81	0.00	0.00
LP_mature (41–80)	1,216.10	9.64	0.00
LP_mixed Age	27.22	0.00	0.00
LPH_immature (16–40)	118.24	0.00	0.00
LPH_mature (41–80)	1,438.44	579.61	0.00
LPH_overmature (80+)	558.75	224.96	4.95
LPH_mixed Age	842.66	1,789.76	1,238.07
MHW_immature (16–40)	23.96	0.00	0.00
MHW_mature (41–80)	103.91	519.79	0.00
MHW_overmature (80+)	1,046.98	7.03	3.81
MHW_mixed age	57.83	2,032.26	3,431.96
Stunted_inoperable	1,458.18	1,728.27	637.22
Islands_other	98.63	126.61	126.61
Subtotal forested acres	8,373.95	7,017.93	5,442.62
Subtotal non-forest acres	0.00	1,356.02	2,931.33
Total	8,373.95	8,373.95	8,373.95

[1] Conditions in 40 years and 80 years with no forest management compared to current conditions

The greatest detriment of the no-management alternative is not the idea that, if we do nothing with our forests, we will lose them. The loss of forested habitats is inevitable due to sea-level rise. The greatest threats to wildlife are the declines in forest health, ecological diversity, and habitat quality. No-management will result in a very unstable ecosystem, in which no species will be able to depend on forested habitats for any length of time. The unpredictable alterations in forest composition resulting from stress can be as devastating as wildfires.

To put it more in perspective, we must ask ourselves what conditions will be best for the long-term health of the ecosystem and its inhabitants. For example, it is by far more ecologically sound to clear-cut or thin a forest stand to improve its health than to leave it alone and then have to deal with a stand of snags. Restoring sites after the effects of disease or insect outbreaks is extremely costly, due to the decreased quality of timber and the lack of interest of timber companies in salvage operations. It is more likely that these areas will then continue to be unmanaged as in the past due to lack of funding. Silvicultural prescriptions not only will help prevent the need for restoration of devastated forests, but also will generate funds that can be used to restore some of the already mismanaged and insect- or disease-killed areas on the refuge (see our preferred alternative B, “Conservation Biology for Trust Species Diversity”).

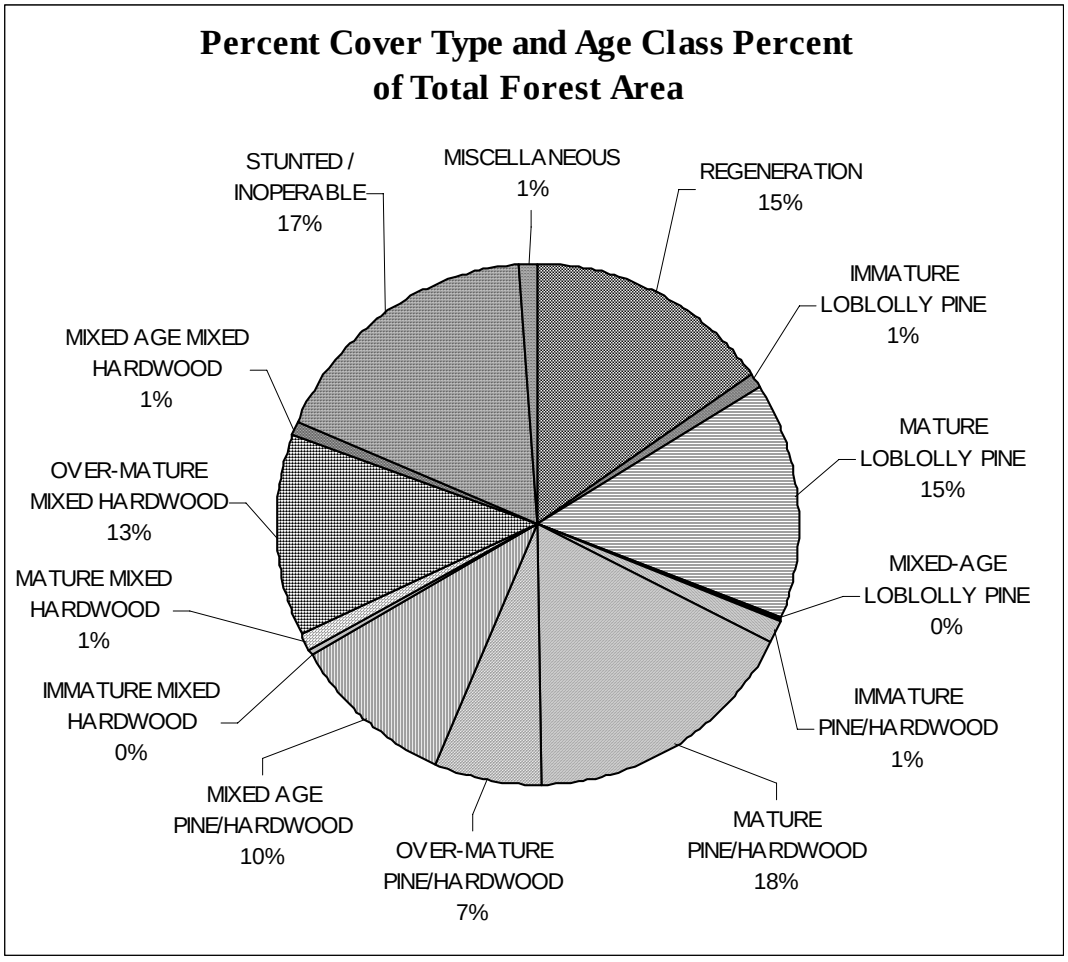

Figure 1. Current cover types by age class as a percent of total forest area

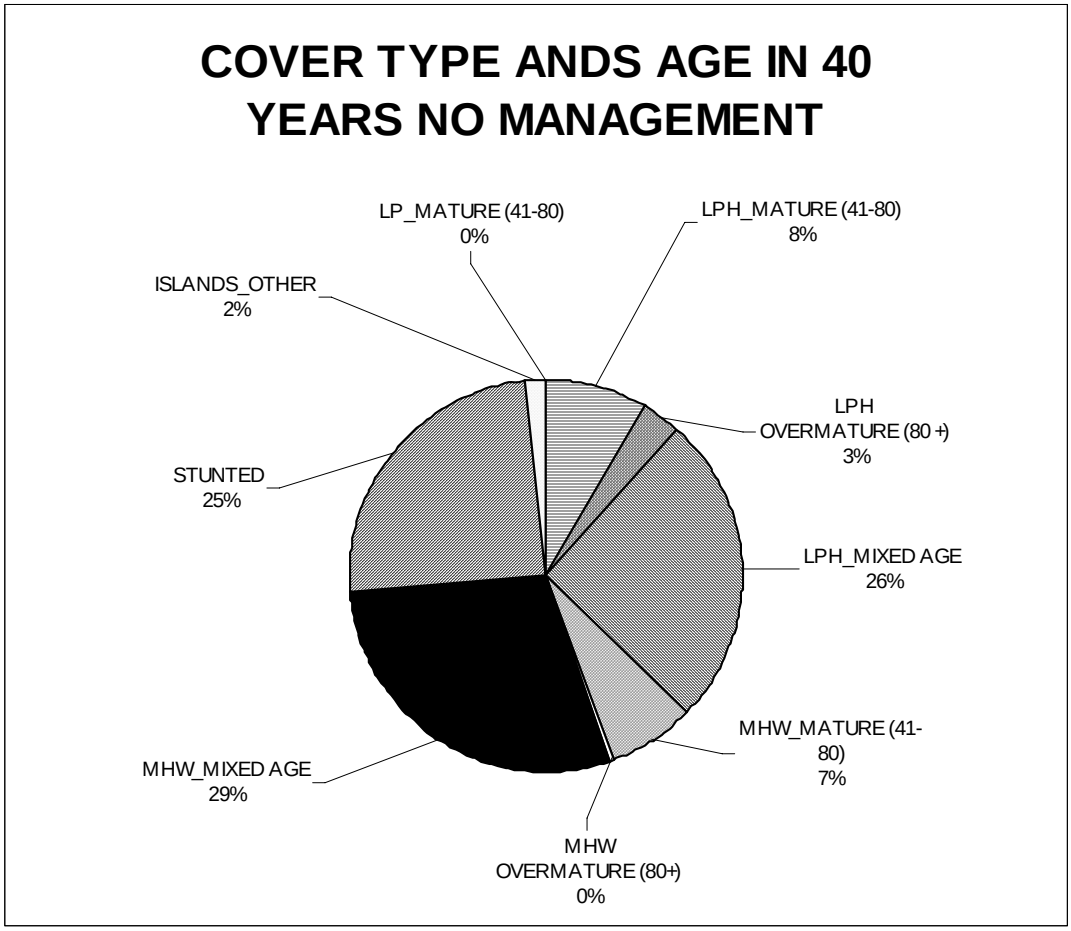

Figure 2. Cover types and age in 40 years (no management)

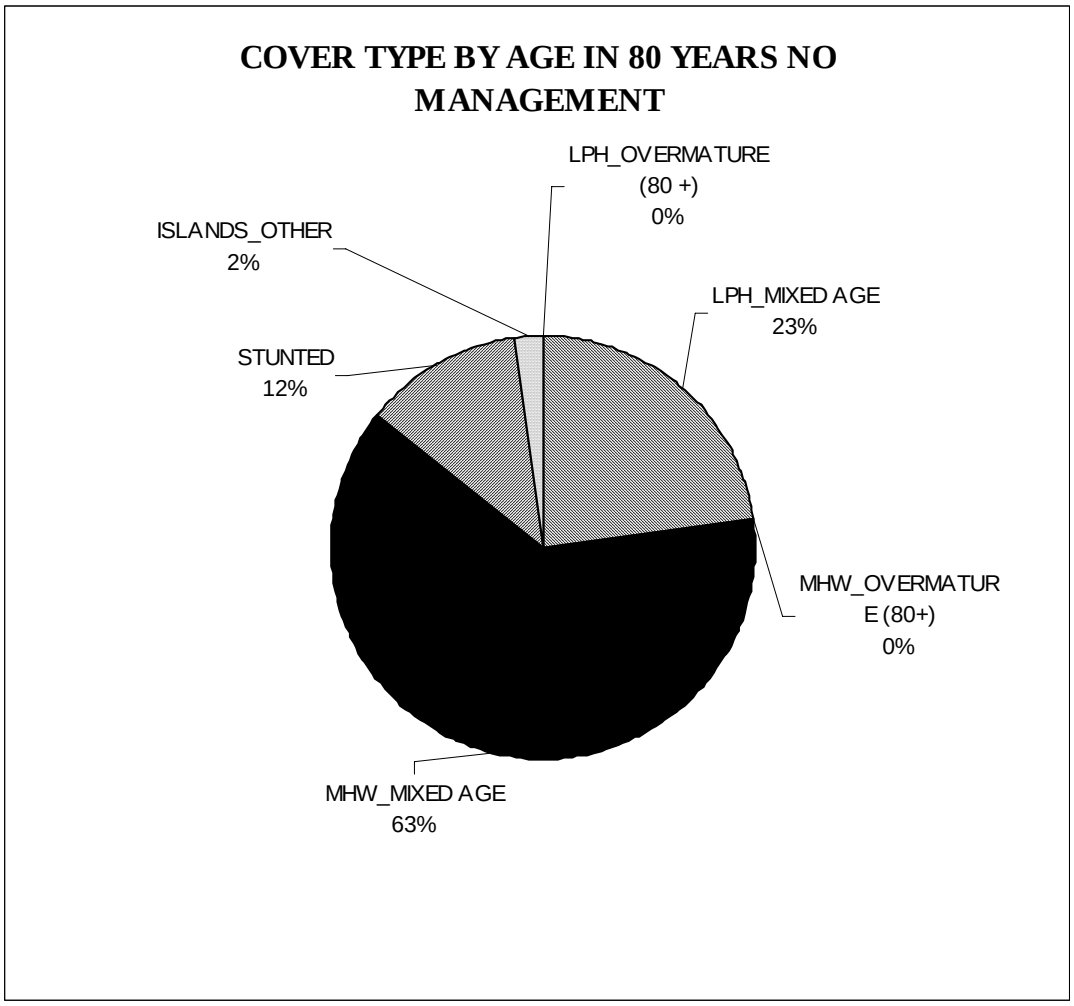

Figure 3. Cover types and age in 80 years (no management)

Socioeconomic Impacts

Much of the forested land now owned by the Blackwater NWR was previously managed for the production of forest products; supplying forest products to families and many small locally owned mills as well as large regional corporations. Some of the Blackwater NWR land was owned and managed by large scale forest product corporations such as Chesapeake Forest Products and Spicer Corporation that supplied forest products throughout the nation. Upon protection by the USFWS, these lands were taken out of timber production and no longer provided forest products that helped to keep small local mills in business. Continuing to protect tracts of forested land without performing forest management would result in a decrease in land base available for harvest, and could subsequently cause additional economic instability among local timber companies. In the past year alone, both of the companies mentioned above were forced to shut down due to a variety of reasons, which included a significant decline in available timber for harvest.

By choosing not to manage our forests, the Refuge Complex would continue to be scrutinized by the public for our lack of stewardship. Our lack of forest management has been a topic of debate in previous public meetings. This public perception of inadequate stewardship ultimately would have a negative impact on our ability to protect additional lands. Many landowners who sell their property to the USFWS do so because they believe that once incorporated into the refuge system, their land will forever be protected and managed for its greatest potential for wildlife benefits. By choosing not to manage forest habitats we would fail to achieve the goals of previous landowners, meet the needs of refuge visitors and local communities, and ultimately to fulfill the purpose(s) of the refuges and the mission of the National Wildlife Refuge System.

Cultural and Historical Resource Impacts

Since no forest management would be performed, there would be no impacts on cultural or historical resources or their protection.

Administration, staffing, infrastructure, law enforcement, and other needs

No additional staffing will be required to implement this alternative. The currently funded Forester position will be retained to perform inventory and monitoring activities as they relate to forested habitats.

Alternative B. Conservation Biology for Trust Species Diversity

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 alternative, the forest management program would 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 would 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 alternative, the refuge would 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 would 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 would 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 5292 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 would 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 would 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 would 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 would 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 would 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 adjacent (i.e., 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 would play a significant role in the establishment and enhancement (increasing the size) of forest cores as well as maintaining a diversity of forest types and age classes, whereas reforestation and regeneration would 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 would 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 would benefit the forest ecosystem. They would 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 would allow increased sunlight to penetrate to the forest floor, which would 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 would directly improve the diameter and crown growth, and would ultimately result in greater mast production for wildlife. Released trees would 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) would 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 would be used throughout all forest cover types and age classes as a form of TSI. When appropriately applied, prescribed burning would 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 would 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 would probably not be able to escape fast-moving wildfires. However, they would easily escape low-intensity, prescribed, ground fires. Researchers found no evidence that prescribed burning caused significant direct mortality among fox squirrels. Wildfires would 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 would also help maintain the pine–oak habitat preferred by fox squirrels, and would have a direct improvement on fox squirrel foods. Prescribed burning would also be effective for manipulating understory vegetation, reducing excessive fuel (hazard reduction), disposing of logging slash, preparing planting sites and seedbeds, and improving wildlife habitat.

Harvesting of timber products would be viewed as a necessary evil. Some people strongly believe that the harvesting of trees would be detrimental to our environment and would 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 would 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 would be harvested to make way for new healthy and vigorous stands of trees. Stand replacement through timber harvesting and regeneration would 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 would 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 would focus on ensuring and optimizing regeneration of or within a stand. The impacts of these methods are discussed under “regeneration,” below.

Clear-cuts would 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 would have minimal impacts on wildlife since emphasis will be put on ensuring that adjacent habitat is provided to harbor displaced species.

Selective cuttings would 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 would be able to better receive sufficient light, moisture, and nutrients to grow to optimal size. Part of this method would also be the manipulation of sunlight on the ground to successfully regenerate desired species. This activity would have significant beneficial impacts on the growth and productivity of desired tree species and wildlife. Selection system harvesting would allow a timber stand to retain its forested appearance in the years immediately following harvest. Disadvantages of selective cutting would 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 would require some canopy removal to allow light to the forest floor to stimulate seed germination. Natural regeneration of desirable tree species would be the preferred method of stand replacement following prescribed management operations of any type. The advantages of relying on natural regeneration would 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 would vary widely in the amount of

overstory that is removed. Therefore, the impacts on wildlife populations would also be varied. The most commonly used strategies to stimulate and enhance natural regeneration would 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 would 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 failed, or did not result in the adequate stocking of desirable species, then planting would be required. Some of the benefits of artificial regeneration would 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, would 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 would 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 would not be practical since the seedlings would 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 would require tree tubes in order to protect them from browsing herbivores and to maintain good form, which, in turn, would substantially increase planting costs.

In areas such as prior converted wetlands (agricultural fields) that would be reforested to create travel corridors or minimize fragmentation, a mix of desirable species suitable for that site would be planted. A mix of hard and soft mast producers would be planted and maintained to ensure a successful conversion back to a diverse forested habitat. Tree shelters would 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 would 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 would 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 would be used to promote natural regeneration of most pine species and the germination of some hardwood species. Most site preparation methods would be aimed at the preparing the seed bed through scarification. Some of the more common methods would include logging, chopping, discing, dozing, herbicide application, and prescribed burning (Wenger 1984). Scarifying the seedbed would 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 would 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 would greatly increase seed germination and seedling survival, which would 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 would offer little to no soil scarification, but would provide more than adequate relief from competing undesirable woody sprouts (see below).

Management of problem or undesirable vegetation would 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 would 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 would 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 would be the least accepted method by the public. Chemical control would 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 would cause substantial harm to regeneration. The primary benefits of chemical control are that they are generally the least expensive, cause the least amount of soil disturbance, and provide control for the longest period of time. Only approved chemicals that are labeled for these specific uses would 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 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.

It has been proven that those substances, when used in accordance with their labeling, would have little to no impact on non-target fauna and flora. Extreme care would be taken to prevent drift to non-target areas as well as non-Federal lands. Under this alternative, the Refuge Complex would continue to implement IPM strategies to reduce the use of chemicals. We would 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 would 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 generally a technique used in wet areas to create raised micro-environments where seedlings are planted. However, by creating micro-topography, 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. 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.

Prescribed burning is an equally effective tool for weed control as it is 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. The consequences of these IPM strategies are covered under the section on exotic species control.

Table 3. Silvicultural prescriptions for seven cores

	Core Areas							All Other Forests (current boundary)
Dimensions	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
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 proposed 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 { } 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 proposed activities are of the highest ranking priority. The need for additional management activities may exist; however, it is unlikely that they will be pursued during the term of this plan.

Physical Impacts

Impacts on the physical environment (water, soil, geology and hydrology, and air quality) would be minimal as long as Forestry Best Management Practices (BMPs) are employed. A list of all possible BMPs, developed by MDNR, is provided in the Forest Management Plan. Adhering to forestry BMPs is mandatory to meet the requirements of the National Wetland Protection Act. Because nearly all refuge lands are flat, with less than 2-percent slope, they would be more resistant to erosion, siltation, and runoff. However, due to their highly organic nature and low elevation, most of the soils would be moderately or severely susceptible to rutting by heavy equipment (USDA 1998).

It is likely that forest management activities would be implemented throughout all forest types across a wide spectrum soil types and conditions. However, in most cases, BMPs would restrict the use of heavy equipment on soils that are highly susceptible to rutting and compaction. Any use of such equipment on most soil types would be limited by soil moisture and water table depth and highly restricted to extremely dry periods of the year. Forested buffers would be maintained in order to prevent any potential negative impacts on nearby waterways.

Adhering to BMPs during all forest management activities would ensure that no significant alterations to hydrology occur, except deliberate hydrologic restoration. Care would be taken not to plug existing desired ditches or waterways, and at the same time, no additional ditches or waterways would be constructed under this alternative. Any temporary ditch crossings would be removed and rehabilitated immediately following forest management activities.

The current hydrology of the Refuge Complex and surrounding land is far from natural, given the fact that large-scale ditching and draining have occurred over the past century. This extensive network of managed and unmanaged drainage ways have significantly altered and, therefore, dictated the species composition of the forests in and around Blackwater NWR. The vastness of this man-induced environmental impact is more a landscape issue. Its effects on all biotic communities is extremely complex, and, therefore, very difficult to manage at just the refuge level. Any major changes in the current hydrologic system may impact adjacent landowners.

Significant alterations to the current hydrology within forested habitats (i.e., making them wetter) most likely would result in a drastic reduction in the natural and man-induced upland sites that support much of our hard mast producing hardwoods, which, in turn, support much of the DFS

population. Therefore, it would be important to maintain the current hydrologic regime on Blackwater NWR, despite the fact that it is somewhat unnatural.

On the proposed Nanticoke protection area, restoring the hydrology (i.e., filling man-made ditches) for the sake of restoring Atlantic white cedar, if performed, will have significant impacts on the hydrologic conditions on specific sites, as well as potential impacts on water quality and soil conditions. Restoring hydrology to mimic natural processes may involve complete closure of selected ditches and the installation of water control structures to facilitate proper surface and subsurface water flows. With existing drainage systems in place, surface and soil water are quickly removed from forest stands, which, over time, ends up creating more xeric soil conditions that are not as suitable for the regeneration or long-term survival of Atlantic white cedars. These man-made ditches have caused dramatic declines in the water table. When young, Atlantic white cedars are highly sensitive to long-term fluctuations in the water table. Prolonged and excess flooding and prolonged drought can cause mortality in seedlings and saplings and significantly slow growth on seed production in older trees.

By restoring the hydrology on a site that historically supported, or now supports, Atlantic white cedar, we would effectively restore the water table and drainage characteristics to conditions that are most suitable for cedar seed germination, seedling survival, and growth, while at the same time making the site less suitable for the regeneration and growth of competing hardwoods and pine. The overall impacts of hydrologic restoration are complex, and will have to be carefully evaluated. The impacts on and from off refuge lands will be one of the primary deciding factors in the applicability of restoration.

Depending on the land use of the surrounding property, effectively decreasing drainage in a forested system could result in a concentration of nutrients and contaminants from runoff. However, by reducing channelized flows and allowing rain waters to slowly filter through the system under natural conditions, much of the excess nutrients and potential contaminants will be captured in the soils and plants instead of being directly dumped into open and flowing waterways. The effects of channelized waterways (ditches) have had a significant impact on the drainage patterns of the tributaries of the Nanticoke River. Restoring natural hydrology would have similar impacts as the natural waterways adjust their patterns and other characteristics to deal with the decrease in channelized inputs and increase in sheet and subsurface flows. Some waterways would experience increased siltation nearer to closed ditches while others, farther from the drainage way would be flushed out.

By elevating the water table and increasing the soil moisture on these sites, we would also restore the sites' ability to efficiently break down litter and accumulate greater amounts of organic material, which is necessary to support substrata essential to cedar seed storage and germination. Additional site modifications will need to be performed, such as leveling of ditch banks, prescribed burning to remove excess hardwood litter, soil scarification to prepare seedbed, and soil disturbance to create micro-topography. These activities would likely have minimal and temporary impacts on the water quality of nearby streams and would be mitigated through the use of BMPs.

No new forest roads would be constructed for the sole purpose of forest management. Some minor road improvements would be needed on our more remote and underused roads should they ever be needed for timber access or haul roads. Therefore, no additional impacts on hydrology would be generated in order to access areas to perform forest management activities.

Other potential impacts on water and soil may result from the use of herbicides to control exotic, invasive, or undesirable plant species in order to ensure optimum growth and quality of preferred tree species such as Atlantic white cedar, loblolly pine, and hard mast producing hardwoods. Herbicides may be applied through the use of ground equipment, aerially or systemically. Herbicides used would consist of only prior approved, and the least problematic and harmful compounds available to do the job (see Forest Management Plan).

The only potential impacts on air quality under this alternative would be related to the use of prescribed burning as a method of TSI, hazardous fuel reduction, and site preparation. Very stringent guidelines are in place related to smoke management and how to reduce or mitigate for the negative impacts of smoke (see Fire Management Plan).

Maintaining healthy forests would improve air quality by absorbing carbon dioxide. One acre of young healthy trees would absorb 2.5 tons of carbon dioxide and give off 2 tons of oxygen each year. However, if trees become unhealthy or reach the end of their life span and begin to rot, this process would be reversed. Oxygen would then be consumed and carbon dioxide released (Miller 1998).

Biological Impacts

As with all forest management activities, particularly concerning the removal of trees or wood products from the site, the implementation of best management practices would minimize or eliminate negative impacts on biological communities.

Effects on aquatic habitats would be minimal. The greatest impact of an active forest management program would be on the health and diversity of wetland and terrestrial habitats, and ultimately wildlife populations, specifically Delmarva fox squirrel and FIDs. The forest management program would focus primarily on the 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. In general, performing forest management and implementing the many associated strategies would ultimately result in a healthier, more diverse forest system. Specific tasks such as reforestation of PC wetlands and protection of large forest patches would have a significant impact on the detrimental effects of forest fragmentation. To minimize the impact on FIDs, we as land managers would abide by the following facts and recommendations (Jastrzembski 2000).

- FID breeding grounds are not harmed by thinning out inferior trees or removing select trees of merchantable quality as long as the forest canopy is not removed in excess of 70 percent crown cover.

- Some regeneration harvests (areas that are cut over completely and left to regenerate naturally) are not detrimental to FIDs either.

- Regeneration harvests such as seed tree harvests, must be conducted on forest tracts that are more than 100 contiguous acres in size. In addition, these harvests must be kept to the edges of the forest, and done in less than 25-acre parcels.

- Many FIDs are cavity nesters and use dead trees, called snags, as homes. When conducting harvests or thinnings, retain as many large snags (10 inches in diameter or greater) as possible.

- The breeding season for FIDs stretches from May 1 – August 31. Forest disturbances should be minimal during the breeding season. To limit fragmentation of forests, limit access roads in forest interiors and keep them narrow. Also maintain forested buffers along streams and shoreline so FIDs have protected access to water.

Performing forest management on Refuge Complex lands would be instrumental in addressing these recovery tasks, identified in the Delmarva Fox Squirrel Recovery Plan (Moncrief, et al. 1993): (**2.3**) field test and define applications for the Habitat Suitability Model; (**4.1**) determine effects of timber management and other land use practices on the DFS; (**4.2**) develop and refine guidelines for prescriptive habitat management for the DFS; (**4.3**) develop and implement guidelines for habitat management on public lands occupied by the DFS; and (**4.4**) monitor the outcome of prescriptive habitat management.

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 < 12 inches) 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 the 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. In summary, performing simple forest management practices will enhance the quality and quantity of the existing fox squirrel habitat at BNWR. Efforts toward crop tree selection would 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 would promote a more consistent mast crop.

Managing Forest Cores

We delineated the cores below based on their having a minimum of 400 contiguous acres of mature (> 40 years old) forest, to create four cores of 400 acres or greater and two cores of less than 400 acres that exhibit the greatest potential for becoming cores. A seventh core will be established in the near future through land protection. All seven cores in their "unmanaged" state are shown in figure 4, below.

All cores represent a patch of contiguous mature forest of a minimum size, and are essentially revolving in both space and time. Once a core reaches the optimum size of 850 acres, that acreage will be maintained as a minimum. However, the 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.

A 100-meter buffer was then delineated from the edge toward the interior of the core to determine the effective area within the core, which can be considered optimal habitats for area-sensitive FIDs. The perimeter-to-area ratio also was calculated as another means of valuating the integrity of the core. Core integrity is significantly diminished by gaps within the core. Access roads may be detrimental to the integrity of the core depending on their width and the amount of canopy closure. Roads that significantly impact the integrity of the core will be evaluated to determine whether more compatible methods of maintaining these forest roads can be employed. The goal for improving core integrity as it relates to road maintenance and skid trail construction will be to promote a nearly closed canopy road system within each cores based on the limitations of maintaining critical access into management areas.

The proposed management for each of the five 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 number 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 and restoration, regeneration cutting, and controlling problem vegetation to release regeneration. Integrated pest management and disease monitoring will be ongoing within all forested habitats.

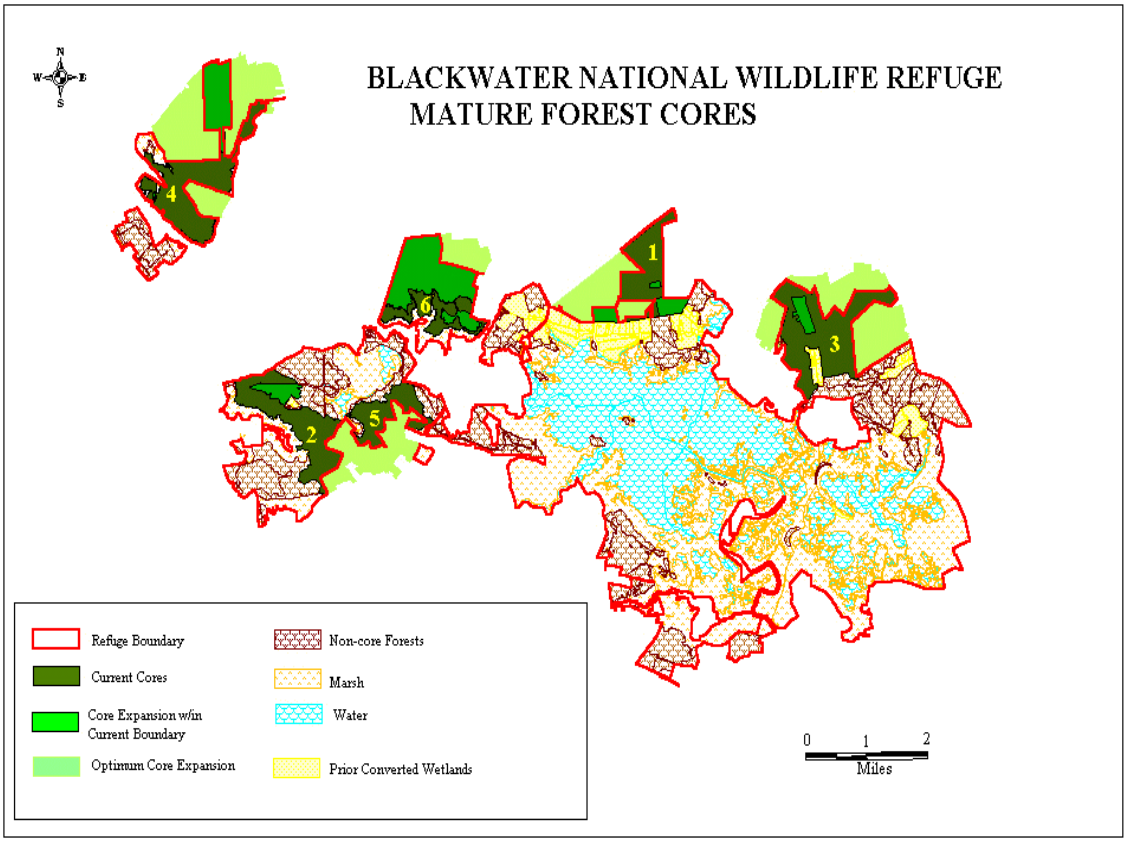

Figure 4. Mature forest cores (BLK)

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 chapter 3, "Affected Environment" and in the Forest Management Plan. A closed canopy road extends south to north, bisecting the entire core; 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 that serves in part as the refuge's boneyard. The current effective area of Core 1 within the 100-meter buffer is 209 acres, and the perimeter-to-area ratio is 86 (see table 2). 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 in order of priority.

Table 4. 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

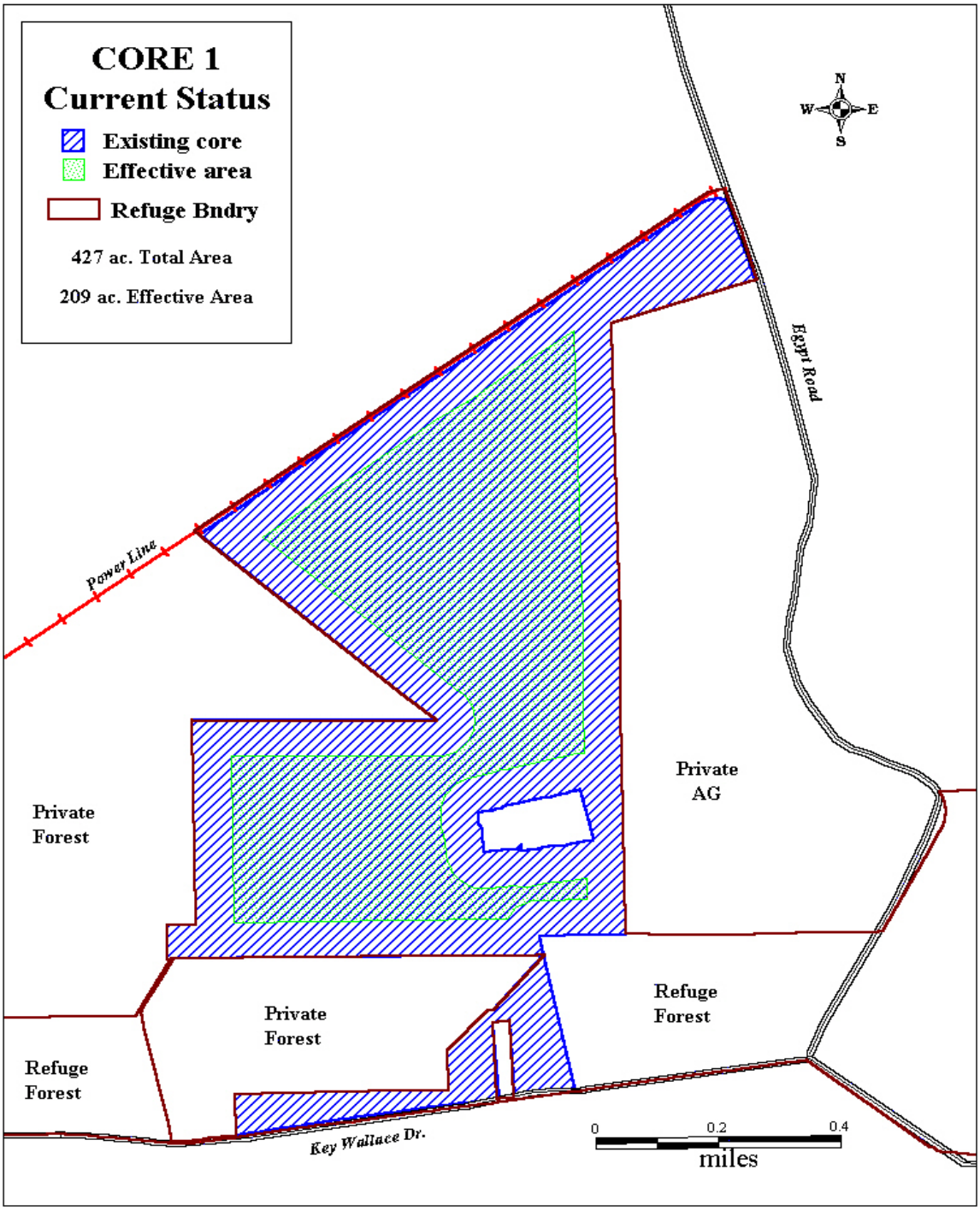

Figure 5. Core 1 current status

Prescription A. 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 are 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.

The specific silvicultural prescription will be a "free thinning," which will likely combine both a "high thinning" (overstory removal) and a "crop tree release." 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 production will provide tremendous benefits for DFS, as well. By adding this particular stand the overall size of the core is increased by 17 percent, and the effective area is increased by 17 percent (35 acres). The perimeter-to-area ratio is also decreased from 86 to 80 (a 7-percent 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. The figure 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-acre stand will be incorporated into the core in fewer than 10 years. This map also provides excellent visual explanation of the consequences of each prescription.

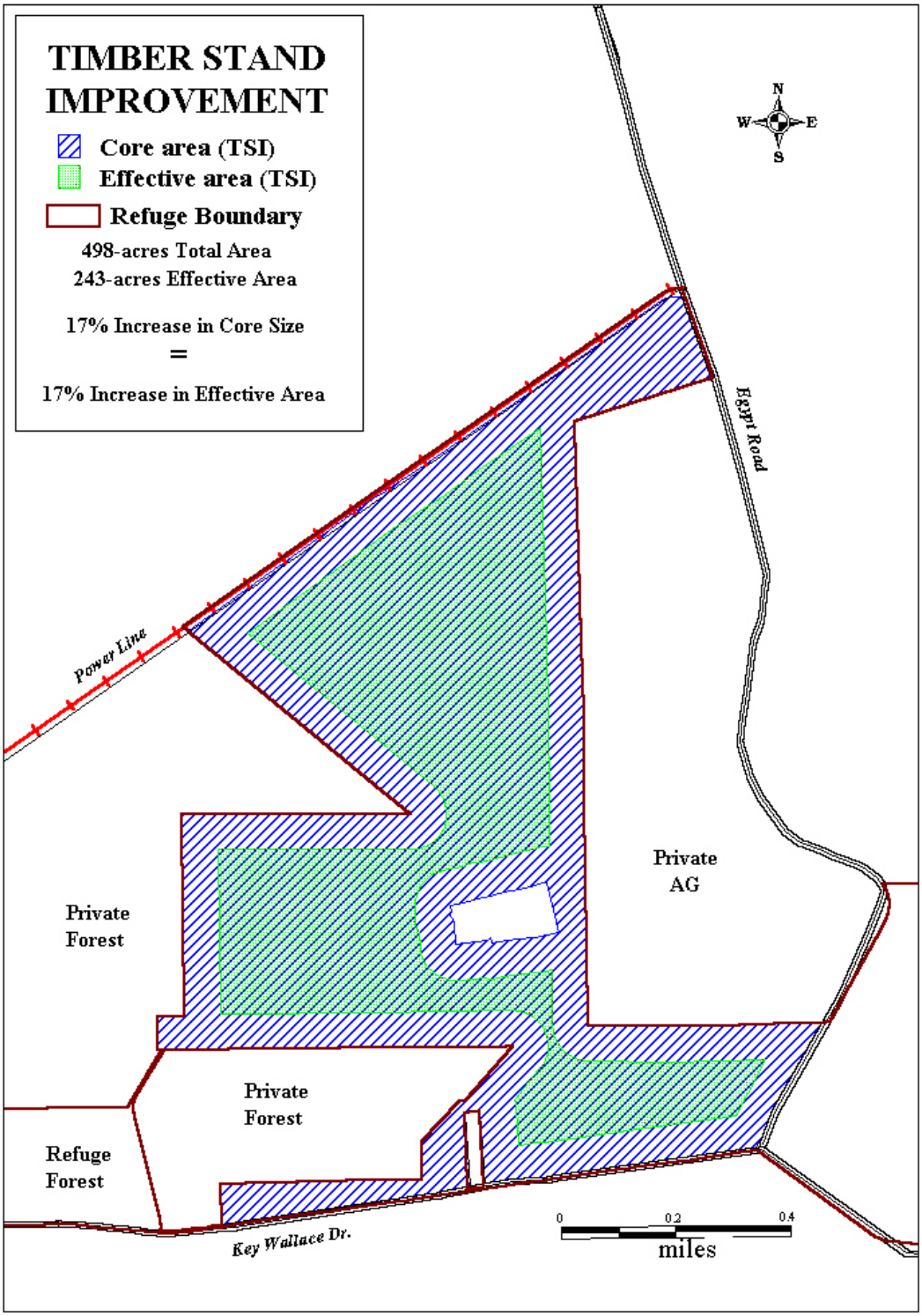

Figure 6. Core 1 TSI and the growth of 71 acres of immature pine–hardwood

Prescription B. Reforestation

The second-highest forest management prescription focuses on the reforestation of the 9-acre abandoned field located in the center of the core. Immediate reforestation of this area is extremely relevant to improving the integrity of the core. Although this parcel will not actually be incorporated into the core until the trees reach maturity, the benefits to wildlife during its development into forest will significantly outweigh its benefits as a field or grassland. The site will be planted with a mix of loblolly pine and hard mast producing hardwoods at a spacing that dictates a stocking of 600 to 1,000 trees per acre.

The reforestation and management of this area up to and beyond the point at which it matures and can be included in the core will have a minor effect on overall core size (2 percent), but increases the core's effective area by an additional 14 percent. The perimeter-to-area ratio is also reduced by another 8.5 percent, from 80 to 73. Since we plan to reforest the site with a mixture of both pine and hardwood species, this prescription will have so impact on species composition. The figure below demonstrates the commutative impacts of implementing both prescriptions A and B, despite the fact that it will take 40 years before the planted acres are added to the core, whereas the 71 acres that simply require TSI will be incorporated in fewer than 10 years. The maps also provide excellent visual explanation of the consequences of each prescription.

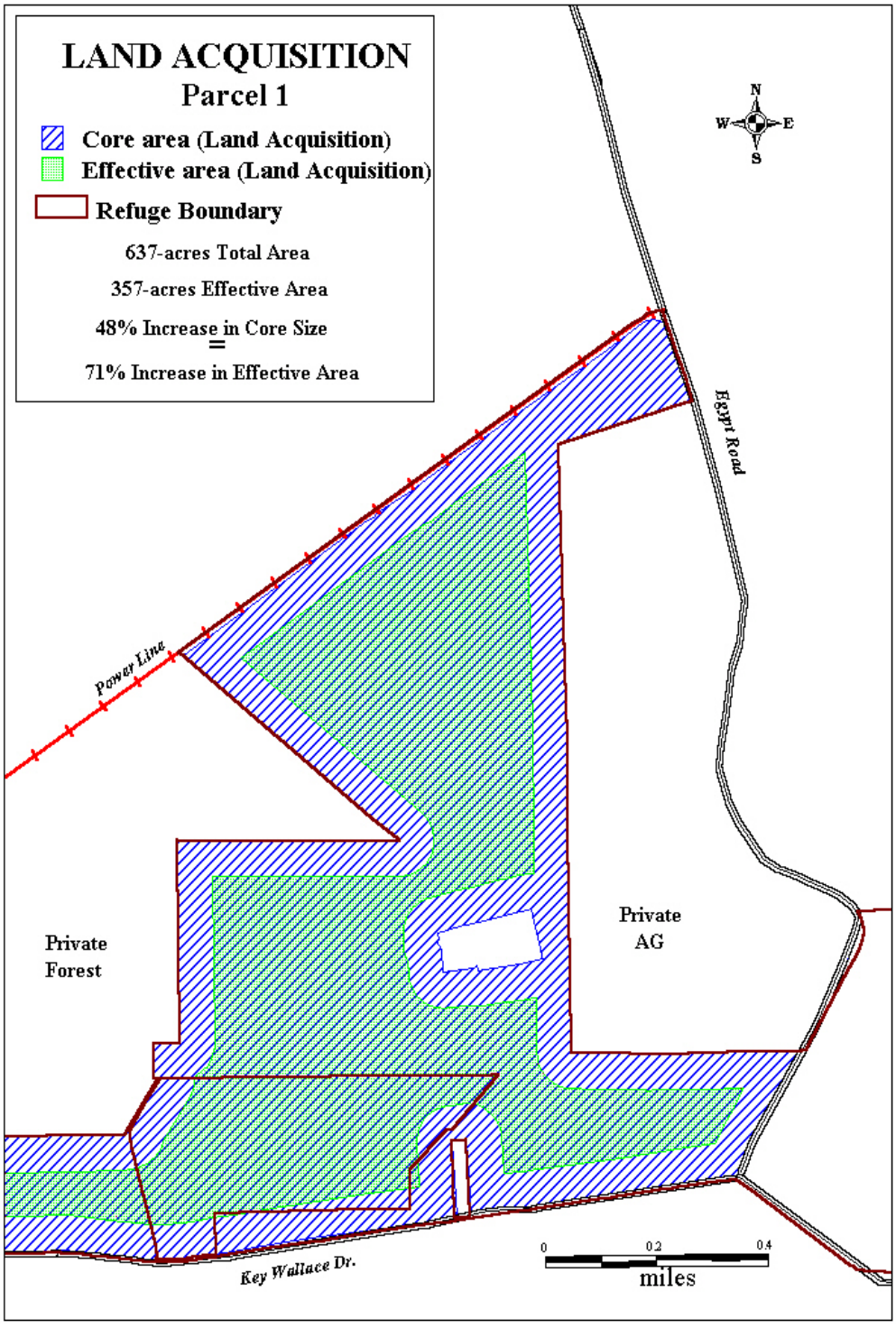

Figure 7. Land protection parcel 1 (prescription A)

Prescription C. Strategic land protection

Continued land protection would ensure the long-term protection of habitat for trust resources and other wildlife. By strategically acquiring tracts adjacent to existing cores or that are large enough to become new cores, we will significantly increase our potential to provide breeding habitats for nearly all 11 priority species of FIDs known to occur on Blackwater NWR.

Through the use of GIS and aerial photography interpretation, lands adjacent to the core were assessed to prioritize land protection for the benefit of the core. All inholdings of any land cover type were ranked the highest due to the significant negative impacts they had on the continuity, connectivity and perimeter-to-area ratio. The primary selection criteria for all other adjacent lands consisted of current land use, maturity and composition. Therefore, the highest priority protection would be an 86-acre tract of mature forest that would connect the existing core to additional mature forest already under Refuge Complex ownership (figure 8). The net results of this protection would be a total increase in core size of 14 acres (32 percent), an additional 49-acre (24-percent) increase in effective area and a reduction in the perimeter-to-area ratio by an additional 13 percent.

The second most critical protection would encompass all remaining forested land north of Key Wallace Drive, south of the power line right-of-way, and west of the existing core (figure 9). The protection of this 421-acre parcel would significantly increase the core's ability to provide potential breeding habitat for FIDs. This protection alone would increase the current core area to 848 acres, which would likely be large enough to provide potential breeding habitat for at least 8 of the 11 FIDs. Acquiring this parcel would also connect a small 1.3-acre parcel of refuge land to the rest of the core. The net benefits of this protection in terms of core integrity would be a 98-percent increase in the total core area and an additional 352-acre (83-percent) increase in effective area. Both of these tracts are dominated by either a mix of pine and hardwood or hardwoods and contain a large percentage of oak and beech. Both consist primarily of mature and over-mature trees and have been subjected to some form of timber harvesting in the past. It is highly suspected that these tracts are also occupied by DFS, which further substantiates the need to protect these lands.

Figures 7 and 8 show the cumulative effects of acquiring these lands in addition to implementing prescription A. The acres discussed in prescription A will be added to the core in fewer than 10 years, and the protection of this parcel could happen even earlier. Prescription B (reforestation) was not displayed on this map since these acres would not be incorporated into the core for another 40 years following planting. Regardless of the management strategy, it is assumed that these lands eventually will be incorporated into the core.

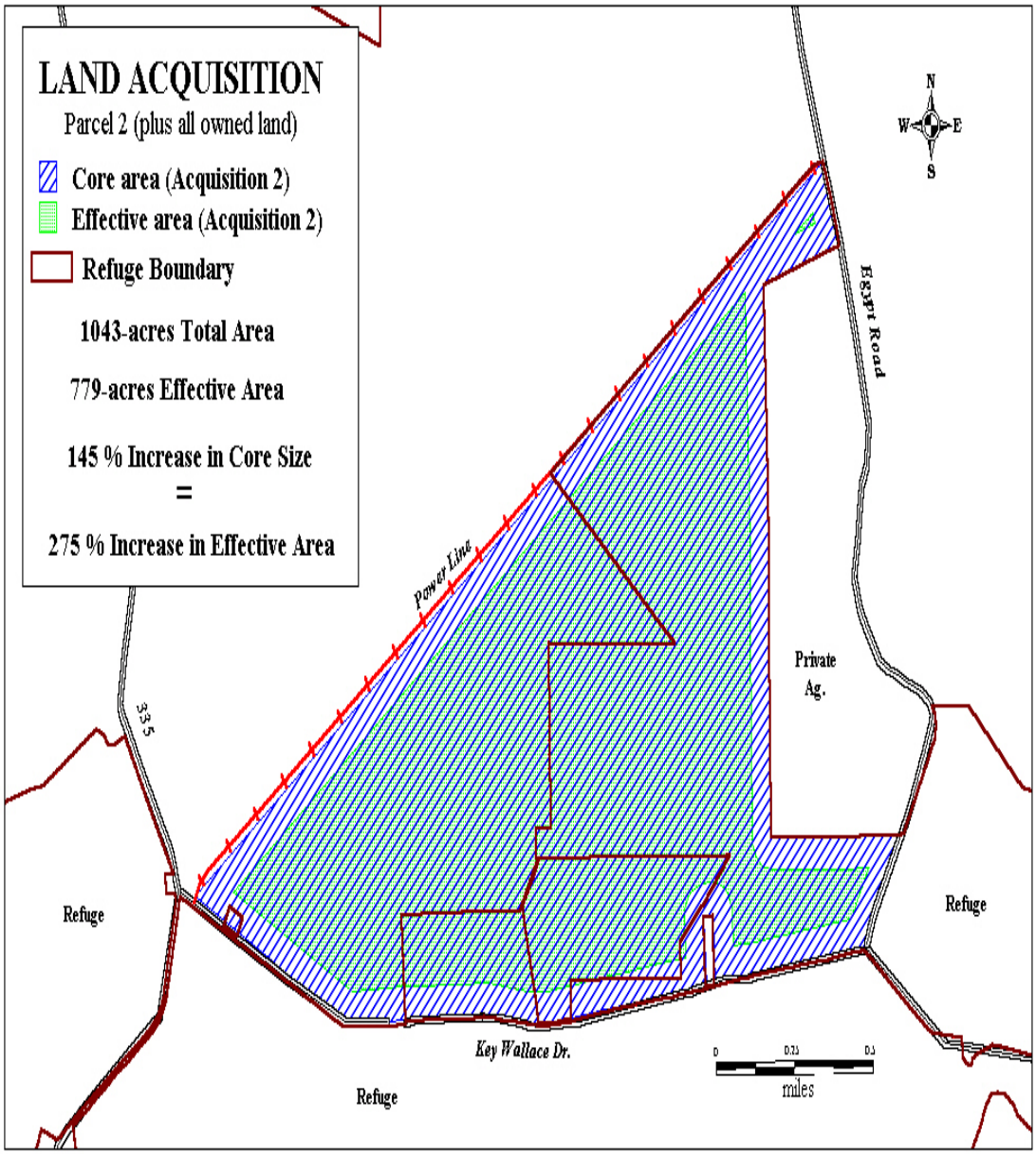

Figure 8. Land protection parcel 2 (prescription A)

Prescription D. Regeneration harvests

Techniques to enhance the natural regeneration of both hardwood and pine species under a mature canopy will likely 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 protection, the proposed treatment acres may also increase. However, this activity will only be performed under the context of "Wildlife First" and improving wildlife habitats. The resulting biological impacts will be the same and are discussed in detail below, under the heading "Prescriptions Common to All Proposed Forested Acres."

Prescription E. Prescribed burning

Prescribed burning will be used to enhance wildlife habitats, particularly for DFS and forest health conditions on a minimum of 225 acres of forested habitats within this core. The proposed acreage is based on current conditions and current land base. As this core expands as a result of land protection, the proposed treatment acres may also increase. However, this activity will only be performed under the context of "Wildlife First" and improving wildlife habitats. The resulting biological impacts will be the same and are discussed, in detail, below under the heading "Prescriptions Common to All Proposed Forested Acres."

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 NWR. This core is highly variable with respect to species composition, age class, and stand conditions. A more detailed description of these forested stands can be found in chapter 3, "Affected Environment," and in the Forest Management Plan. This core also exhibits some of the greatest potential for expansion through silviculture and land protection. However, due to its somewhat linear shape, the current effective area of the core is only 294 acres.

The most significant ecological factor that detracts 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 saltwater intrusion. This compartment is also characterized by having wider than average roadbeds that span up to 60 feet wide. Some portions of these roads are well on their way to becoming closed canopy. By strategically releasing appropriate crop trees along the opposite ditch bank, an acceptable level of canopy closure will be achieved over time.

Like most other forest lands on the refuge, the stands within and around this core are not exclusive of the need for forest management. While the habitat within the core will be managed to maintain or enhance species composition, mast production, regeneration, overall health and the integrity of the core, the surrounding forested habitats will be managed to improve species composition, growth and health for the purpose of being incorporated into a core if possible. 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 it, which will eventually improve the integrity of the core. The proposed actions and consequences will be described and geographically displayed in order of priority.

Prescription A. Reforestation of a portion of salt-killed forest

The highest priority management issue on adjacent habitat is the potential restoration of a portion of the salt-killed area. A detailed site assessment will be required to determine the suitability of the site for restoration. The most important test will be to have the soil analyzed for salt content to determine if the site will be able to support trees again and if so, what species. If possible and economically feasible, the restoration of the salt-killed areas will eventually result in significant improvements to the size and shape of the core.

The restoration of these areas will also provide the means for connecting several otherwise disjunct stands within the core. These changes in the dynamics of the core translate to an increase in the overall size of the core by 95 acres or 15 percent, and an increase in effective area by122 acres or 41 percent. The perimeter-to-area ratio is subsequently reduced by 20 percent, from 25 to 20. The above-mentioned core enhancements will significantly improve breeding potential for FIDs in the future.

Additionally, by restoring this area to a mixed pine and hardwood forest, we will ensure future availability of habitat for DFS and other wildlife species. Improvements to the water control measures have been made to reduce the risk of such an event repeating itself. Other biological impacts of this activity are discussed under the sub-heading “Reforestation and planting” under “Prescriptions Common to All Proposed Forested Acres,” below

Prescription B. Land protection

The biological impacts of land protection, as it relates to this core, are based on a single protection. The most obvious effect of this protection is that it physically joins Core 2 to Core 5, thus creating a new larger contiguous core. Although there are many other possibilities for the expansion of this core through land protection, the majority of them will be discussed under Core 5, Prescription B, “The Cumulative Effects of Land Protection on Cores 2 and 5.”

The highest priority protection will be the 116-acre tract of immature forest that will connect the two existing cores. The net results of this protection, specific to Core 2 alone, will be an increase in core size of 116 acres (19 percent) to 733 acres. The effective area will be increased by 103 acres (35 percent), while the perimeter-to-area ratio will be reduced by 12 percent from 25 to 22. These values reflect the impacts of this single protection alone without the impacts of the restoration of the salt-killed area. The reason being that it is likely that the protection will happen in the near future and could be incorporated into the core much earlier than the restored acres, despite the fact that it contains only young trees.

The protection of this 116-acre parcel would significantly increase the core's ability to provide potential breeding habitat for FIDs. This protection, alone, would increase the current core area to a size large enough to provide potential breeding habitat for 9 of the 11 FIDs. As previously mentioned, the greatest benefit from acquiring this tract will be the resulting connection between Core 2 and 5. The figures below represent the impacts on Core integrity as a result of acquiring this parcel and managing it to ensure its placement in the core.

All other prescriptions will focus on the improvement of current stand conditions for the benefit of DFS and FIDs and to encourage natural regeneration of preferred species. These activities, when performed within current cores, have no direct impact on the size, effective area or perimeter-to-area ratio values, therefore maps depicting these activities have not been generated.

Prescription C. 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. The particular form of TSI has not yet been determined. The exact method will be chosen based on a more detailed inventory of these acres. The bulk of TSI prescriptions associated within this compartment will be carried out in forested habitats adjacent to the core for the purpose of enhancing those habitats for their potential of being included in the core. As this core expands as a result of land protection, the proposed treatment acres may also increase. However, this activity will only be performed under the context of "Wildlife First" and improving wildlife habitats. The resulting biological impacts will be the same and are discussed, in detail, below under the heading "Prescriptions Common to All Proposed Forested Acres."

Prescription D. Regeneration harvests

Techniques to enhance the natural regeneration of both hardwood and pine species under a mature canopy will likely 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 protection, the proposed treatment acres may also increase. However, this activity will only be performed under the context of "Wildlife First" and improving wildlife habitats. The resulting biological impacts will be the same and are discussed, in detail, below under the heading "Prescriptions Common to All Proposed Forested Acres."

Prescription E. Prescribed burning

Prescribed burning will be used to enhance wildlife habitats, particularly for DFS and forest health conditions on a minimum of 280 acres of forested habitats within this core. The proposed acreage is based on current conditions, current land base and a limited base of information pertaining to some newly protected tracts. As this core expands as a result of land protection, the proposed treatment acres may also increase. However, this activity will only be performed under the context of "Wildlife First" and improving wildlife habitats. The resulting biological impacts will be the same and are discussed, in detail, below under the heading "Prescriptions Common to All Proposed Forested Acres."

Core 3

Core 3 comprises 864 contiguous acres of mature hardwood-dominated forest within compartment U. A previous harvest extracted the large, valuable pines and left the more numerous hardwoods. This assemblage of high-graded stands is not only the largest block of mature hardwoods on the refuge, it also is currently the largest mature forest core with the greatest amount of effective area: 445 acres. A more detailed description of the forests in this compartment can be found in chapter 3, "Affected Environment," and in the Forest Management Plan.

The current perimeter-to-area ratio is 68, which will be reduced by 57 percent to 29, if all priority strategies are implemented. In its current state, this core provides potential breeding habitat for 9 of the 11 priority FID species for which we are managing. Much of the 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. Gypsy moth infestations have also had their tole on the oaks in this area in recent years. 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 that preclude natural regeneration and may have negative impacts on DFS populations.

This core like most others, is characterized by a network of haul roads that were improved to serve as all-weather roads for vehicular access. Although not as wide as the roads in other cores, the roadbeds dissecting this core average 30 feet wide. With minimal management such as enhancing the growth of selected roadside trees, an acceptable level of canopy closure will be accomplished. While the habitat within the core will be managed to maintain or enhance species composition, mast production, regeneration, overall health and the integrity of the core, the surrounding forested habitats will be managed to improve species composition, growth and health for the purpose of being incorporated into a core if possible.

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 it, which will eventually improve the integrity of the core. The proposed actions and consequences will be described and geographically displayed in order of priority.

Prescription A. Reforestation of prior converted wetlands

The most significant detriment to the current and future integrity of the core is the existence of two large areas of prior converted (PC) forested wetlands that carve holes in what should be forested habitat. The southernmost area of PC wetlands has recently been reconstructed into waterfowl management areas (moist soil units). This prescription involves the reforestation of almost the entire 72 acres of prior converted forested wetlands that remain within the center of

the northern portion of the core. The site will likely be planted with a mixture of hardwood species that can thrive under slightly wet conditions. The planted area will be managed intensively to perpetuate survivability, health and vigor to ensure that this area becomes a viable addition to the existing core.

The addition of this 72 acres results in a mere 8.3-percent increase in the overall size of the core to 935 acres, yet due to is juxtaposition within the current core and its level of impact, its inclusion yields a 142-acre or 32-percent increase in the effective area of the core. The perimeter-to-area ratio will subsequently be reduced by 23 percent to a value of 53. Although the new core size will still provide potential breeding habitats for the same 9 species of FIDs, the reduction in the fragmentation of this core will significantly enhance the quality of this habitat. The restoration of this area back to forest will also ensure future additional habitat for DFS and other woodland wildlife species.

This GIS analysis was solely responsible for reversing the original plan to restore this area to additional waterfowl management units. We feel that the benefits to FIDs and DFS will far out way any benefits to waterfowl populations that would result from moist soil management.

Prescription B. Strategic land protection

Essentially, the entire land protection strategy associated with this core hinges on three major parcels adjacent to the core. Beyond these privately owned parcels the core is bounded by major roads on all but the South end. The highest priority protection is the 167-acre parcel that is directly adjacent to the East of the current core. This parcel is of highest priority due to the fact that it still contains high quality mature forested habitats and the positive impacts it will have on the effective area and perimeter-to-area ratio of the core.

The first map will illustrate the impacts of this protection alone without the impacts of prescription A or any other protection. This parcel was singled out to demonstrate differences between the effects of filling in gaps within the core versus adding additional acreage to the outside of the core. By adding this parcel to the current core, the total area of the core is increased by 167 acres or 19 percent. These values are more than twice the acreage increase resulting from the restoration of the 72 acres of PC wetlands. However, despite the significant difference in the increase in core size, both prescriptions yield nearly the same increase in effective area of 142 acres (32 percent) and 146 acres (33 percent) respectively.

Other significant differences are that acquiring this parcel will result in an immediate addition to the core, but will cost the service substantial dollars. Restoring the PC wetlands will be quite a bit less expensive but will not be incorporated into the core for at least another 40 years. The reduction in effective area as a result of this protection will be 11 percent, as compared to the 23-percent reduction associated with prescription A.

The second map illustrates the cumulative consequences of acquiring all three adjoining private parcels along with the benefits of restoring the PC wetlands. This map demonstrates both the maximum core size and the optimum core integrity as it relates to effective area and perimeter-to-area ratio. By acquiring all three parcels and restoring the 72 acres of PC wetlands, we will

increase the total core area by 116 percent to 1,870 acres, and the effective area will be increased by 237 percent to 1,498 acres. The perimeter-to-area ratio will effectively be reduced by 57 percent to a value of 29. Increasing this core to this level, which far exceeds optimum core size of 850 acres, will provide us with a buffer of acres that will be readily available management and possible harvest, without significantly detracting from the core's ability to provide potential breeding habitat for all 11 species of area-sensitive FIDs.

All other prescriptions will focus on the improvement of current stand conditions for the benefit of DFS and FIDs and to encourage natural regeneration of preferred species. These activities, when performed within current cores, have no direct impact on the size, effective area or perimeter-to-area ratio, therefore maps depicting these activities have not been generated.

Prescription C. Timber stand improvement

Timber stand improvement is currently proposed on approximately 250 acres within Core 3. It is highly likely that the preferred method of TSI will be crop tree release or a combination of this and one other TSI method. As in the case with Core 2, the majority of the stands within this core are mature to overmature and are more in need of regeneration harvesting than TSI. As this core expands as a result of land protection, the proposed treatment acres within the core may also increase. However, this activity will only be performed under the context of "Wildlife First" and improving wildlife habitats. The resulting biological impacts will be the same and are discussed, in detail, below under the heading "Prescriptions Common to All Proposed Forested Acres."

Prescription D. Regeneration harvests

Techniques to enhance the natural regeneration of both hardwood and pine species under a mature canopy will likely 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 protection, the proposed treatment acres may also increase. However, this activity will only be performed under the context of "Wildlife First' and improving wildlife habitats. The resulting biological impacts will be the same and are discussed, in detail, below under the heading 'Prescriptions Common to All Proposed Forested Acres.'

Prescription E. Prescribed burning

Prescribed burning will be used to enhance wildlife habitats, particularly for DFS and forest health conditions on a minimum of 500 acres of forested habitats within this core. The proposed acreage is based on current conditions, current land base and a limited base of information pertaining to some newly protected tracts. As this core expands as a result of land protection, the proposed treatment acres may also increase. However, this activity will only be performed under the context of 'Wildlife First" and improving wildlife habitats. The resulting biological impacts will be the same and are discussed, in detail, below under the heading "Prescriptions Common to All Proposed Forested Acres."

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 of 92. The current core area consists predominantly of a mixture of pine and hardwood, which changes 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 chapter 3, "Affected Environment," and in the Forest Management Plan. The current core size of 722 acres should provide potential breeding habitat for 5 of the 11 area-sensitive FIDs. The only primary roads through the compartment bisect these cut-over areas and acceptable canopy closure will be ensured along with the management practices that address the enhancement of stand regeneration. All other roads within the current compartment and core will remain as closed canopy roads. Directly adjacent to this compartment and core lies a tract of land currently owned by The Conservation Fund. A significant portion of this tract has been harvested within the past 3 years as part of a Delmarva fox squirrel and Demonstration Forest research project. The temporary yet significant loss of FID and DFS habitat emphasizes the need for the protection and management of all forested habitats within this compartment along with the need to expand this core through land protection.

Prescription A. Release of natural pine regeneration and site restoration

Approximately 292 acres of mature loblolly pine timber had been harvested from this compartment prior to protection in 1994. Fortunately all of the timber harvesting took place within the Burton Tract, which is situated at the north end of the compartment. For the most part, the harvest was clear-cut, but in areas where the hardwood as 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 already, 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, have been a significant setback in the establishment of a new stand. Other areas that 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. Prescription A will focus on the restoration and management of all of these areas impacted by recent timber operations.

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 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. Since little to no oak regeneration is present, the preferred method release will be that of chemical release combined with or followed up by prescribed burning. Aerial applications of broadleaf-specific herbicides will provide temporary control of competing woody vegetation, which will reduce stress and improve the growth of the pines. This period of uninhibited growth would allow the pines to outgrow other species and ensures them canopy dominance. The affected hardwood trees will sprout new stems within the next couple of years and, eventually, grow to claim positions of co-dominance in the canopy and dominance in the subcanopy.

Follow-up prescriptions will include several thinnings and periodic prescribed burning throughout the life of the stand prior to reaching maturity. The several small logging decks that have been more severely impacted by the harvest contain virtually no regeneration of any trees. These areas will require site preparation and planting in order to restore them back to forests. In certain cases where the landing is small enough that it will not cause a significant gap in the canopy in the future, we may decide to rehabilitate these sites to grassland habitats. Small patches of grassland will provide some habitat diversity and may be preferred by some wildlife for feeding and breeding.

By ensuring the successful regeneration of these stands and their inclusion in the core, we will increase the overall size of the core by 292 acres (40 percent) to 1,015 acres. While the effective area will be increased by 173 acres (49 percent) to 528 acres. 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 that 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 protection and reforestation of the adjacent lands (prescription B). However, by increasing the overall size of the core to 1,015 acres, the new core will potentially provide breeding habitats for all 11 species of the area-sensitive FIDs shown.

Prescription B. Strategic land protection

The highest priority protection associated with Core 4 is a 158-acre inholding located along the Eastern side of the compartment. This parcel is of highest priority due to the fact that it is an inholding and is the only remaining timbered tract in the area. The first analysis will illustrate the impacts of this protection alone without the impacts of prescription A or any other protection. This analysis will further substantiate the tremendous impact that acquiring inholdings will have on the establishment and enhancement of these cores.

The inclusion of this tract will have the most significant positive impacts on the integrity of the core. The protection of this parcel in its current condition (not harvested) will immediately increase the total core area by 158 acres (18 percent) to 880 acres and have an even greater impact on the effective area, increasing it by 183 acres (34 percent) to 538 acres. The perimeter-

to-area ratio value will be decreased by 23 percent from 92 to 71. Through this protection alone, this core will reach optimum conditions that will provide potential breeding habitat for 9 of the 11 species of area-sensitive FIDs.

The second analysis illustrates the cumulative consequences of acquiring and reforesting all adjacent properties along with the benefits of restoring the previously mentioned harvested areas. Beyond these privately owned parcels the core is bounded by major roads on the North and East sides and Parsons Creek to the West, South and Southeast. This map demonstrates both the maximum core size and the optimum core integrity as it relates to effective area and perimeter-to-area ratio.

By acquiring all adjacent parcels and restoring them will increase the total core area by 1,431 acres (67 percent) to 2,153 acres. The effective area will be increased by 1,378 acres (80 percent) to 1,733 acres. The perimeter-to-area ratio will effectively be reduced by 66 percent to a value of 31. Increasing this core to this size, which far exceeds optimum core size of 850 acres, will provide us with a buffer of acres that will be readily available management and possible harvest, without significantly detracting from the core's ability to potentially provide breeding habitats for all 11 species of area-sensitive FIDs.

All other prescriptions will focus on the improvement of current stand conditions for the benefit of DFS and FIDs and to encourage natural regeneration of preferred species. These activities, when performed within current cores, have no direct impact on the size, effective area or perimeter-to-area ratio; therefore, maps depicting these activities have not been generated.

Prescription C. Timber stand improvement

Timber stand improvement is currently proposed on approximately 100 acres within this core. It is highly likely that 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 protection, the proposed treatment acres within the core may also increase. However, this activity will only be performed under the context of "Wildlife First" and improving wildlife habitats. The resulting biological impacts will be the same and are discussed, in detail, below under the heading "Prescriptions Common to All Proposed Forested Acres."

Prescription D. Regeneration harvests

Techniques to enhance the natural regeneration of both hardwood and pine species under a mature canopy will likely 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 protection, the proposed treatment acres may also increase. However, this activity will only be performed under the context of "Wildlife First" and improving wildlife habitats. The resulting biological impacts will be the same and are discussed, in detail, below under the heading "Prescriptions Common to All Proposed Forested Acres."

Prescription E. Prescribed burning

Prescribed burning will be used to enhance wildlife habitats, particularly for DFS and forest health conditions on a minimum of 250 acres of forested habitats within this core. The proposed acreage is based on current conditions, current land base and a limited base of information pertaining to some newly protected tracts. As this core expands as a result of land protection, the proposed treatment acres may also increase. However, this activity will only be performed under the context of "Wildlife First" and improving wildlife habitats. The resulting biological impacts will be the same and are discussed, in detail, below under the heading "Prescriptions Common to All Proposed Forested Acres."

Core 5

Core 5 is located within compartment M, and currently consists of only 348 acres of contiguous mature forest. Therefore, it is a very high priority to expand this core through land protection. The current effective area of core 6 is 132 acres and has a perimeter-to-area ratio value of 32. The current core area consists predominantly of a mixture of mature and over mature pine and hardwood. A more detailed description of the forests in this compartment can be found in chapter 3, "Affected Environment," and in the Forest Management Plan. The current core size of only 348 acres is capable of providing potential breeding habitat for 4 of the 11 area-sensitive FIDs.

Several roadbeds were constructed several years ago in an attempt to provide access between the Jarrett East and Jarrett West tracts. This project was abandoned, and so were the road beds, which are now well on their way to being reforested. Only a small section of a permanent primary access road will remain within the current core boundaries. As new lands are added to the core, so will a new network of roadways that will either be improved or put to rest, depending on the priority of management objectives.

As previously stated, the primary means of expanding this core is through protection. There is currently a land base directly adjacent to the core sufficient to make this a stand-alone core of more than 400 acres. This will be illustrated under prescription A. However, as with Core 2, the greatest potential of this core is the conjoining of this core with Core 2 through land protection. The cumulative impacts on Cores 2 and 5, and of strategic land protection, will be illustrated in prescription B.

Prescription A. Strategic land protection, Core 5 alone

The highest priority protections associated with Core 5 if treated as a stand-alone core are two parcels southeast of the Core that total 141 acres. These parcels are directly adjacent to the existing core and will facilitate connectivity with other currently owned forested habitat. These protections will add an additional 127 acres of mature forest to the core, thus expanding the core by 36 percent to 475 acres

The inclusion of these parcels will also have significant positive impacts on the integrity of the core. The effective area of the core will be increased by 173 acres (131 percent) to 305 acres. The perimeter-to-area ratio value will be reduced by 47 percent, from 32 to 17. The map below illustrates the impacts of only a couple of high priority protections and the first steps to increasing this core to its optimum size. Through this protection alone, this core will reach the minimum conditions that will provide potential breeding habitat for 5 of the 11 area-sensitive FIDs.

Prescription B. Strategic land protection, Cores 2 and 5

The first part of this analysis will discuss the cumulative impacts of a single protection (same one discussed under Core 2, Prescription B) on both Core 2 and Core 5. In the consequences of land protection section under Core 2, the impacts of a single protection were discussed as it related to Core 2 alone. Here we will demonstrate to impacts of the same protection on Core 5 as well.

Once again, this parcel can be described as a 116-acre tract of immature forest that is situated along the western border of Core 2 and touches a portion of the eastern border of Core 5. Acquiring this parcel will essentially connect the two established cores and eventually create one large contiguous core. The combined total area of the two separate cores is currently 965 acres and 426 acres, respectively. By adding this parcel and connecting the two cores, we will create a new contiguous core that is 1,081 acres or 12 percent larger than the area of the two separate cores. The effective area of this new core will be 534 acres, which is 25 percent greater than the current conditions. The perimeter-to-area ratio value will be reduced by 14 percent, from 28 to 24. By combining these two cores through this single protection, we will establish a contiguous forest core that will provide potential breeding habitat for at least 9 of the 11 FID species for which we are managing.

The second part of this analysis illustrates the cumulative impacts of combining Cores 2 and 5 as a result of the protection above, along with the impacts of acquiring all parcels North of Hip Roof Road that are part of approved Land Protection Plans (Conservation Biology for Trust Species Diversity). The protection of all approved parcels will provide an additional 552 forested acres to the compartment and the cores. By adding these acres, the new core will be 1,517 acres in size, which is a 57-percent increase from current conditions. The effective area of this new Core will be 959 acres, which is a 125-percent increase, whereas the perimeter-to-area ratio value is reduced by 39 percent, from 28 to 17.

Expanding these cores to this size will further enhance the likelihood of providing potential breeding habitat. for all of Blackwater’s priority FIDs, while also providing us with greater flexibility regarding the management of these lands. If and when a non-selective regeneration harvest such as a seed-tree or patch clear-cut is warranted, it will have less of an impact on the integrity of the core. Harvesting techniques such as these will cause temporary reductions in core size and effective area but by maintaining a minimum core size of 850 acres, bird population will be able to shift within the same core and not be significantly impacted.

Core 6

Core 6 is located within Compartment R, and is currently only 283 acres in size. Due to its linear shape and the expanse of clear-cut within its boundary, the current effective area for FIDs is only 10 acres. This assemblage of mature forest stands consists primarily of pure pine forests that are located within the "Critical Areas" and a previously high-graded over-mature hardwood-dominated stand. No management has been proposed for those stands within the designated "Critical Area." Only a very light selection harvest will be implemented within the current core boundaries to promote natural regeneration within this stand (prescription C).

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 in the core. The current forest conditions in this compartment are a result of timber harvesting that 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 chapter 3, "Affected Environment," and in the Forest Management Plan.

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 management practices that will be performed in the near future are discussed below. This compartment also contains some of the widest roads on the refuge. Mitigation of the impacts of these roads will be explored once forest management objectives are achieved and the core has reached the minimum area requirements of 400 acres.

Prescription A. 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- to 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. Prescribed burning will also be employed prior to or following the thinning operation in order to reduce excess fuel loading and improve the quality of growth of the remaining crop of trees.

The long-term benefits to the quality of these stands will be most evident at maturity, at which time 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 an amazing 870 percent to 97 acres. The perimeter-to-area ratio value is subsequently reduced by 21 percent from 58 to 46. 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 of the 11 area-sensitive FIDs.

Prescription B. Release of natural pine regeneration and site restoration

Approximately 150 acres or more of mature loblolly pine timber was harvested from this compartment prior to and post protection throughout 1994 to 1999. For the most part the harvest was in the form of a clear-cuts 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 hardwood shrubs and vines and in some areas, 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. Other areas that 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. Prescription A will focus on the restoration and management of all of these areas impacted by recent timber operations.

Since the original stand was a predominantly pine forest, we intend 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 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. Since little to no oak regeneration is present, the preferred method release will be that of chemical release combined with or followed up by prescribed burning. Aerial applications of broadleaf specific herbicide will provide temporary control of competing woody vegetation, which will reduce stress and improve the growth of the pines. This period of uninhibited growth would allow the pines to outgrow other species and ensure them canopy dominance. Any affected hardwood trees, such as red maple or sweet gum, will sprout new stems within the next couple of years and, eventually, grow to positions of co-dominance in the canopy and dominance in the subcanopy.

Follow-up prescriptions will include several thinnings and periodic prescribed burning throughout the life of the stand prior to reaching maturity. The several small logging decks that have been more severely impacted by the harvest contain virtually no regeneration of any trees. These areas will require site preparation and planting in order to restore them back to forests. In certain cases where the landing is small enough that it will not cause a significant gap in the canopy in the future, we may decide to rehabilitate these sites to grassland habitats. Small patches of grassland will provide some habitat diversity and may be preferred by some wildlife for feeding and breeding.

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 in conjunction with the impacts of Prescription B since both areas will be added to the core around the same time. Therefore, statistics regarding the changes in core size and effective area as a result of this prescription can be found under prescription C, below.

Prescription C. Timber stand improvement

A variety of timber stand improvement techniques may be required 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 that 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 cost-prohibitive. Initial treatments of prescribed burning will be tested to determine its effectiveness in reducing the stocking and basal area of the stand and improve the regeneration of pine and hard mast producing hardwoods. Fire will be the first treatment implemented due to its lower cost and greater efficacy in controlling younger trees.

As the trees put on some age and grow out of the sapling stage, the stocking of maple and gum will also likely be reduced through a natural thinning process. At this time, it may be somewhat more cost-effective to employ various mechanical TSI techniques to encourage the regeneration of more preferred species. Nonetheless, whether it is a pure maple and gum stand or a mixed pine and hardwood stand, these areas will eventually reach maturity and will be added to the core along with the other cut-over areas discussed under prescription B.

Enhancing conditions of these acres along with the cut-over areas discussed under prescription B 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 percent) to 954 acres. Whereas the effective area will be increased by 642 acres, or an unbelievable 6,420 percent, to 652 acres. 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.

Prescription D. Land protection

The impacts of land protection, as it relates to the future conditions of this core is based on a small cluster of private parcels that are included in the approved Conservation Biology for Trust Species Diversity. These parcels are located along the Northern border of the compartment just off Buttons Neck Road and currently contain approximately 210 acres of forested habitats. Due to their juxtaposition in relation to the existing core, these protections will not have an impact on

the integrity of the core until all of the previously discussed habitats are added to the core. Therefore, these protections are of slightly less priority. The primary reason for acquiring these lands as soon as possible is to prevent them from being harvested prior to being sold to the Refuge Complex.

The cumulative impacts on the core as a result of adding these parcels and the previously mentioned forested habitat with in the compartment will not be evident until at least 2030. However, at that time the new core will be 1,158 acres, a 309-percent increase over its original size. Its effective area will be increased by 8,330 percent to 833 acres, and the perimeter-to-area ratio value will be reduced by 79 percent, from 58 to 12. Core 6, in its new condition, will then provide potential breeding habitats for at least 9 of 11 highly area-sensitive FIDs.

All other prescriptions will focus on the improvement of current stand conditions for the benefit of DFS and FIDs and to encourage natural regeneration of preferred species. These activities, when performed within current cores, have no direct impact on the size, effective area or perimeter-to-area ratio, therefore maps depicting these activities have not been generated.

Prescription E. 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 protection, the proposed treatment acres may also increase. However, this activity will only be performed under the context of “Wildlife First” and improving wildlife habitats. The resulting biological impacts will be the same and are discussed, in detail, below under the heading “Prescriptions Common to All Proposed Forested Acres.”

Prescription F. Prescribed burning

Prescribed burning may be used to enhance wildlife habitats, particularly for DFS, and forest health conditions on approximately 100 acres of forested habitats within this core. The proposed acreage is based on current conditions, current land base and a limited base of information pertaining to some newly protected tracts. As this core expands as a result of land protection, the proposed treatment acres may also increase. However, this activity will only be performed under the context of “Wildlife First” and improving wildlife habitats. The resulting biological impacts will be the same, and are discussed in detail below, under the heading “Prescriptions Common to All Proposed Forested Acres.”

Core 7

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 Proposed 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 proposed 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 proposed 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 would 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 would 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 would 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 proposed 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 proposed 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 proposed 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 alternative B under 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 would provide temporary control woody and herbaceous vegetation in the understory. A series of two or more annual burns would provide a significantly greater period of control, thus enhancing habitat quality for DFS. The reduction in understory density would 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 proposed 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 would 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 would once again result in a dramatic shift in species composition and forest structure. Tree species that are more suited to adequately drained soils would 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 would 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 would 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 would only be performed on a small scale, therefore, impacts would be minimal. If remnant cedars still occupy the site, the removal and subsequent control of all other trees would 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 would expose the organic layer of the soil and created micro-relief, which will enhance survival of planted seedlings. The alterations in hydrology would decrease the ability of most trees' seeds to germinate due to longer periods of standing water. The increase in soil and surface water would 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) would also displace certain ground dwelling species that cannot tolerate flooded conditions.

However, increased soil moisture would 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 would 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 would 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.

Socioeconomic Impacts

As previously mentioned, much of the forested lands that are now part of the Refuge Complex once were managed for the production of forest products; supplying forest products to families and many small locally owned mills as well as large regional corporations. Some of the Blackwater NWR land was owned and managed by both large and small scale forest product corporations such as Chesapeake Forest Products and Spicer Corporation. These companies supplied forest products throughout Maryland and many other states. Upon protection by the Service, these lands were taken out of timber production, and no longer provided forest products that helped to keep small local mills in business. Performing wildlife-oriented, forest habitat management on Blackwater NWR would result in the sale of forest products resulting in

additional indirect increased revenues to the local economy. The sale of the timber would also eliminate the need to use Refuge Complex staff and funding to implement forest management prescriptions.

Implementing manual methods of release and weed control is also very effective in achieving objectives and will create a source of employment that will contribute to the local economy or provide for volunteer opportunities. Many of our habitat management objectives may also be achieved through a firewood cutting program that will be developed at a later date.

The most significant and sensitive sociological impact of hydrologic restoration related to Atlantic white cedar management on the proposed Nanticoke protection area would be the effects on hydrologic conditions on off-refuge lands. Eliminating or restricting drainage ways on-refuge could result in flooding adjacent agricultural lands, tree plantations and residential lands. The effects of on-refuge restoration would be assessed and closely monitored so that off refuge impacts are eliminated or mitigated. The use of water control structures may be necessary in order to control water levels and reduce the potential of flooding private properties.

The sociological aspects of forest habitat management programs are complex, and vary widely across geographic boundaries. These activities, particularly the cutting of trees, while appreciated and promoted in rural America, are less likely to be viewed the same way by people in urban settings and backgrounds. In many cases, urban America sees and hears only the negative aspects of forest management and associates forest management programs on refuges with wildlife destruction and commercialization of the resource rather than with the objectives of wildlife habitat improvement, improved forest health, and other benefits to the environment. In spite of the potential of managing for a diverse public and equally diverse populations of wildlife, it is impossible to please all interest groups and individuals. Some would object to management in any form, and it would be difficult to argue against the pursuit of natural values. Realistically, there are few remaining areas where protection of the habitat alone is the only necessary management option. This is especially true in cases where man has already caused significant impacts on the landscape, as at Blackwater NWR and the Nanticoke protection area. The majority of habitats are degraded, are far from natural, and have the growing inability to support the historical abundance and diversity of fauna that is necessary and expected. These concerns and issues would be addressed in environmental education and interpretation programs about the refuge's forest management program.

Cultural and Historical Resource Impacts

Based on the Archeological and Geomorphological Reconnaissance Study conducted on Blackwater NWR (TRC Garrow Assoc. Inc. 2000), it has been determined that forest management activities would cause minimal to no negative impacts on cultural and historical resources. Very little direct evidence of prehistoric use of the refuge was documented, but based on existing data from the surrounding area, some probability predictions were made. The few forested areas of the refuge that were determined to have a high or moderate probability of containing archaeological artifacts are located at the headwaters of streams or waterways where

forest management activities would be severely limited because of hydrology and soil conditions. These areas along waterways and emergent wetlands are also regulated by the Maryland Critical Area Commission. The Critical Area regulations would prohibit any management within a 50' buffer, restrict activities out to 100', and may regulate activities out to 1,000' from these protected areas. The majority of the high probability sites are located along larger waterways in marsh habitats that would not be impacted by a forest management program.

Administration, staffing, infrastructure, law enforcement, and other needs

Current Staffing Needs

Refuge Complex Supervisory Forester (GS-12) . . . . . 1 FTE
Field Forester (GS-9) . . . . . 1 FTE
2 Forestry Technicians (GS-5/7) . . . . . 2 FTEs
Refuge Complex Fire Management Officer (GS-12) . . . . . 1 FTE

Most forest management prescriptions will be performed at a substantial expense to the Service, while some of the prescribed activities will result in the sale of forest products and a payment to the Service. For example, if all 2,800 acres proposed for Timber Stand Improvement are treated during the time period of this plan, and the going rate for this work is $75.00 per acre, it will cost the Service an estimated $210,000 over a 15-year period. The alternative to contracting this work out is to perform the work through “force account.” This would require the use of the Region 5 hydro-axe with shears for extended periods of time during the dry season, making it unavailable for use by other stations. This alternative is also not realistic due to the limitations of the hydro-axe for performing this type of work in these forest types. Another alternative would be to purchase an additional piece of equipment that was manufactured to perform highly selective work in fragile ecosystems. This could cost the Service as much as $300,000, but it could benefit multiple field stations. Purchasing a low ground pressure tracked land clearing machine (~$275,000) would greatly enhance site preparation, forest thinning, and hazardous fuel reduction capabililities.

Performing forest management activities in which the sale of forest products is a secondary objective will result in the service receiving fair market price for these products. Generally, these funds are pooled together in either regional or national pots. Through the submission of our timber receipts we will be able to draw from these funds to implement additional forest management prescriptions.

Alternative C. Maximum Public Use with No Habitat Management

Management Strategy

There would be no forest management program. Forested habitats will be altered or not altered through natural processes only, similar to the lack of forest management under the 1991 Station Management Plan, the 1984 Forest Management Plan, and the entire time since the inception of this refuge. No habitat improvement techniques would be implemented. Prescribed burning

would only be used as a tool to reduce fuel loading, protect facilities, and ensure employee and public safety both on and off refuge lands. Efforts to control forest insect pests and diseases would not be pursued. Populations of forest insect pests such as gypsy moths would be left to natural causes for control. All forests along with the abandoned agricultural lands would be left to natural succession. The existing infrastructure (roads) associated with management of this program would be abandoned and would not be maintained unless needed for public use and the protection of life and property. Therefore, the consequences of alternative C, no management, will have the same environmental consequences as alternative A,current management.

Physical Impacts

The physical impacts under this alternative will be no different than those illustrated under alternative A due to the fact that no forest management will occur in either alternative.

Biological Impacts

The impacts resulting from this alternative will be primarily of natural causes and will be no different than the consequences of alternative A.

Socioeconomic Impacts

Same as alternative A.

Cultural and Historical Resource Impacts

Since no forest management would be performed, there would be no impacts on cultural or historical resources or their protection.

Administration, staffing, infrastructure, law enforcement, and other needs

No additional staffing will be required to implement this alternative. The currently funded Forester position will be retained to perform inventory and monitoring activities as they relate to forested habitats.

Habitat Management—Cropland

Introduction

In relationship to the objectives and strategies necessary to fulfill refuge purpose(s), we base our cropland management proposals upon the principle of "Wildlife First," rather than on considerations that primarily are economically, historically, or sociologically driven, although these considerations may be affected by the program. As with any management program, there are numerous options, management techniques, and alternative ways of accomplishing the activity. The three CCP alternatives consider three different options for conducting the cropland management program (i.e., "force account," "contractual," and "cooperative"), as well as a proposal to eliminate cropland management.

Alternative A involves only Blackwater NWR, while alternatives B and C relate to both the Blackwater NWR and the proposed Nanticoke protection area. Cropland management is not being proposed for the Chesapeake Island Refuges.

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).

While 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.

Alternative A. Species–specific Management

Management Strategies

Approximately 640 acres of croplands would be managed for waterfowl and other wildlife purposes on Blackwater NWR only. Approximately 160 acres would be cultivated in corn and milo (sorghum), and approximately 480 acres would be planted in cool season grasses and forbs, consisting of ladino or crimson clover, annual rye grass, and buckwheat (over-seeded with winter wheat). Refuge staff, equipment, and operational dollars would be used to conduct the force-account program. The methods, crop rotations, best management practices, conservation tillage practices, and all other aspects of the cropland management program would be the same as in

alternative B, except that in alternative B, the corn and milo planting preferably would be done under contract, or planted by a cooperator(s) if funding was unavailable for contracting the work.

Physical Impacts

Impacts on the physical environment (water, soil, geology, hydrology, and air quality) would be minimal, although greater than in alternatives B or C. Only historical croplands, representing about 3 percent of the refuge's total acreage, would be cultivated, about 1 percent more than in alternative B. The main difference between alternatives A and B would be that approximately 220 acres of soils that are characterized as being poorly drained, and are not considered "prime agricultural soils," would be cultivated. Cultivating these 220 acres would be difficult or even impossible in wet years. Successful production on their marginal soils would occur on an average of once every 5 years. Soil compaction and siltation is these areas would be greater than on prime agricultural soils, but would continue to be mitigated by the best management practices described in alternative B. The actual methods, techniques, and cropland management practices in alternatives A and B would be the same, and the physical impacts on the environment would be almost identical, save for the exceptions noted above.

Biological Impacts

The effects on aquatic, wetland, and terrestrial habitats would be minimal. Again, only historical croplands would be cultivated. No new drainage systems would be created, and the actions used to minimize and mitigate runoff and erosion described in alternative B would result in very minor, if any, impacts on surrounding wetlands and aquatic systems. Once again, the major difference between alternatives A and B would be the cultivation of 220 acres of marginally productive cropland which, if restored to forested wetlands or moist soil management units, would produce greater benefits to the biological environment. Maintaining approximately 60 acres of these 220 acres in croplands, rather than converting them to historical woodlands, would isolate a couple of 50-acre forest tracts by fragmenting them (see alternative B.) Please note that grasslands are not a historical habitat component of Blackwater NWR and, therefore, would not be considered in a restoration scheme for converting croplands to this type of habitat. The overall impacts on the biological environment (aquatic habitats, wetlands, terrestrial habitats, and fish and wildlife populations) generally would be identical to alternative B, except for the differences noted above.

Socioeconomic Impacts

The only major difference between alternatives A and B would be the slightly negative socioeconomic impact associated with the options of "force account" vs. "contractual" or "cooperative" planting of crops. Alternative B would generate additional revenue in the local economy, paying farmers for planting these crops or share-cropping on a 75:25-percent ratio, rather than depending on paid refuge staff and Federal operational dollars to conduct the

program. Other socioeconomic impacts, as described in alternative B, would apply equally to alternative A.

Cultural and Historical Resource Impacts

The impacts on cultural and historical resources would be the same as described in alternative B.

Administration, staffing, infrastructure, law enforcement, and other needs

The "force account" management alternative would require approximately 325 staff days (1.25 FTEs @ $140/staff day) to plan and administer the cropland management program. Approximately $45,000 per year would be required for the procurement of seed, fertilizer, lime, herbicide, fuel, equipment maintenance, and aerial seeding contracts. Overall, this alternative would require an annual expenditure of less than $.01 per waterfowl use day. The infrastructure (cropland, dikes, drainage ditches, roads, and storage facilities) and equipment are now available; that is, it would not need to be procured, constructed, or created. See alternative C for a discussion of how retaining the cropland designation would avoid additional regulatory review, and benefit the future development or restoration of these lands.

Alternative B. Conservation Biology for Trust Species Diversity

Strategies for Blackwater NWR

A minimum of 420 acres of existing croplands (2 percent of the refuge's total acreage) would be managed annually to achieve refuge purposes and wildlife management objectives (a 33-percent reduction in the cropland management program described in alternative A).

Our **preferred option** would 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 would be left unharvested exclusively for wildlife utilization. Lands having Conservation Reserve Program or similar easements would be managed and maintained in accordance with NRCS guidelines and requirements. The planting of the corn and milo would be contracted each year on a competitive bid basis to a local farmer for a fixed price per acre, and would be left unharvested for use by waterfowl and other wildlife. Refuge staff, equipment, and operational dollars would be used to plant and cultivate the cool season grasses and forbs. Crop rotations would 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 would not be plowed under in the spring, but would 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 would these lands be cultivated and replanted to winter wheat or buckwheat, which later would be over-seeded back to ladino clover the following February (freezing in the

seed rather than planting with normal tillage). The wheat would be allowed to mature in early summer to provide food for passerines and other wildlife.

If sufficient funding for the preferred contractual and force account activities 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 proposed 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 preferred 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 would be planted and maintained by refuge staff around each of the field units. Runoff would be directed into existing impoundment systems prior to entering natural waterways. Only annual cropland management plans that utilize BMPs and integrated pest management would be developed and approved by NRCS prior to implementing actions. Conservation tillage and no-till farming practices would be widely utilized and preferred over conventional methods. While animal waste is readily available and would 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, would remain unharvested to be utilized by wintering waterfowl, Neotropical migrants (birds and butterflies), endangered species, and other wildlife. Standing crops, corn and milo, would only be manipulated (mowed or knocked down) after the waterfowl season to avoid conflicts with baiting laws. The unharvested corn crop would 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 would be closed to public use to ensure undisturbed availability and utilization. A special effort would 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 would 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 would be implemented to evaluate the program's contributions to refuge purposes on both areas. Adaptive management techniques would be applied on all refuge lands.

Physical Impacts

Impacts on the physical environment (water, soil, geology, hydrology, and air quality) would be minimal. Only historical croplands would be cultivated, representing less than 2 percent of Blackwater NWR's total acreage and 30 percent of the lands within the Nanticoke protection area (again, not all these lands would continue to be managed as croplands). Because fields are flat, with less than 2-percent slope, and have very stable soil types, they would be more resistant to erosion, siltation, and runoff (see chapter 3, "Affected Environment"). A major difference between alternative B and alternative A is that 220 acres of marginally productive and seasonally wet soils on Blackwater NWR will be removed from the cropland management program and restored. Similar actions would be taken on the Nanticoke protection area. Only soils considered as prime farmlands by NRCS and the U.S. Department of Agriculture, as described in the Farm Land Protection Act (Public Law 9798, Article 7, U.S.C. 4201), will be maintained in alternative B's cropland management program. These silt loam soils are not preferred for conversion to moist soil impoundments due to their permeability and sandy subsoils, which make water retention and management difficult, if not impossible.

All cropland fields would be bordered by filter strips and buffers that contain and filter runoff. Immediately adjacent impoundment systems, that are diked to separate them and croplands from the natural wetland systems, would contain, hold, and filter all runoff before it would enter natural wetlands and waterways. No additional ditches or canals would be constructed; however, the existing infrastructure would be maintained. The 3:1 cropland rotation, in the preferred option, would eliminate the need to apply ammonium nitrate on corn crops in most cases, since the clover crops produce sufficient natural nitrogen (approximately 110 units per acre per year). The use of no-till and conservation tillage methods and equipment would significantly minimize erosion and siltation. Corn or milo crops would be followed by wheat or buckwheat cover crops in the preferred option to bind and utilize excess nitrogen created by waterfowl feces and clover rotation schemes. Similar effects would be achieved by planting winter wheat in harvested soybean fields if the second option was utilized.

Herbicide applications would consist only of previously approved, least problematic, least harmful compounds available to do the job, in accordance with Integrated Pest Management Plans (IPM). Pesticides would not be used except in the rarest of situations, when pests exceed threshold levels and are certified by the Agricultural Extension Office and IPM agent.

Biological Impacts

Effects on aquatic, wetland, and terrestrial habitats would be minimal. Again, only historical croplands would be cultivated. No new drainage systems would be created, and the actions used to minimize and mitigate runoff and erosion described above would result in very minor, if any, impacts on surrounding wetlands and aquatic systems. The restoration of 220 acres of prior converted wetlands to moist soil management impoundments and forested wetlands on Blackwater NWR, and a currently unknown amount of acreage within the Nanticoke protection area, would greatly improve the utilization of these lands for wildlife. Approximately 60 acres on

Blackwater NWR would be reforested to provide connective travel corridors thus minimizing forest fragmentation on several isolated 50-acre tracts. Similar actions would be implemented on the Nanticoke protection area lands when opportunities were identified. Approximately 160 acres on Blackwater NWR and a currently unspecified amount in the Nanticoke protection area would be converted to moist soil management to benefit a diversity of waterbirds, shorebirds, and waterfowl (see the Moist Soil Management Program for further details).

The greatest impact of a cropland management program would be on wildlife populations, specifically wintering waterfowl, and to a lesser degree Neotropical migrants and endangered species. Cropland management has been used extensively on national wildlife refuges to provide food for migrating and wintering waterfowl and to lessen depredations on private cropland. Surveys at several refuges showed that about one-third of all feeding by waterfowl was on cultivated crops. Seventy-five percent of the geese and 30 percent of the ducks using national wildlife refuges in the Southwestern States were harbored on refuges where cropland management was practiced. Three million birds were maintained for several weeks in California on three small refuges totaling only 17,000 acres, where cropland management was practiced to minimize private cropland depredation (Givens, et al. 1964).

These are significant statistics relating to the contributions that croplands on refuges make to waterfowl management and the achievement of refuge purposes. Publications such as Reinecke, et al. (1989); McFarland, et al. (1966); Ringelman, et al. (1989); and others, have repeatedly validated the scientific importance of cropland management to waterfowl. The success of these cropland management programs lies in the relatively large body size of waterfowl, which enables them to store fat, protein, and minerals for later use. These reserves can then be mobilized for egg formation, migration, molt, or in times of food shortage. Although strategies for depositing and using nutrient reserves differ among species, and necessarily are dependent upon the seasonal availability of foods, cropland grains are among the most extensively exploited food resources (Ringelman 1990). Clutch size and perhaps nesting dates of mallards and Canada geese are thought to be directly related to the amount of reserves obtained on their wintering grounds. During breeding and molting periods, waterfowl require a balanced diet with a high protein content. Grain crops, most of which are not very high in protein, are seldom used during these periods. However, during fall, winter, and early spring, when vegetative foods make up a large part of the diet and energy producing carbohydrates (hot foods) are the main nutritional requirement, grain crops such as corn and milo are preferred forage.

The cropland management program, as practiced in these strategies, would also recognize the importance of high protein as a nutritional requirement during prebreeding and molting periods. Efforts would be made to make these crops available during the premolt and early migration periods to build and replenish protein. Ladino clover and buckwheat would be planted to provide sought after sources of protein, particularly for Canada and lesser snow geese.

Cropland grain is an abundant, high-energy food that can be quickly consumed by waterfowl (Ringelman 1990). The best indication of the nutritional quality of foods is given by an analysis of their chemical composition. The amount of gross energy, crude protein, fat, ash, fiber, and digestible carbohydrates (NFE or nitrogen-free extract) are indices to food value. However, since waterfowl use grains primarily as a high-energy food and supplement their diet with natural

foods to compensate for nutritional deficiencies (Ringelman 1990), the energy content of grains is the most commonly used basis for comparison. Unfortunately, energy content varies among varieties of the same grain, as well as by soil and environmental conditions.

Moreover, waterfowl cannot digest different grains with similar efficiencies. In recognition of this digestive efficiency, metabolizable energy, which is indicative of the energy actually derived from a food, is a better comparative measure than gross energy content. Agricultural foods (with the exception of soybeans) provide high levels of metabolizable energy. Corn and milo are planted because they produce the highest amounts of metabolized energy, 4.01 and 3.85 kcal/g, respectively, for Canada geese (values four to 10 times greater than some of the natural plants such as smartweed and pondweed) (Fredrickson, et al. 1988). It should be noted that these values, while indicative of fresh seeds, are not representative of grains underwater or exposed outdoors for an extended period. Under these conditions, energy value may decline rapidly. For example, rice will lose only 19 percent of its energy value after 90 days of flooding, but milo and corn will lose 42 percent and 50 percent, respectively, and soybeans will lose 86 percent of their energy content. Such losses underscore the need for well-timed manipulations to maintain food quality.

In this alternative, therefore, corn and milo crops would be held standing and unflooded until made available by mowing or knocking them down during post-hunting season periods. The intended purposes of reserving these crops would be (1) to provide sources of high energy foods to build fat reserves prior to migration, (2) to provide food resources on the refuge to minimize depredation of winter wheat crops on adjacent private lands, and (3) to minimize long distance travel to food during the coldest periods of the year. Flight is the most energetic requirement for waterfowl and by late January there are few areas left in the county where waterfowl have not already gleaned all waste grain thus necessitating long travel distances. For example, a 2.5-lb. mallard would require 3 days of foraging to replenish fat reserves following an 8-hour flight, if caloric intake were 480 kcal/day (the amount of intake from corn in an unharvested field) (Frederickson and Reid 1988). Refuge crops would be mowed or knocked down in strips at different intervals until the waterfowl migrated north to ensure a constant supply of fresh feed beginning in late January and continuing until mid-March. In this alternative, soybeans would be avoided, since they decompose rapidly when they shatter during the winter and are subsequently exposed to water and weather. Soybeans also can cause impaction in the esophagus, and contain digestive inhibitors that reduce the availability of protein and other nutrients.

To improve availability of standing crops prior to post-hunting season manipulation, corn and milo would be planted on a 35-inch row spacing to allow waterfowl to fly directly into the crop when severe weather events occur. For example, during major snow storms in December and January, prior to the corn or milo being mowed or knocked down, waterfowl will alight in the standing crops to feed.

The amount of acreage to be planted would be based both on studies of waterfowl base metabolism rates (BMR) and adaptive management practices developed after monitoring and evaluating cropland programs on Blackwater NWR for more than 65 years. Daily food consumption varies among species, individuals within species, and with energetic demands related to behavior and thermoregulation (Frederickson, et al. 1988). The average Canada goose will consume about 200g/day or about a half-pound, whereas large ducks will consume about

half that amount or ¼–pound/day (Ringelman 1990). At these rates and average needs for thermoregulation, 100 acres of corn (100 bushels/acre) would support 30,000 Canada geese for 40 days. Experience has demonstrated that except in very mild winters, no corn is left by planting 100 acres. Since grain is not always the food of choice and there are other foods available, 100 acres of corn is a reasonable amount to plant each year at Blackwater. The amount needed at the Nanticoke protection area would be evaluated over time and adapted to meet wildlife requirements.

Frederickson, et al. (1988) determined that because a variety of strategies exist within and among waterfowl species (wintering, migrating, breeding), not all individuals or species require similar food resources simultaneously. Thus, a diverse habitat base presented by this alternative would be the best logical approach to meet the various needs of waterfowl. Furthermore, when suitable food and cover are within daily foraging range, protection of required resources would be enhanced. Frederickson thus suggested that the optimum management strategy would be to provide many wetland types and food choices within the smallest radius to waterfowl concentrations as possible. Appropriate waterfowl management requires preservation, development, and manipulation of manmade and natural wetland complexes. Such an approach would provide nutritionally balanced diets for diverse waterfowl populations.

Management of refuge croplands consistent with the methods and techniques described above would also lessen crop depredation on private lands surrounding the refuge. This has particularly been true during the last four years when the AP Canada goose season has been closed and the birds were not threatened by hunting pressures. Winter wheat is particularly jeopardized in the late winter when most other food resources have been consumed. Timing the manipulation of standing corn and milo would keep geese on the refuge, away from area farmers' cash crops in late winter and early spring, when damage is the greatest.

Observations and censuses have demonstrated that many other resident and migratory bird species would also benefit from cropland management programs. In the summer, Eastern meadowlarks and several sparrow species use the clover fields. Since the winter wheat would remain unharvested and be left to mature, wild turkeys would use these fields as preferred nesting and brooding areas. Passerines seeking seeds or invertebrates would also heavily use the mature wheat. The eastern bluebird, in particular, seems to favor these areas during most of the year. Many species of raptors, including red-tailed hawks and kestrels, are often seen hunting in these areas. The once productive corn and milo fields would be left fallow throughout the summer to naturally succeed to warm season grasslands, which would be used for nesting and food by several Neotropical bird species.

Maintaining field borders would particularly benefit sparrow species, including song sparrows (*Melospiza melodia*), swamp sparrows (*Melospiza georgiana*), field sparrows (*Spizella pusilla*), chipping sparrows (*Spizella passerina*), white-throated sparrows (*Zonotrichia albicollis*), and savannah sparrows (*Passerculus sandwichensis*) (Marcus, et al. 2000). Fields with field borders contain approximately three times the sparrows than fields without borders.

Second only to its importance for waterfowl, the ladino clover would provide for a Lepidopteran spectacle. Literally millions of butterflies and skippers use these sweet clover fields throughout

the summer and during early fall migrations. When they are kept mowed, the clover fields are perpetually blooming. Likewise, the planting of buckwheat fields, if properly timed, can provide impressive habitat for migrating butterflies.

The Delmarva Fox Squirrel Recovery Team has repeatedly recognized the importance of cropland management programs for the recovery of the endangered Delmarva fox squirrel. One of the recommended strategies is to supplement natural food resources by planting high energy crops (corn and milo) in areas adjoining forested tracts. Croplands can also attract squirrels to areas such as roadways, where mortality can occur. When corn and milo are planted near roadways, a 100-foot buffer of ladino clover would be planted between the corn or milo and the roadway. This practice would greatly minimize the enticement for squirrels to cross the roadways since they would be reluctant to travel over these long open distances, being fearful of avian predators.

Socioeconomic Impacts

Blackwater NWR is the largest tourist attraction in Dorchester County. That attraction is based primarily on the abundance of waterfowl that tourists can readily observe, study, and photograph. Very few places provide the opportunity to enjoy these priority public uses like the refuge's Wildlife Drive. Two factors primarily facilitate those uses: the proper infrastructure, which allows visitors to travel along a confined corridor almost without disturbance to waterfowl; and, the juxtaposition of natural marshland habitats, moist soil management impoundments, and croplands in close proximity. Maintaining croplands would, therefore, significantly benefit the public, professional birders, and photographers, who have learned to schedule their visits when croplands are being manipulated and waterfowl abundance is at its peak prior to migration. The refuge's visitation and associated ecotourism contributes a reported $15,000,000 annually to the local economy.

As previously mentioned, another equally important socioeconomic impact of the cropland management program would be the reduction in private crop depredation by wintering waterfowl (and to some degree by white-tailed and sika deer). Also, since the cropland management program contributes to the overall health and abundance of waterfowl on and around the refuge, the local economy would greatly benefit from waterfowl hunting and the leasing of hunting rights on private lands. About 47,000 waterfowl hunters were reported for Maryland during our National Survey in 1996. Those hunters mostly utilized Maryland's Eastern Shore, and spent approximately $25,000,000 during their 209,000 days afield. Nationwide, waterfowl hunters spent almost $3 billion in 1996!

Croplands also are a threatened land cover type in Maryland. The American Farmland Trust completed a survey in 1997, and ranked croplands in the Mid-Atlantic Coastal Plain (principally in Delaware and Maryland) as ninth of the "Top 10 Most Threatened Agricultural Areas" in the country. From 1945 to 1970, the State lost an average of 55,000 acres per year, or about one-third of its agricultural land base, primarily to urban sprawl and development. Approximately 34,000 acres of agricultural lands have been converted to other uses in Dorchester County since

1959. In addition, the lower end of the county is rapidly losing agricultural fields to saltwater intrusion and sea-level rise. Each year, croplands are becoming more and more threatened. New programs, such as the Rural Legacy Program, are actually paying farmers to keep their lands in production. Land trust organizations are also paying farmers to enroll their farms in easements with protective covenants that keep the farmlands from being developed. The Farm Land Protection Act (PL 9798) requires Federal agencies to protect and preserve prime agricultural lands.

Another socioeconomic benefit would be the additional revenue generated by the contractual or cooperative farming aspects of the cropland management program. Under a strictly force-account program, the community would benefit only indirectly from the purchase of materials and supplies; whereas, under this alternative, farmers would also benefit from direct payments for services rendered, or, if the second option is chosen, by being able to cultivate land on a shared-crop basis of 75 percent for the farmer and 25 percent for the refuge.

The sociological aspects of cropland management programs are complex, and vary widely across geographic boundaries. In spite of the potential for managing refuge resources for a diverse public as well as for equally diverse wildlife, it is difficult to please all interest groups and individuals. People from urban backgrounds are less likely to appreciate or promote these programs than people from rural agrarian backgrounds. Realistically, few areas remain where protecting habitat alone is the only necessary management option. Most habitats are degraded, are far from natural, and are increasingly unable to support their historical abundance and diversity of fauna. Environmental education and interpretation focusing on refuge cropland management would address those issues.

Cultural and Historical Resource Impacts

We have determined that the cropland management program does not adversely impact cultural and historical resources. Archaeological investigations have determined that no cultural or historical sites will be impacted within the “plow zone” by normal cropland management practices.

Administration, staffing, infrastructure, law enforcement, and other needs

The preferred management alternative would require approximately 195 staff days (0.75 FTEs @ $140/staff day) and $18,000 per year for refuge staff to administer, plan, and conduct planting and maintenance of the 300 acres of cool season grasses and forbs and a few food plots on Blackwater NWR. Between $10,000 and $15,000 would also be required to contractually plant the 100 to 120 acres of corn and milo on Blackwater NWR. Overall, this alternative would require an annual expenditure of an average of 0.75 cents per waterfowl use day on the refuge. The infrastructure (cropland, dikes, drainage ditches, roads, and storage facilities) and equipment are currently available; that is, they would not need to be procured, constructed, or created. No new equipment or equipment replacement would be anticipated during the 15-year expected duration of this plan, since most equipment was replaced in 2001.

If the second option were chosen, approximately 300 acres of harvested soybeans would be no-till planted or aerially over-seeded in winter wheat or crimson clover. The wheat seed would be made available from Resource Management, Inc., at a minimal charge (second-year seed from Pioneer Seed Company). Approximately 45 staff days (0.10 FTEs @ $140/staff day) and $8,000 per year in operational funds would be required for refuge staff to plan and administer the cooperative farming effort, conduct planting, and manage a few food plots.

The initial costs for cropland management on the proposed Nanticoke protection area would be minimal, consisting of administrative costs to develop and monitor one or two cooperative farming permits. Upon obtaining sufficient acreage, we would develop a step-down management plan to evaluate and describe annual prescriptions and the costs necessary to implement a cropland management program. We expect the costs to implement this program on the proposed Nanticoke protection area would be equal to or less than the costs for the activities proposed for Blackwater NWR. See this section under alternative C for a discussion of how retaining the "cropland" designation would avoid additional regulatory review and would benefit the future development or restoration of these lands.

Alternative C. Maximum Public Use with No Habitat Management

Management Strategy

There would be no cropland management program on any portion of the Refuge Complex. Cultivating, mowing, and other agricultural activities would be eliminated on the existing 560 acres of cropland at Blackwater NWR and all cropland protected on the proposed Nanticoke protection area. Agricultural fields would be allowed to succeed naturally to native vegetation. The existing infrastructure (roads, ditches, etc.) associated with the management of this program would be abandoned and would not be maintained.

Physical Impacts

Alternative C would completely eliminate the very minimal and mitigated impacts in alternatives A and B on water quality, soils, and hydrology from agriculture. No herbicides would be used, and water quality would not be impacted by additional nitrates, potassium, or phosphorous associated with cropland management.

Biological Impacts

Not using cropland management would eliminate all of its impacts on aquatic and wetland habitats. During the 15-year projected duration of this plan, the most obvious change would impact terrestrial habitats. We would expect the 560 acres of crops, grasses, and forbs historically cultivated on Blackwater NWR to convert naturally to almost pure monotypic forest stands of

sweet gum and red maple, with a few interspersed loblolly pines. The same would be true for cropland in the proposed Nanticoke protection area.

Surveys have demonstrated that approximately 90 percent of all waterfowl on the refuge depend on its cropland management program for supplemental food to meet their nutritional requirements. Cropland that converted to sweet gum and red maple acreage would no longer sustain waterfowl, seriously affecting the body reserves they need to sustain life activities. Refuge goals for waterfowl would simply not be met. Unquestionably, the greatest consequence of eliminating cropland management would be the negative impacts on the abundance, diversity, and health of wildlife populations: specifically, wintering waterfowl and, to a lesser degree, Neotropical migrants and threatened or endangered species. (See alternative B for a more thorough discussion of waterfowl physiological requirements associated with cropland management.)

Waterfowl would have to expend much more energy searching for food; their physiological condition and reproduction would be adversely impacted; and, populations would be exposed to greater mortality by hunters. For example, Service agents observed commercially guided hunters in Kent County legally kill more than 1,000 Canada geese from one blind, in one day, during a winter storm that had buried all but one small patch of winter wheat atop a wind-swept field. Present-day waterfowl have lost the instinct to migrate further south to avoid such situations. In times of severe weather or physiological stress, they simply remain in Maryland. (See the discussion about hunting impacts in "Socioeconomic Impacts," below.)

The contributions of the program to resident species and other species described in alternative B would likely be compromised or lost if cropland management were eliminated. Those species might find other locations for food and sanctuary, but, in many cases, such areas no longer exist outside the refuge. Urban sprawl and development, commercial forestry, "clean" farming, and other activities on private lands have eliminated those habitats. The Delmarva fox squirrel is a prime example of the loss of forest lands driving an endangered species to depend increasingly on agriculture for survival.

With the exception of forest regeneration on approximately 60 acres, converting the remaining 500 acres of existing cropland on Blackwater NWR to forest land would not significantly benefit FIDs or the endangered Delmarva fox squirrel. As previously mentioned, the carrying capacities of existing forest lands to support Delmarva fox squirrels are enhanced by the recommended planting of supplemental foods, such as corn and milo, along woodland borders. Please note, as an example of the need to maintain croplands, the Delmarva Fox Squirrel Recovery Team recommended restoring row crops to converted agricultural fields on Eastern Neck NWR. Furthermore, because these particular lands on Blackwater NWR are separated physically from the refuge's existing woodlands by roadways, they would not contribute to enlarging contiguously forested cores or providing the life requirements of the FIDs of concern. The conversion of cropland to forest within the proposed Nanticoke protection area would contribute to the enlargement of contiguously forested cores and thus benefit forest interior dwelling birds and endangered species, but at the expense of waterfowl and other migratory birds such as the sparrows mentioned in alternative B.

Socioeconomic Impacts

The elimination of the cropland program would significantly reduce the number and diversity of waterfowl and other wildlife using these habitats. In turn, the public would be afforded significantly fewer opportunities for wildlife observation and photography. We suspect that visitation to Blackwater NWR, Dorchester County's largest tourist attraction, would be adversely impacted; the revenue associated with refuge ecotourism would decline accordingly.

We would expect crop depredation on private land to significantly increase. With less food on the refuge, hungry waterfowl would assuredly depredate local crops. The impacts of Canada geese and snow geese in particular on crops have been well documented.

As noted above, waterfowl would be forced to feed for longer periods of time outside the sanctuary of the refuge where they could fall prey more easily to hunters. Selecting this option anytime in the next 5 years would produce the worst case scenario for the declining population of AP Canada geese, because the hunting season has been closed since 1996. Eliminating croplands that waterfowl use not only for food but for sanctuary on the refuge would force the birds into much more jeopardy.

This alternative would also contribute to the serious loss of croplands in Dorchester County, as described in alternative B. It would take "prime farmland" out of production forever, and totally eliminate any economic contributions of these lands to the local economy. As the experience at Eastern Neck NWR demonstrated, if the cropland were allowed to succeed to sweet gum and red maple, it would be almost impossible to obtain the permits required to convert them back to productive croplands.

Cultural and Historical Resource Impacts

While this alternative would have no direct influence on cultural or historical resources and their protection, it would make future archaeological investigations more difficult and costly. It is certainly more feasible logistically and economically to conduct surveys in agricultural fields than in sweet gum, red maple, and green briar thickets.

Administration, staffing, infrastructure, law enforcement, and other needs

This alternative would eliminate the need for the expenditure of any refuge operational dollars for staff and materials or contractual services.

One of the most serious impacts of allowing prior converted wetlands to naturally convert to forested wetlands would be in the inability to obtain regulatory approval to subsequently convert these habitats to other management uses (moist soil units, facility operations, public use areas, infrastructures, etc.). With few exceptions, any future development of infrastructure would be restricted to existing croplands, because they are the only lands that have any regulatory flexibility; almost all other areas are designated wetlands.

Regulatory agencies have classified most of the croplands on Blackwater NWR and within the Nanticoke protection area as prior converted wetlands. Accordingly, certain types of development are approved under general permits, which greatly facilitate management actions to convert or restore these areas to other uses noted above. Unless these areas are cultivated once every 5 years, this regulatory advantage would be lost, and, in most cases, future development activity would be prohibited. Therefore, any future infrastructure development would be limited to the existing headquarters and maintenance areas if alternative C were selected.

Habitat Management—Moist Soil

Introduction

The consequences of moist soil management are evaluated for Blackwater NWR and the proposed Nanticoke protection area. We would not practice moist soil management on other units of the Refuge Complex.

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 over 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, there is 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.

Alternative A. Species–specific Management

Management Strategies

Moist soil management would be used only on Blackwater NWR. Approximately 370 acres of existing moist soil management impoundments would be managed for waterfowl and other wildlife purposes, using the same type of water management techniques, timing, and methods described in alternative B. The existing infrastructure would be rehabilitated but not expanded (i.e., dikes would be resloped, water control structures would be replaced, woody vegetation controlled, etc.). For Blackwater NWR, the main difference between alternatives A and B would be the conversion and restoration of approximately 90 acres of prior converted croplands in alternative A to moist soil management impoundments in alternative B. (See chapter 3, "Affected Environment," for a more thorough description of the moist soil management program and associated infrastructure.) Please note, the construction, rehabilitation, and management of these existing impoundments has previously been subjected to NEPA and public involvement, particularly in 1990, when the refuge's entire moist soil management system was rehabilitated.

Physical Impacts

The impact of the continued management of these moist soil impoundments on the physical environment (water, soil, geology and hydrology, and air quality) of Blackwater NWR would be minimal. The infrastructure is already in place and stabilized, and no new construction would be required. Annual maintenance, including mowing and the replacement of gravel on levee surfaces, would not impact physical resources. Cyclical, less frequent maintenance activities, such as replacing water control structures, cleaning the ditch and water distribution system, and occasionally resloping the levee would temporarily disturb the soil, as would certain types of manipulation within the impoundments, such as discing to control woody vegetation and set back succession. Water quality in the water distribution systems would be temporarily affected, but these waters would be prohibited from entering the natural wetland ecosystems by the primary outlet water control structures.

The principle effect of the management of the system on the physical environment would be the beneficial effects on water quality and storm water runoff associated with the system's filtration and water retention capabilities. Most of the refuge's ditches would be directed to flow into the moist soil impoundments, where water quality would be improved before timely and controlled discharge into the natural wetlands. This program and its associated infrastructure would represent less than 1.5 percent of the entire refuge acreage.

Biological Impacts

The effects on natural aquatic, wetland, and terrestrial habitats would be minimal. Again, only existing moist soil management units on Blackwater NWR would be managed. The infrastructure would not be expanded, only maintained. The greatest impact would be on wetland-dependent wildlife, particularly waterfowl and shorebirds, and their food resources. The effects on biological resources would be very similar to the consequences described in alternative B. One important exception would be 25 percent more highly productive wetland habitat available to wetland-dependent species in alternative B.

Simply put, waterfowl conservation is habitat management; and that, in turn, is mainly plant management. Waterfowl require water. Even more they require plants; not just any plants, but specific species. The moist soil management program would provide the moisture regimes necessary to grow the plants, and the ability to provide sources of fresh water to flood these plants, a commodity that is increasingly rare on Blackwater NWR. Some of the most desirable waterfowl foods are annuals, which cannot maintain themselves on permanently flooded sites. They require moist ground to grow and produce good seed yields and invertebrate populations. Later, these food resources must be flooded to be attractive to waterfowl and shorebirds. Sometimes Nature provides the proper sequence of conditions through summer drought, fall rains, and flooding. But Nature more often than not accomplishes the least when the most is needed. That is when the moist soil management program would contribute most significantly to the overall abundance and diversity of waterfowl, shorebirds, and other wetland-dependent wildlife.

Socioeconomic Impacts

Impacts on the socioeconomic environment would be similar to those described in alternative B.

Cultural and Historical Resource Impacts

The management of the existing moist soil management impoundments would not adversely impact cultural and historical resources. Prior to construction of the original associated infrastructure, archaeological and historical surveys were conducted and "no effect" determinations were provided by the Regional Historical Preservation Officer with the concurrence of the State Historical Preservation Officer.

Administration, staffing, infrastructure, law enforcement, and other needs

Approximately 25 miles of water delivery ditches, 53 water control structures, 4,000 linear feet of water distribution lines, 4 wells, and 11 miles of dikes (levees) would be required to manage 25 moist soil impoundments totaling 370 acres. The combined replacement costs of the existing infrastructure in this alternative would be approximately $18 million.

Approximately 400 staff days per year would be required to conduct the moist soil management program (i.e., develop water level management plans and annual programs, manage water levels, conduct plant and invertebrate surveys, maintain the infrastructure, control undesirable vegetation, set back succession, etc.). Based on 1 percent of the replacement cost (other agencies advocate 3 percent), approximately $180,000 would be required annually to maintain the infrastructure in accordance with Service standards. The current infrastructure would need a significant amount of maintenance immediately as noted in the attached list of Maintenance Management System projects.

Alternative B. Conservation Biology for Trust Species Diversity

Strategies for Blackwater NWR

A minimum of 460 acres of moist soil management impoundments would be annually managed to achieve refuge purposes and wildlife management objectives (a 25-percent increase in the program described in alternative A). An additional 90 acres of existing prior converted croplands would 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 would 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 would 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, would be installed to better facilitate drawdown and flooding. Three additional water control structures would be installed between Pools 3A-3B, 3B-3C, and 5A-5B. In the Pool 4 system, the water control supply structure would be replaced and a new pumping and delivery station would be install. The main river dike around Pools 3 and 5 would be resloped and rip-rapped on the marsh side to prevent erosion.

Strategies for the proposed Nanticoke protection area

It is currently impossible to determine the exact acreage that would be included in a moist soil management program, but it is certain that moist soil management would be desirable and practiced on new additions to the Refuge System. It is estimated that moist soil management would be practiced on 2 percent, or less, of the entire refuge acreage. Moist soil management impoundments would 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, would attempt to mimic natural conditions with drawdowns in the spring and reflooding in the fall. Drawdowns would typically occur between mid-March and early June, depending on the wildlife objectives and plant and invertebrate response desired. Drawdowns would be staggered among moist soil management units. All drawdowns would be completed by mid-June and pool bottoms would be maintained as moist as conditions would 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 would be monitored and recorded weekly during the growing season and biweekly during periods of flooding. Exact water level management protocols would be described in an Annual Water Management Program, and would consider bird migration phenology. Vegetation transects would 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 would 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, would occur in September. Optimum water depths of 6 to 12 inches would be maintained throughout the winter season.

The general objective would 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 would not be used for flooding and

moist soil management purposes due to the high salinity that would kill the soil and the fresh water vegetation. Rejuvenation of the seed bed and control of "undesirable" species would be required. Occasionally, chemical control would be necessary to combat invasive species such as Phragmites and purple loosestrife, but mechanical control would be the preferred method of control.

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

Physical Impacts

Impacts on the overall physical environment (water, soil, geology and hydrology, and air quality) would be minimal on both refuge areas. With the proposed 90-acre addition, the program and associated infrastructure would represent less than 2 percent of the entire refuge acreage on Blackwater NWR and the proposed Nanticoke protection area. Approximately 370 acres of moist soil management units have been constructed in Blackwater's 65-year history, and their development and management have previously been subjected to the required NEPA analysis and public input. These existing areas would continue to contribute to the existing health of the physical environment by serving as additional filters before runoff from the surrounding croplands and uplands could enter the natural wetlands. Currently, the majority of drainage systems on Blackwater NWR discharge into the impoundments, not directly into the river wetlands and marshes. (See alternative A for a discussion of normal maintenance activities on the physical environment.)

Impacts associated with the construction of the additional 90 acres of moist soil management units on Blackwater NWR and the future infrastructure on the proposed Nanticoke protection area would be short lived and mitigated by proper timing and use of BMPs (Best Management Practices) for construction. Virtually all problems with siltation, erosion, and degraded water quality would be eliminated by proper use of silt fences, grassy waterways, proper and timely revegetation of exposed soils, etc. Construction would be regulated by specific provisions in sediment and erosion plans and permits administered by Maryland's Nontidal Wetlands Administration and Dorchester County Highway Administration. All construction would be conducted by refuge staff with refuge equipment, and take place on prior converted croplands that are currently being disced and manipulated annually. If anything, the conversion to moist soil management would result in fewer impacts on the physical environment than current management practices. The new units would be constructed on soils that are recommended for these engineering and management purposes (i.e., heavy clay soils that hold water, are not erosion-prone, and have a very gentle or no slope). Removing these lands from cropland management would avoid existing problems with soil compaction and annual disturbance of native vegetation. "The restoration of disturbed wetlands would have its greatest potential in areas of marginal agricultural lands." (Frederickson, et al. 1988).

It should be noted that water, a principle ingredient in the science and practice of moist soil management, is of little value to waterfowl if its level is constantly stable or changes at the wrong time. Water must be managed if it is to be most useful to ducks and geese. It must be "off" and "on" at the right time (Green, et al. 1964). Water-level manipulation within these impounded systems would be practiced as described in the management strategies in chapter 2, "Alternatives," or in the "strategies" above, and then fine-tuned by biologists to produce the best results.

Biological Impacts

The effects on natural aquatic, wetland, and terrestrial habitats would be minimal. Again, only historical cropland acreage would be impacted by the proposed expansion and initiation of moist soil management. The existing croplands that would be recommended for conversion to moist soil management are all seasonally wet, subject to flooding from even the slightest rainfall, and produce only a modest cultivated crop once every 5 years on the average. Conversion to moist soil management would mimic the natural functions of these historical, prior converted wetlands, and would contribute significantly more to a wider diversity of wetland-dependent species. The greatest impact of a moist soil management program, conducted as described above, would be on wildlife populations, specifically, wintering waterfowl and shorebirds, and on the vegetation and invertebrate populations these species use for food within these management units.

The timing of drawdowns would have an important influence on the composition and production of moist soil plants. For example, an early drawdown has been shown to produce more red-root flat sedge in highly organic soils, whereas later drawdowns produce more Walter's millet. In mineral soils, early drawdowns would result in more smartweed species, whereas later drawdowns would result in more barnyard millet (refuge files). Other factors, such as seed banks, soil types, soil temperatures, soil moisture levels, soil and water salinities, day length, and residual herbicides would also influence the composition and abundance of developing vegetation. The slow drawdown regime described in this alternative would be preferred because it creates conditions favorable for moist soil plant germination and establishment. For example, slow drawdowns on experimental plots result in seed yields of 700 pounds per acre, whereas fast drawdowns on similar units resulted in yields of only 50 pounds per acre (Fredrickson 1991). Furthermore, slow drawdowns would provide shallow water over a longer period, ensuring optimum foraging conditions for wildlife.

When water is discharged slowly from a unit, invertebrates would be trapped and become readily available to birds foraging along the edge or in shallow water zones. The management of moist soil management units would promote invertebrate production, which would provide the critical protein-rich food resources required by pre-breeding and breeding female ducks, molting ducks, newly hatched waterfowl, and shorebirds. The vast majority of wetland-dependent wildlife species require shallow water for foraging (Frederickson 1991).

Slow drawdowns would therefore be recommended to enhance the duration and diversity of bird use. Creating a situation in which the optimum foraging depths are available for the longest

period would provide for the efficient use of food resources, particularly invertebrate resources. The most effective use of invertebrate foods by wetland birds occurs when drawdowns to promote plant growth are scheduled to match key periods of migratory movement in spring. By varying drawdown dates among units, the productivity of each unit would be maintained and resources would be provided for longer periods.

The contributions of this management program to waterfowl and shorebirds would be significant. Habitat for wintering waterfowl and shorebirds is critical, far more important than most people realize. Winter is the time when waterfowl and shorebirds form pair bonds and recharge body reserves in preparation for spring migration and breeding. If their bodies are not adequately recharged by the time these species arrive on their breeding grounds, their reproductive success would be diminished. To maintain adequate populations, waterbird species must winter over in good condition. Adequate quality habitat is therefore paramount for proper conditioning on the wintering grounds. It deserves repeating that the refuge's natural marshes and wetlands alone cannot this maintain that quality, due to the significant amount of marsh loss and degradation.

Waterfowl and shorebirds undergo processes each year (molt, migration, reproduction, etc.) that elevate their energy requirements and other nutritional needs. Moist soil management programs help meet those needs (Frederickson, et al. 1988). For example, protein-rich foods are essential for waterfowl and shorebirds during egg laying, migration, and molt. The percentage of protein composition of some of the more common invertebrates in moist soil impoundments, such as water boatmen, back swimmers, midges, and amphipods, ranges from 50 percent to more than 70 percent, while the seeds of preferred plants, such as smartweed and fall panicum, are only 12 percent protein. This alternative, therefore, would use management schemes based on the migration, wintering, and breeding phenology of wildlife species and their food requirements to maximize use of habitat and available funds.

Many species of plants satisfy the nutritional requirements and provide suitable habitat for waterfowl and other wildlife throughout the year. Until recently, the seeds of only a few moist soil plants were recognized as valuable food sources for wildlife, but evidence now suggests that many plants provide essential nutrients and energy. Esophageal samples obtained from ducks that fed in moist soil impoundments have shown that soft seeds, such as crabgrass, panic grass, and beggar-ticks, are eaten readily when available. Often these naturally occurring seeds, which are not generally recognized as important foods for ducks by the public, have higher overall nutritive qualities than many of the cereal grains. However, it cannot be emphasized enough that availability is the key to successful utilization.

Frederickson, et al. (1982) note that in middle and southern latitudes, cropland management is an integral part of wildlife and waterfowl management. When weather is favorable and management is intensive, more food per unit area is consistently provided by croplands than by naturally occurring vegetation. Croplands are particularly important in providing high-energy foods (corn and milo) for large concentrations of waterfowl during winter, and high protein foods (clover and buckwheat, for example) following and preceding migration. However, while the grains produced from corn and milo are most suitable for the larger species of waterfowl, primarily geese, mallards, black ducks, pintails, and a few others, they do not contribute to the requirements of shorebirds and many other wetland-dependent species.

Croplands also fail to provide adequate shelter for many species of waterfowl and other wildlife, and grains alone, while important, do not satisfy many of the seasonal nutritive requirements because many essential amino acids are lacking. Where row crops, such as corn and milo, are produced by sharecroppers on public lands, typically much of the grain is removed as the tenant's share (see the section on cropland management for further information). Moist soil management is, therefore, an important component of wildlife management, and has advantages and disadvantages when compared to other forms of management and natural systems.

For example, adverse weather would have little effect on the production of naturally occurring plants because a diverse natural flora includes species that produce well under a variety of conditions. Different species or groups of plants are adapted to different climatic conditions and site characteristics, such as specific water depths or degree of soil saturation. For example, water-tolerant or wetland-adapted plants such as smartweed, barnyard grass, and spikerush are productive during wet years; beggar-ticks are productive on drier sites; and crabgrass and panic grass do well under more intermediate moisture conditions. Because naturally occurring plants often are productive despite weather conditions, failures to produce food resources are rare in moist soil management as long as the soil remains moist. Drought conditions, routinely experienced at Blackwater NWR, significantly impact many of the existing moist soil units, because their mineral soil content (a product of being planted in croplands for many years) is high. Mineral soils dry out quickly, and, when drought conditions prevail, the germination of favorable moist soil plants will not occur. When this happens, undesirable species, such as fleabane and cocklebur, flourish. Drought also can adversely affect moist soil management by eliminating the opportunity to flood these natural food sources in the fall.

At Blackwater NWR, reflooding has often been delayed because of drought until these areas are of little use to waterfowl and other wetland-dependent wildlife. Another major drawback in moist soil management is the resulting unavailability of moist soil plants, their seeds, and invertebrates during long periods of freezing weather when impoundments are covered with impenetrable ice. When these conditions exist, waterfowl most often turn to the croplands to meet their needs.

It should be noted that moist soil management units periodically require manipulation and rejuvenation (Frederickson, et al. 1982). Without manipulation, these wetlands would shift rapidly to “undesirable” species and often would be colonized by invasives and exotics. These undesirable species would quickly shift diverse floral systems toward monocultures, have minimum values for wetland wildlife, and out-compete plants with greater value (Frederickson 1991). Mechanical manipulation (mowing, discing, flooding, burning, etc.) would be used to set back succession, reduce monocultures, diversify monotypic plant communities with undesirable characteristics, reduce woody invasion in moist soil areas, and modify vegetative structure. Occasionally, low impact herbicides, such as Rodeo, would be used to control exotic species, such as Phragmites and purple loosestrife, but only after other means of control have failed.

Frederickson, et al. (1988) determine that, because a variety of strategies exist within and among waterfowl species (wintering, migrating, breeding), not all individuals or species require similar food resources simultaneously. Thus, a diverse habitat base is a logical approach to meeting the various needs of waterfowl. Furthermore, when suitable food and cover lie within daily foraging range, the protection of required resources is enhanced, and energy reserves are maintained and

not lost on long flights searching for foods. Thus, Frederickson suggests that the optimum management strategy is to provide as many wetland types and food choices within the smallest radius to waterfowl concentrations as possible. Appropriate waterfowl management thus requires the preservation, development, and manipulation of man-made and natural complexes. Alternative B, more than either of the others, recognizes this importance by recommending the management of the three most important components known to waterfowl conservationists: croplands, moist soil impoundments, and natural marshlands, all extremely close to each other. Such an approach provides nutritionally balanced diets for diverse waterfowl populations.

"Water off and water on the land makes possible the planned production of valuable waterfowl and shorebird foods, facilitates the control of noxious plants, creates nesting and brood habitat, and contributes to the recreational potential of the waterfowl resource. It is an economical means of improving on Nature, and increasing the productivity of habitat for waterfowl." (Green 1964) In short, it is a way to grow two where only one grew before. In these days of diminished habitat, that is important.

These moist soil management units would be expected to provide important food resources to over 90 percent of the waterfowl that use these refuges. In addition, the resultant increase in wetland acreage and management of moist soil management units would also benefit many wetland-dependent species other than waterfowl, including wading birds, raptors, mammals, amphibians, and reptiles. Fish populations would become established in the ditches and water supply systems that hold permanent water, thereby providing food resources for the many herons, egrets, and other species of wading birds. Terns would also use these food resources. Raptors, particularly Northern harriers, would be attracted to the dikes and levees for the small mammals that winter in the grasses. Kestrels would likewise benefit from the "edge" effects that the dikes would produce. Larger raptors, such as bald and golden eagles, would be attracted to feed on the waterfowl during the winter. Muskrats and other mammals such as raccoons and red foxes, would use the dike systems for shelter and travel corridors.

Socioeconomic Impacts

Blackwater NWR is the largest tourist attraction in Dorchester County, generating a reported $15 million in ecotourism yearly. This attraction is based primarily on the abundance of waterfowl that tourists can readily observe, study, and photograph. Very few places provide the opportunity to enjoy these priority public uses like the refuge's Wildlife Drive. These uses are facilitated for the most part by two factors; the proper infrastructure that allows visitors to travel along a confined corridor almost disturbance free to waterfowl, and the juxtaposition of natural marshland habitats, moist soil management impoundments, and croplands in close proximity to these viewing areas. The maintenance of moist soil management is therefore a significant benefit to the public, professional birders, and photographers who have learned to schedule visitation to times when impoundments are flooded and wildlife abundance is at its peak.

Since the moist soil management program contributes to the overall health and abundance of waterfowl on and surrounding the refuge, the local economy is greatly benefitted by waterfowl

hunting and the leasing of hunting rights on private lands. (See Croplands Management Program for benefits to hunting and economic contributions.)

Like croplands management, the sociological aspects of moist soil management programs are complex, and vary widely across geographic boundaries. In spite of the potential of managing for a diverse public and equally diverse populations of wildlife, it is impossible to please all interest groups and individuals. As noted in other sections, some object to management in any form, and it is difficult to argue against the pursuit of natural values. Realistically, there are few remaining areas where protection alone of the habitat is the only necessary management option. The majority of habitats are degraded, are far from natural, and have the growing inability to support the historical abundance and diversity of fauna that is necessary and expected. These concerns and issues would be addressed in environmental education and interpretation programs about the refuge's moist soil management program.

It should be noted that another sociological benefit to society is knowing that there are still places available where wild creatures can remain wild and free with their life needs properly met. Like the aesthetic benefits of watching a flock of 20,000 waterfowl envelop a setting sun, these benefits are impossible to evaluate for they are different in every person. But for those who find it difficult to live without knowing that such wild places exist, management programs such as those associated with the moist soil management provide a critical link to the resource that in many places is no longer attainable.

Cultural and Historical Resource Impacts

The proposed moist soil management program would not adversely impact cultural and historical resources. Archaeological studies and investigations have verified that no cultural or historical sites would be impacted within the proposed new infrastructure construction zones.

Administration, staffing, infrastructure, law enforcement, and other needs

Initial development of moist soil management impoundments would be expensive, and certainly more so if construction were contracted to private companies rather than accomplished "force account" with refuge staff and Service equipment. Dike construction, procurement and installation of water-control structures, seeding slopes, graveling dike surfaces, and the future maintenance and management would be particularly costly. The infrastructure associated with this alternative would have a real property replacement value of $18,500,000. We estimate the cost for the initial construction of the infrastructure associated with the new 90 acres of moist soil units, using force account construction (see "Management Strategies"), at approximately $90,000. Annual maintenance cost to maintain the required infrastructure in accordance with Service standards (using the 3 percent of replacement cost rule) would be approximately $185,000 each year for all 460 acres. The improvements noted in the management strategies, such as the new pumping stations, are shown in the attached list of maintenance management and refuge operational needs.

The dynamic nature of moist soil management would demand that the manager have a special expertise, and require that he or she regularly inspect each unit to ensure proper monitoring of the system. The manager must understand the interplay between wildlife and ecosystems, and spend the time required on each moist soil area to make manipulations when needed. Approximately 450 staff days would be required for annual management and adaptive management research needed to properly evaluate and fine-tune the program.

Another cost consideration for managing moist soil units at Blackwater would be the significant amount of pumping necessary to dewater and flood moist soil units. Several of the impoundments in the Pool 1, 4, and 5 complex are actually below sea level, requiring pumping to dewater these units. A variety of pumps, costing approximately $250,000, plus approximately $2,000 a year in fuel, would be required. Since rainfall and runoff provide the primary sources of fresh water, the two existing wells would be maintained and used in drought emergencies.

Man-made wetland habitats are only as good as the design, construction characteristics of the impoundment, and soil types. Levees would be constructed that are large enough to support equipment capable of mowing woody growth, and wide enough to alleviate problems with burrowing muskrats. Ideally, the levees would be approximately 12 feet on top, with 5:1 slopes for ease in mowing and better stability against erosion. The actual width and height would depend on the land contours and depth of flooding, but most dike tops would not be greater than 4 feet above mean sea level. Interior levees would be constructed on contours, generally a 15-cm contour interval. Several types of water control structures would be installed, including the conventional “stop-log” and “screw-gate” structures.

Alternative C. Maximum Public Use with No Habitat Management

Management Strategies

There would be no moist soil management program. Water control structures would be opened, abandoned, and allowed to deteriorate over time. There would be no manipulation of water levels, no attempt would be made to keep saltwater out of the freshwater impoundments, and the existing 370 acres would be allowed to succeed naturally to native vegetation. The existing infrastructure (levees, ditches, wells, etc.) would be abandoned and would not be maintained. Ditches would be allowed to silt in. Associated management actions such as vegetative transects, water quality and chemistry monitoring, and invertebrate population surveys would not be conducted. Actions to control “undesirable” species, invasives, and exotics would not be performed. The only levee that would be maintained would be the main river dike that serves as the Wildlife Drive. However, this structure would not be used for wildlife and water management purposes, but solely for public use activities.

Physical Impacts

Although very minimal and mitigated, impacts on water quality, soils, and hydrology in alternatives A and B from soil disturbance, siltation, water manipulation, levee construction, water control structure installation, etc. would be completely eliminated in this alternative. No herbicides would be used. Drainage, via the ditch systems, would continue for a number of years until the ditches silted completely in. The quality of runoff entering directly into the natural wetlands would therefore be less under this alternative because of the elimination of the filtration effects of these impoundments.

The greatest impact on the physical environment would be the loss of these freshwater habitats. Freshwater is at a premium on Blackwater as sea-level rise and the attendant saltwater intrusion continue to destroy historical freshwater habitats.

Biological Impacts

This alternative would eliminate all impacts on aquatic and wetland habitats from the associated activities and management practices. The most obvious predicted change for the majority of the acreage would be the conversion from annual plants to almost pure monotypic forest stands of stunted sweet gum and red maple, with loblolly pines on the old dike surfaces. The Pool 1, 4, and 5 units that are below sea level would flood with brackish water averaging 10 to 12 ppt (parts per thousand) salt, killing all the freshwater-dependent plants, invertebrates, amphibians, and reptiles. The mineral soils in these areas and even on some of the adjoining higher sites would uptake the salt quickly, becoming sterilized. Most likely these areas would simply revert to open water like much of the open natural marsh. A few of the higher moist soil management sites would eventually convert to hardwood and loblolly pine forests over time.

Unquestionably, the greatest impact of eliminating the moist soil management program would be the negative effects on the abundance, diversity, and health of wildlife populations, specifically wintering waterfowl and shorebirds. Over 60 species of birds and mammals have responded positively to management of these areas in moist soil management (Frederickson, et al. 1982). They would be displaced and lose the food resources these areas provide. The conversion of the existing 370 acres of moist soil impoundments to sweet gum and red maple saplings, or even to hardwood and loblolly pine forests, would in no way make the same contribution to the refuge's primary mission and purpose as when these acres would be maintained as highly productive wetlands. Surveys have demonstrated that approximately 90 percent of all waterfowl on Blackwater NWR depend on the moist soil management program to meet their nutritional requirements. New information is also becoming available that shows these areas also contribute substantially to migrating shorebirds under the proper water management regimes. The amount of body reserves needed to sustain life activities (migration, molting, breeding, etc.) would be seriously affected. (See alternative B for a more thorough discussion of waterfowl physiological requirements associated with moist soil management.) Refuge purposes and objectives would simply not be met, nor would the objectives of the Atlantic Coast Joint Venture, the Canada Goose Management Plan for Maryland, or the Chesapeake Bay Waterfowl Management Plan.

The contributions of the program to resident and other migratory birds, mammals, and other species described in alternative B would likely be compromised or lost if the program were eliminated. These species might find other locations for food and sanctuary, but in many cases, these areas no longer exist outside the refuge, and their needs within the refuge are adversely affected by natural wetland loss and degradation. Urban sprawl and development, commercial forestry, "clean" farming, and other activities on private lands have eliminated these habitats.

The conversion of an estimated 300 of the 370 acres to some form of forest land would not significantly benefit FIDs or the endangered Delmarva fox squirrel. These particular lands are separated physically from the refuge's existing woodlands by roadways, and therefore would not contribute to the enlargement of contiguously forested cores and the life requirements of the FIDs of concern.

Socioeconomic Impacts

While this alternative would immediately abandon $18 million worth of infrastructure, the elimination of this type of active management would be approved and promoted by some people as a way back to nature and a way to achieve restoration of the biological integrity of these lands and waters to a time and period before man's influence. Other people would heatedly oppose the elimination of the program because of the adverse effects on wildlife and refuge purposes, and the waste of government funds that already have been invested.

Eliminating management would unquestionably reduce the number and diversity of waterfowl and other wildlife using these habitats. In turn, the public would be afforded significantly fewer opportunities for wildlife observation, study, and photography. We expect visitation to the refuge, Dorchester County's largest tourist attraction, to be adversely impacted. Accordingly, revenue associated with refuge ecotourism would decline significantly.

With no moist soil or cropland management, private land crop depredation would be expected to significantly increase. With little food on the refuge, hungry waterfowl would assuredly depredate private crops. It has repeatedly been well demonstrated and documented that particularly Canada geese and snow geese would impact private croplands.

As noted in the cropland management program, waterfowl would be forced to feed for longer periods of time outside the sanctuary of the refuge where they could fall more easily to the hunter's gun. Selecting this option anytime in the near future (next 5 years) would produce the worst case scenario for the declining population of AP Canada geese because the hunting season has been closed since 1996. These birds would be drawn to the gun much more readily than anytime in the past.

Another significant socioeconomic consideration would be that once these lands converted to "natural wetlands," future management personnel would not be able to reverse the decision. Current wetland regulatory guidelines would prohibit any effort to restore these areas to intensively managed moist soil units or some other function.

Cultural and Historical Resource Impacts

This alternative would have no direct influence on cultural or historical resources and their protection.

Administration, staffing, infrastructure, law enforcement, and other needs

As noted above, this alternative would abandon an $18 million infrastructure. It would also eliminate the need for the expenditure of any refuge operational dollars for staff, materials, or contractual services. Most of the refuge's heavy equipment could be sold or excessed since it would no longer be required for construction and maintenance associated with alternatives A and B.

Habitat Management—Supplemental Nest Structures

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.

Given these concerns, three management alternatives are presented. Alternative A would continue the existing nest structure program. Alternative B would evaluate the efficacy of maintaining, downsizing, or expanding the nest structure program; specifically the contribution of the various structures to desired local, regional, and national population goals would be compared with the program costs. Alternative C would eliminate supplemental nest structures except for those used as demonstrations for educational purposes.

Alternative A. Species–specific Management

Management Strategies

Under alternative A, the Refuge Complex would continue to maintain the supplemental nest structure program. On Blackwater NWR, the existing program would include nest platforms for 30 ospreys and nest boxes for approximately 200 wood ducks, 30 bluebirds, 10 barn owls, and several (<10) prothonotary warblers. On the Chesapeake Island Refuges, this program would include four peregrine falcon hacking towers on Smith, Watts, and Spring Islands, and more than 70 osprey platforms on Martin NWR. Volunteers will complete most of the construction and installation.

Physical Impacts

In this alternative, there are no significant impacts on the physical environment.

Biological Impacts

In this alternative, the supplemental nest structure program would continue to contribute to local and regional bird populations. Since 1973, ospreys using nest platforms at Blackwater and Martin Refuges have fledged at least 1,769 young. Since 1989, nest boxes at Blackwater NWR have produced 589 barn owls. Since 1986, the two hacking towers on Martin NWR have fledged 56 peregrine falcons. Literally thousands of wood ducks been produced from the 200 nest boxes on Blackwater NWR.

Socioeconomic Impacts

The opportunity to view nesting wildlife on nest structures that are in close proximity to the Visitor Center and the Wildlife Drive are one of the features that attract over 100,000 visitors annually to Blackwater NWR. Additionally, supplemental nest structures provide an opportunity to educate the general public about these species and associated conservation issues. Similarly, supplemental nest structures on the Refuge Complex clearly demonstrate to interested private landowners how they can contribute to wildlife populations.

Cultural and Historical Resource Impacts

Under this alternative, there are no cultural or historical resource impacts.

Administration, staffing, infrastructure, law enforcement, and other needs

As this alternative does not change the existing management regime on either Blackwater Refuge or the Chesapeake Islands Unit, additional staff or administrative support specifically for this purpose are not anticipated.

Alternative B. Conservation Biology for Trust Species Diversity

Management Strategies

In alternative B, the Refuge Complex would 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 would be compared with the program costs. Novel placement of nest structures would be considered; e.g., placing nest boxes for prothonotary warblers and wood ducks on the same pole in appropriate habitat. Part of this evaluation would 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) would 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 Plan). Also, the use of floating nest platforms to increase American black duck production, particularly on the Chesapeake Island Refuges, would be field tested as part of the American Black Duck Initiative.

Physical Impacts

There are no significant impacts on the physical environment.

Biological Impacts

Under this alternative, the biological impacts are difficult to predict, since supplemental nest structures could stay the same, increase, or decrease in number and type. However, the decision to change the supplemental nest structure program will be based on an evaluation of their contribution to local, regional, and national population goals versus the cost and labor of maintaining and monitoring this program. Time and money saved by any reduction or elimination of nest structures would presumably be better spent on other wildlife programs.

Socioeconomic Impacts

Under this alternative, the use of supplemental nest structures for public outreach and education will continue regardless of the outcome of their evaluation as a wildlife management tool on the Refuge Complex. Consequently, a change in the number or type of structures is not expected to affect visitor opportunities on the Refuge Complex.

Cultural and Historical Resource Impacts

In this alternative, there are no significant cultural or historical impacts.

Administration, staffing, infrastructure, law enforcement, and other needs

Although this alternative proposes an evaluation of the efficacy of maintaining, downsizing, or expanding the supplemental nest structure program, additional staffing specifically for this purpose is not anticipated other than what is proposed under the preferred alternative for Inventory, Monitoring and Research. At least a few of the assessments are expected to be contracted; e.g., the potential use of floating nest platforms in black needlerush marsh to enhance American black duck productivity would like be assessed by USGS-BRD scientists.

Alternative C. Maximum Public Use with No Habitat Management

Management Strategies

Alternative C would eliminate supplemental nest structures except for those used as demonstrations for educational purposes.

Physical Impacts

There are no significant impacts on the physical environment.

Biological Impacts

Supplemental nest structures on the Refuge Complex have produced 1,769 ospreys, 589 barn owls, 56 peregrine falcons, and thousands of wood ducks since 1973 (see alternative A). The elimination of these nest structures, without regard to their contributions, could impact the continued recovery of these species, at least at the local level. The evaluation and use of floating nest structures to enhance American black duck production on the Chesapeake Island Refuges may represent a significant loss of opportunity for the Refuge Complex to contribute to the

Chesapeake Bay population goals (see NAWMP, the Chesapeake Bay Programs 2000 Waterfowl Management Plan).

Socioeconomic Impacts

In alternative C, the use of supplemental nest structures for public outreach and education will continue, regardless of the outcome of their evaluation as a wildlife management tool on the Refuge Complex. Consequently, the elimination of the supplemental nest structure program is not expected to affect visitor opportunities on the Refuge Complex.

Cultural and Historical Resource Impacts

In this alternative, there would be no significant cultural or historical impacts.

Administration, staffing, infrastructure, law enforcement, and other needs

As this alternative actually reduces the existing management regime on both Blackwater and Martin NWRs, additional staff or administrative support specifically for this purpose are not anticipated.

Habitat Management—Furbearers

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 this 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. In this section, we specifically evaluate three solutions for managing nutria and muskrat populations. Alternative A would continue our current furbearer management program, which includes permitted furbearer trapping (muskrat, red fox, gray fox, raccoon, opossum, and skunk), and a monetary rebate for nutria. Alternative B would 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. Alternative C would implement monitoring programs, but no active herbivore population management. The consequences of these alternatives will be discussed in the context of Blackwater NWR, but also apply to lands protected for the proposed Nanticoke protection area.

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 would 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).

Alternative A. Species–specific Management

Management Strategies

The extensive wetland habitats of the Refuge Complex support healthy populations of native muskrats, red and gray foxes, beavers, minks (*Mustela vison*), river otters (*Lutra canadensis*), and raccoons, as well as the exotic nutria. Most, but not all, of these species are trapped on Blackwater NWR and the Nanticoke protection area, and provide a fur harvest that is a regionally important source of income. Beavers, often a problem species for many refuges, are not found on

Blackwater, but do occur within the Nanticoke protection area. Furbearers are not managed on other units of the Refuge Complex.

The Service recognizes regulated trapping as an effective tool of wildlife population management on national wildlife refuges (Refuge Manual Chapter 7, Section 15). Hunting alone is relatively ineffective in managing aquatic and many terrestrial furbearer species, due to their secretive habits; trapping is the single most viable management alternative (Payne 1980). Regulated trapping is a valid, ecologically sound, versatile, safe, and cost-effective technique of managing furbearer populations (National Wildlife Federation 1979, Boggess, et al. 1990, Organ, et al. 1996, Southwick Associates 1999, Maryland Department of Natural Resources 2000). Regulated trapping has been documented to provide a variety of ecological benefits that are directly applicable to the Refuge Complex including prevention and alleviation of habitat degradation, facilitation of habitat and wildlife restoration, reduction of predation on key species of management concern, protection of rare and endangered species, dampening of disease transmission and severity of disease outbreaks among wildlife and between wildlife and humans, and the conservation and enhancement of biological and genetic diversity (Boggess, et al. 1990, Organ, et al. 1996).

In alternative A, the Refuge Complex would continue the use of trapping as a tool for managing furbearer populations. We propose to continue applying funds from bid revenues to conduct the rebate program for nutria removal from furbearer management units. These rebates have been the only incentive for trappers to remove nutria from refuge marshes. Nutria pelts were as high as $7 in the 1970s but, in more recent years, nutria pelts have been unprofitable to the point that nutria are not a commercially viable furbearer. Selected management compartments would be available for trapping. An individual may bid on one or more compartments, but only two will be awarded to any bidder. A successful bidder must personally trap the compartment but may have one helper; subleasing is prohibited. Under the nutria rebate program, trappers can be reimbursed $1.50 for each nutria taken by hunting or trapping; however, the total reimbursement would not exceed the amount of the trapping bid.

Furbearer surveys would be conducted in November to evaluate pre-harvest population levels. The proposed refuge trapping season would start December 15 and end March 15 or the end of the Maryland trapping season for each species, whichever comes first. These dates permit the accomplishment of program goals with minimal disturbance to waterfowl and endangered species.

Physical Impacts

The rebate program proposed under alternative A has been the only incentive for trappers to remove nutria from refuge marshes, since there is no dependable market incentive for trapping nutria. During the 1998–99 trapping season, 5,690 nutria were killed by refuge trappers, of which 4,515 were taken under the refuge rebate program, and an additional 835 were killed by refuge staff. Since 1990, 53,961 nutria have been removed from Refuge marshes, of which 36,949 were harvested under the rebate program, 12,502 were taken by refuge trappers in addition to their

rebate numbers, and 4,510 were killed by refuge staff during nutria mark and recapture studies, dike protection, and prescribed burn operations. Prior to implementation of the rebate program in 1990, only 21,000 nutria were taken during the previous four decades.

While the overall efficacy of the current furbearer trapping program for regulating nutria populations could be questioned, the removal of more than 50,000 nutria during the past decade certainly must have depressed the rate of marsh degradation on Blackwater NWR. The refuge has lost marsh at the rate of 142 acres per year since 1938 (Stevenson, et al. 1985). Although many factors contributed, the generally accepted paradigm is that nutria herbivory has exacerbated the rate of wetland loss. Nutria may exceed 20 lbs., and they eat about 25 percent of their body weight daily. Compounding this problem is the fact that Olney's three-square is a preferred forage item for nutria. Both nutria and native muskrats feed on the underground and overground parts of marsh vegetation. However, unlike muskrats, nutria feed on the root mass by digging from the surface; i.e., nutria literally tear up the marsh and expose the underlying peat. It is not unreasonable to assume that most of the remaining 8,000 acres of estuarine emergent marsh would be more vulnerable to degradation and loss without the implementation of alternative A. Consequently, the full implementation of this alternative is expected to help maintain the vigor of the marsh with reduced turbidity and improved water quality.

Biological Impacts

A regulated trapping program, as described under this alternative, is compatible with the purposes for which the Refuge Complex was established, the purpose and mission of the National Wildlife Refuge System, the intent of the NWRSIA, and is considered to be in the public interest. Trapping on Blackwater NWR is a management activity designed to control the population levels of furbearers as well as provide an economic benefit to local trappers. Uncontrolled muskrat and nutria populations seriously damage marsh vegetation. Trapping of predator species such as raccoon, fox, skunk, and opossum helps to maintain heathy populations, reduce the likelihood of mammalian diseases (e.g., rabies), reduce predation on nesting waterfowl, and provides an economic value to local residents who successfully bid to trap on the refuge. During 1990–99, annual harvests of red fox, gray fox, opossum, raccoon, and skunk have averaged 2, 0, 28, 83, and 6, respectively.

The impacts on existing biota are expected to be severe and dynamic without the implementation of the nutria rebate program under alternative A. The current rate of marsh loss is exceeding the rate of natural succession within the forest-marsh transition zone. Continued loss of the estuarine emergent marsh can only negatively impact breeding and wintering waterfowl. Historically, the marsh provided significant wintering habitat (particularly Olney's three-square bulrush) for Canada geese, lesser snow geese, American black ducks, and other dabbling waterfowl. Similarly, the refuge was noted for its extensive breeding habitat for American black duck and blue-winged teal (*Anas discors orphana*).

Dr. Oliver L. Austin (U.S. Biological Survey), during testimony to the Migratory Bird Conservation Commission in 1931, described Blackwater NWR as "the most important

waterfowl breeding area on the Atlantic coast south of Labrador." However, in the past decade, aerial surveys suggest that the majority of the waterfowl population wintering on Blackwater NWR is associated with its freshwater impoundments, croplands, and adjacent off-shore areas on the Blackwater and Little Blackwater Rivers. Relatively high counts of American black ducks can still be found in the areas that sustain healthy emergent marsh. On the other hand, the open water that has displaced 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 pelagic phalaropes, and few diving duck species use this habitat due to its lack of SAV (see below). Under this alternative, both breeding and wintering waterfowl populations on Blackwater would benefit as the rate of emergent marsh loss is slowed. Other marsh-dependent fauna, such as the saltmarsh sharp-tailed sparrow, coastal plain swamp sparrow, black rail, muskrat, and rare skippers would be expected to benefit as well.

Similarly, improved water clarity as a result of removing nutria can only be beneficial for fish. At least 44 fish species in Dorchester County use marshes for spawning, nursery, and feeding (Metzgar 1973). However, turbid waters due to marsh loss have greatly reduced the quality of aquatic habitats. With the continued loss of emergent marsh and the inability of the system to flush flocculent detritus, it is very likely that the bottom of the expanding open water will not stabilize for some time. This has resulted in the degradation of existing SAV (primarily wigeongrass) and has inhibited the establishment of new SAV beds as open water has expanded.

Failure to control nutria populations would certainly threaten the Upper Blackwater River Natural Heritage Area, an area identified by the Maryland Heritage Program as significant. This area represents one of the best examples of a complex of tidal saltwater wetlands, tidal freshwater wetlands, contiguous non-tidal wetlands, upland islands, and Delmarva Bays in Maryland. Wetland communities extending from the Ewing (Madison) Tract at the headwaters of the Little Choptank River, east to the Seward Tract, include 10 different major tidal types and approximately 15 types of non-tidal wetlands that support a number of rare, threatened, and endangered species, including the rare skipper and bald eagles. Both estuarine and palustrine wetlands are well represented. Tidal wetland communities within these parcels (Salt Marsh Cordgrass, Saltmeadow, Saltbush, Black Needlerush, Freshwater Mixed, Arrow Arum-Pickerel Weed, Cattail, Narrowleaf Cattail, Yellow Pond Lily, and Tidal Mudflat) make this complex extremely diverse and important for preservation and protection.

Socioeconomic Impacts

Blackwater NWR is the largest tourist attraction in Dorchester County. Its visitation and associated ecotourism contributes a reported $15 million annually to the local economy. More than 100,000 visitors register annually at the Visitor Center and most come here for wildlife viewing, particularly waterfowl. Waterfowl populations seeking refuge and forage at Blackwater also directly affect the leasing of hunting rights on nearby private lands. More than 4,500 jobs and $31 million in state and Federal tax revenues are directly related to hunting and non-consumptive activities associated with migratory waterfowl and bird use in Maryland (Southwick

Associates 1995). The overall economic benefits to Maryland from hunting waterfowl and other wildlife species that depend upon the Chesapeake Bay marshes are estimated at more than $300 million annually (USFWS 1995). Under alternative A, waterfowl use of the refuge would continue as nutria herbivory is somewhat depressed. Consequently, visitation and its contribution to the local economy can be expected to benefit as well.

Furbearers in the marshes have always provided a source of livelihood since the time of the earliest settlers. Trappers in Maryland earn about a million dollars per year, and Dorchester County, with about 1,000 commercial trappers, has more than any other county. Fur trapping is a major source of supplemental income to many Dorchester County residents. Blackwater NWR's most prized furbearer, the muskrat, is found in equivalent numbers in the United States only in the marshes of Louisiana. The number of muskrats trapped at Blackwater NWR each year for the commercial trade has varied considerably in nearly 67 years of trapping. The take has varied from approximately 1,000 to 26,000 a year. During the early years of the refuge (1936–1940), harvests ranged from 19,000 to 26,000 muskrats. During a peak population year, as in 1938, five or more muskrats per acre were trapped in the Blackwater mashes (see chapter 3, "Affected Environment").

Muskrats, in particular, are one of the most important furbearers in terms of pelt production and total economic value both locally and nationally. In 1997, for example, more than $9,400 were bid for trapping rights on Blackwater NWR. Trapping income from the refuge during that year contributed approximately $53,000 to the local economy, mostly through muskrat pelts. Muskrat pelts have been as high as $5 in the 1970s.This supplemental income would not exist without the muskrat trapping proposed under alternative A.

Cultural and Historical Resource Impacts

The furbearer management program under alternative A would not adversely impact cultural and historical resources. Furbearers are a renewable natural resource with cultural and economic values (Kellert 1981, Organ, et al. 1996). Several human dimensions studies have documented trapper profiles, cultural aspects of trapping, and the socioeconomic role of trapping in the United States (Boddicker 1981, Todd and Boggess 1987, Brown, et al. 1995) and in the Northeast (Muth, et al. 1996, Daigle, et al. 1998, Mason 1990, Glass, et al. 1991). Regulated trapping can provide an organic source of food and clothing with minimal impacts on other natural resources. A regulated trapping program on the refuge also could support and promote the fostering of appreciation of wildlife and nature, wildlife observation, environmental education, a greater understanding of ecological relationships, stewardship of natural resources, and inter-generational passage of the methodologies of renewable resource use. Trapping is an activity in which family members and friends often participate together and share joint experiences that broaden the sense of appreciation for natural resources and ecological awareness, and indeed even a sense of community (Glass, et al. 1991, Daigle, et al. 1998). In this economically depressed area of the state, trapping provides a supplemental, and in some circumstances, primary source of income for some families.

The removal of nutria is extremely important to local inhabitants, visitors, scientists, and agency personnel. It would also improve the natural scenic quality of the area. The Chesapeake Bay marshes are recognized as some of the most important marshes in the United States (Tiner and Burke 1995). The loss of these critical marshes affects the health of the Chesapeake Bay ecosystem, impacts state and local economies, and lowers fish and wildlife productivity. The natural resources of the Chesapeake Bay contribute significantly to the economic well-being of Maryland and to the quality of life of its residents. The Chesapeake Bay's well-established marsh and riparian areas frequently are used by wildlife, and have a very high scenic value.

Conversely, alternative A is not expected to conflict with public use on the refuge. With respect to possible negative reaction to trapping on the refuge by some members of the visiting public, conflicts are not expected because trapping is generally an inconspicuous activity, traps are usually hidden from view, are not set near roads, and are checked in the early morning. These characteristics serve to limit the potential for encounters between traps or captured animals and those engaged in other public use activities.

Administration, staffing, infrastructure, law enforcement, and other needs

As this alternative does not change the existing management regime on the Refuge Complex, additional staff or administrative support specifically for this purpose are not anticipated.

Alternative B. Conservation Biology for Trust Species Diversity

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 due to 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, as described in alternative A, Blackwater NWR initiated a nutria rebate program in 1990. This program and incidental take by refuge staff have removed almost 58,000 nutria from Blackwater NWR in the past 15 years. However, this likely represents a very small fraction of the extant population. Limited mark-and-recapture estimates of tagged individuals have suggested that populations have been as high as 50,000 nutria on the refuge. Using these 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 would 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.

In alternative B, the feasibility of nutria population control or eradication would 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 alternative, recommendations resulting from the three-year pilot program would subsequently be implemented. Additionally, muskrat trapping and the nutria trapper rebate program at Blackwater NWR would be continued (see alternative A) and, perhaps, modified to reflect recommendations forthcoming from the Nutria Damage Reduction Pilot Program. Furbearers other than nutria and muskrats would be taken only incidentally under this alternative.

Physical Impacts

The impacts of fully implementing this alternative, in conjunction with other restoration and management strategies identified in the Marsh Management Program, are expected to be beneficial to marsh health. The degree to which this alternative may be implemented will depend to a great degree on recommendations resulting from the Nutria Damage Reduction Pilot Program. This study is evaluating marsh restoration in combination with nutria control, different control methods, and the feasibility of nutria eradication on the Eastern Shore. However, all actions are intended to improve the health of existing marsh, reduce the rate of marsh degradation, enhance marsh restorative actions, and improve water quality.

Biological Impacts

The biological impacts of this alternative are expected to be similar to those described under alternative A. However, red fox, gray fox, opossum, and skunk will not be managed as target species; take of these furbearers will occur only incidentally. Consequently, take will be less than it is under the current furbearer management program (alternative A).

Socioeconomic Impacts

The implementation of a regulated nutria control program on the refuge affords a potential mechanism to collect, survey, and monitor information to contribute to research on furbearer (and other wildlife) occurrence, activity, movement, population status, and ecology. The ecological and monitoring benefits mentioned above are management services that will be accomplished through minimal or even no cost to the government compared to costs associated with using salaried staff or contractual arrangements with private individuals or organizations, other agencies, or refuge staff. By maintaining a trained and experienced cadre of trappers, the Service can utilize their skills and local knowledge to perform or assist with valuable management or research functions such as described above (Mason 1990). Trappers that participate in the refuge program could provide assistance with the implementation of structured management objectives, such as alleviation or reduction of wildlife damage conflicts and negative species interactions. Limited budgets and staff can thus be used for other refuge programs for the benefit of wildlife, habitat, and the public. Refuge trappers have a vested interest in proper habitat and wildlife conservation, and protection of the ecological integrity of the refuge (Kellert 1981). Accordingly, they are valuable assets to the refuge manager in terms of providing onsite reports concerning the fundamental status of habitat, wildlife, and refuge conditions.

Cultural and Historical Resource Impacts

Same as described under alternative A.

Administration, staffing, infrastructure, law enforcement, and other needs

Although this alternative proposes implementation of recommendations stemming from the Nutria Damage Reduction Pilot Program, additional staffing specifically for this purpose is not anticipated. An extensive nutria population control or eradication program would almost certainly be contracted to USDA Wildlife Services.

Alternative C. Maximum Public Use with No Habitat Management

Management Strategies

In alternative C, no management of nutria, muskrat, and other furbearer populations would occur. Nutria populations would continue to be monitored with mark-and-recapture methods and muskrat house densities would continue to be surveyed. The Nutria Damage Reduction Pilot Program would not be initiated.

Physical Impacts

Our implementing this alternative would demonstrate a lack of resource stewardship and poor planning, because it fails to capitalize on a proactive integrated program that manages furbearers as assets instead of liabilities (Siemer and Decker 1991; Organ, et al. 1996). The ecological aspects of a regulated trapping program in terms of regulation of population extremes, incidence and severity of disease, and predation levels are not realized with implementation of this alternative. Additionally, opportunities would be lost for environmental education involving ecologically sound resource management, elucidating the role of the trapper and regulated trapping in support of refuge programs, and promotion of socioeconomic and cultural benefits to the local community through use of a renewable natural resource. Diminished support for the refuge and Service programs from adjacent landowners, cooperating agencies, and the public could be expected due to the lack of implementation of sound principles of wildlife management, and programs that would allow socioeconomic and cultural benefit. Such negative perceptions and loss of credibility with supporters could result in an erosion of community trust and could negatively affect implementation of refuge management or land protection programs on the Refuge Complex.

Biological Impacts

At their peak numbers, muskrat and nutria populations on Blackwater NWR have reached as high as 5–8 per acre. Failure to manage nutria and other problematic herbivore populations on the Refuge Complex would lead to accelerated loss of marsh and marsh-dependent wildlife populations. Of special concern are waterfowl (particularly American black ducks), saltmarsh sharp-tailed sparrows, coastal plain swamp sparrows, black rails, and rare skippers. These are all expected to decline in abundance and distribution on the refuge as the marsh degrades.

Socioeconomic Impacts

Both biological and cultural carrying capacity, the tolerance of conflicts between wildlife and humans, would be exceeded as a result of this alternative. Alternative management or control methods, such as exclusion, barriers, shooting, oral vaccines, or toxicants, would be more costly and less effective than a regulated trapping program (Organ, et al. 1996; Southwick Associates

1999). The cumulative effect of the circumstances described above presumably would lead to an erosion of support from the public, the Maryland Department of Natural Resources and other resource agencies, the professional wildlife community, and from conservation organizations. Inaction and ineffective management could result in legal action taken against the Refuge Complex to recover financial losses from property damage or compensate from losses due to bodily injury resulting from negligence in properly providing or maintaining safe facilities. Furthermore, as described in alternative A, this alternative would result in the loss of over $50,000 annually to the local economy, derived primarily from the sales of muskrat pelts.

Additionally, the refuge would not benefit from the experienced and trained observations of trappers regularly and systematically viewing and assessing habitat conditions, and wildlife spoor, occurrence, and conflicts, and reporting such observations to Refuge staff for consideration in management planning and decision-making. Refuge trappers would not be available to assist with management, monitoring, research, or environmental education programs. The cultural and socioeconomic benefits that regulated trapping provides in this rural, working landscape would be diminished if this alternative were implemented, and the refuge and the Service would not be viewed as a good neighbor or as a credible partner in the cooperative conservation of natural resources for the benefit of wildlife, habitat, and people. Such negative perceptions and loss of credibility with supporters would create an unsuitable community climate for the implementation of refuge management or land protection programs on the Refuge Complex.

Should any wildlife disease outbreaks in the vicinity of the refuge occur, regardless of cause, the Service likely would be implicated by the public as negligent in not adequately managing the wildlife population within its realm of influence. Transmission of diseases from wildlife to humans or domestic animals in the proximity of the refuge (e.g., rabies or distemper) could be perceived by the public as a result of mismanagement on the part of the Service.

Cultural and Historical Resource Impacts

Failure to reduce nutria populations and the continued loss of a significant estuarine marsh on the Chesapeake Bay would have impacts that go beyond tangible biological, physical, and economic concerns. Coastal intertidal marshes, like all wetlands, have figured prominently in human artistic and aesthetic considerations for ages. Wiegert and Freeman (1990) point out that tidal marshes are wilderness by many definitions despite their use by people in search of recreation and commercial return. Unlike most terrestrial systems, intertidal marshes have retained relatively pristine processes because they were largely undisturbed by agriculture, the dominant vegetation responsible for the productivity of the system is continually renewed, and the trophic web has been essentially retained. Furthermore, the intertidal system, because of the stress imposed by high salinity, is not an easy system for non-native plants or animals to invade. Perpetuation of the relatively pristine tidal marsh system is the underpinning to what gives the Eastern Shore its unique character and gave rise to the waterman and trapper traditions.

Administration, staffing, infrastructure, law enforcement, and other needs

As this alternative actually reduces the existing management regime on the Refuge Complex, we do not plan on added staff or administrative support specifically for this purpose.

Habitat Management—Prescribed Fire

Introduction

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 (as described here as alternative B) 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 FMP EA includes alternatives consistent with alternatives A, B, and C of this draft CCP and EA. The relevant consequences of those actions are described in detail in the original EA, and will not be repeated here, except for the preferred alternative.

Background

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 social 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, proposed to develop 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 proposed to establish, 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 for the preferred alternative, which is presented as the "Proposed Action."

Six Fire Management Regimes

The panel developed six alternative fire management regimes, including three that conform to the alternatives presented in this draft CCP and EA. See the table that follows for the acreage burned annually under each regime.

1. *Annual Fire Regime,* consistent with alternative A, no action

2. *Multiple Objective Fire Regime,* consistent with alternative B, our proposed action

3. *Annual Marsh plus Five-year Woodland Fire Regime*

4. *Annual and Five-year Fire Regime*

5. *Limited Suppression Fire Regime*, consistent with alternative C, no active management

6. *Fire Suppression Regime*

Annual Fire Regime (Alternative A. Species–specific Management)

This regime conforms to alternative A, the species-specific alternative. Under this regime, the Service would develop a FMP that would continue fire management as practiced up to 1997. Annual prescribed burning would 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 would be prescribed burned annually. Approximately 80 acres (9 percent) of refuge agricultural lands would also be burned.

One of the primary goals of burning marshes and woodlands would be to reduce fuel loading hazards and resultant wildfire dangers. Additional goals of the marsh burning program would 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 would 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 would be to facilitate tillage operations by reducing the vegetative litter. In all habitats, appropriate suppression actions would be taken on all wildfires based on firefighter and public safety, values at risk (property and natural resources), and cost of suppression.

This alternative would define specific conditions under which burning would occur. The refuge would conduct marsh burns in the winter, normally between late-December and mid-March. Woodlands and agricultural lands would be burned during other seasons depending upon environmental conditions necessary to meet objectives. Wind directions would be chosen for a particular burn that would minimize fire escape potential and adverse impacts of smoke and

particulate matter. Wind speeds would be selected to ensure that fire intensity would be commensurate with firefighter and public safety requirements and with burn and habitat objectives. Air temperature, relative humidity, and fuel and soil moisture would also be important factors of the burning prescription. Upper and lower limits of these factors would be set to produce fire intensity and behavior to meet burn objectives.

Multiple Objective Fire Regime (Alternative B. Conservation Biology for Trust Species Diversity)

The Multiple Objective Fire Regime conforms to alternative B of this draft CCP and EA. Under this regime, the Service and DNR would develop a FMP that provides guidance for wildfire suppression and prescribed burning. It would 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 would 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 would 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 would total approximately 1,830 acres (1,380 acres of marsh land and 450 acres of woodlands). Within each site, four treatment areas would be established and assigned to one of the four burn rotations. These areas and treatment rotations would allow evaluation of the effects of varying intervals of prescribed burning application on various vegetative communities, to determine which rotation would yield the vegetative and wildlife responses that best meet management objectives.

This alternative would 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 would 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 would 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 would be based upon extensive surveys of the refuge and Fishing Bay WMA. Consideration would 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 would be Olney three-square, saltmarsh hay, giant cordgrass, smooth cordgrass, saltgrass, black needlerush, and woody shrubs. Marsh vegetation characteristics would be monitored, such as species, frequency of occurrence, area of coverage,

and areas of bare ground. Monitoring efforts would 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 would be loblolly pine, loblolly pine–oak, loblolly pine–mixed hardwoods, and mixed hardwoods. Characteristics of the woodland community to be monitored would include species, diameter breast height (dbh), frequency of occurrence, percent coverage, height, and basal area. Overstory, shrub and herbaceous layers in the woodlands would 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 alternative A would be used.

Annual Marsh plus Five-year Woodland Fire Regime

The Service would 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 would 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 alternatives, this would be the greatest amount of woodland acres burned (610; 5 percent). The amount of agricultural lands subjected to annual burning would not change under this alternative. Appropriate wildfire suppression actions would 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 would develop a FMP that ensures frequent fire regimes are maintained in all vegetative community types. Under this alternative, wildfire suppression and prescribed burning activities would 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 alternative, there would be a reduction in annual marsh acreage that would be prescribed burned because part of the current annually burned acreage would be converted to a 5-year rotation.

Therefore, 12,310 acres (39 percent) of marsh would be burned annually, and 690 acres (2 percent) would be burned every 5 years. Also, 335 acres (3 percent) of woodlands would be burned on an annual basis, and 225 acres (2 percent) would be burned on a 5-year rotation. This would be the most woodland acreage burned annually under any of the alternatives. The amount of agricultural lands subjected to annual burning would not change under this alternative. Appropriate wildfire suppression actions would be taken in all habitats relative to firefighter and public safety, resources at risk, and costs of suppression.

Limited Suppression Fire Regime (Alternative C. Maximum Public Use with No Habitat Management)

The limited suppression fire regime conforms to alternative C of this draft CCP and EA. The Service would develop a FMP that ensures appropriate wildfire suppression actions would be taken in all habitats relative to firefighter and public safety, resources at risk, and cost of suppression. Under this alternative, no prescribed burning would be used in any habitat. It is anticipated that aggressive suppression would 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 would 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 would develop a FMP that ensures ALL wildfires would be controlled at a minimum size irrespective of values at risk or suppression cost, and no prescribed burnings would be used in any habitat. Under this alternative, aggressive wildfire suppression would be taken on all fires regardless of the values at risk to ensure that a minimum of public land would be affected. We expect less average annual acreage would be burned, compared to the current program.

Table 5. 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 Suppression[c]	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.

Alternatives Dismissed from Further Consideration

The alternative of having no fire management plan was dismissed as irresponsible. This alternative would risk public safety, adversely affect ecological stewardship, and contravene agency policies. Total fire exclusion was also dismissed. Since the area supports flammable vegetation, fire will occur either from lightning strikes, accidental causes, or arson; thus, the concept of totally excluding fire is unrealistic. Therefore, these alternatives were dismissed from further consideration.

Environmental Consequences

Only the consequences of implementing the Multiple Objective Fire Regime, which conforms to alternative B, "Conservation Biology for Trust Species Diversity," will be discussed here. Our Fire Management Plan EA contains the consequences of the other regimes. It is available from the Refuge Complex upon request. The effects of the Multiple Objective Fire Regime on physical, biological, socioeconomic, and cultural resources are discussed below.

Physical Impacts

Geology and Soils

Blackwater NWR and Fishing Bay WMA marsh prescribed burnings would be surface or cover fires. Under the proper soil moisture conditions, they would consume only dead and living plant components and seldom, if ever, consume organic material in the soil because the soils remain saturated. Because prescribed burnings cause little heat penetration of the soil and do not directly consume the soil, they would have little direct effect on the soil (USDA 1978). Hoffpauer (1968) found that cover fires conducted when the water level was at or above the surface of the marsh formed a vapor layer of steam that extended to a height of approximately 3 inches above the surface. This steam layer provided insulation to grass stubble as well as the soil.

Fires at Blackwater NWR and Fishing Bay WMA conducted according to the prescription (defined soil moisture, wind speed and direction, air temperature, and relative humidity) would have minimal impact, and therefore, would have little negative effect on the soils of the refuge. Marsh fires, when conducted according to the refuge's prescription, typically would result in a 2- to 6-inch stubble layer remaining after the burn. Extreme care would be taken to not burn when the marsh surface is frozen and soil moisture is low, to prevent burning into the root layer and consuming organic soil.

Marsh burning could potentially affect vertical accretion and organic matter export and deposition. Marsh vertical accretion is the formation of new soil on the marsh surface (Nyman and Chabreck 1995). Organic matter export and deposition provides detritus from marsh grasses, which is an important food source for juvenile fish (Nyman and Chabreck 1995). Because fire

directly removes organic matter (standing dead biomass and surface litter) that could be used in marsh accretion, exactly what effect fire has had on marsh loss is unknown (Nyman and Chabreck 1995; Pendleton and Stevenson 1983).

Vertical accretion is important because it helps keep marsh plants from drowning as the sea-level rises and the land subsides. Accretion depends upon the accumulation of organic matter, which results primarily from root production. Periodic burning may be detrimental to marshes by inhibiting vertical accretion, or it could benefit vertical accretion through stimulating above and below ground plant production. However, no studies have investigated the effect of burning on peat production and vertical accretion (Nyman and Chabreck 1995). Following prescribed burning as practiced at Blackwater NWR, Pendleton and Stevenson (1983) found an increase in Olney three-square bulrush production and deposition. This result, especially in below-ground roots and rhizomes, was equal to or greater than the potential deposition of organic matter lost due to combustion.

Therefore, they concluded that annual marsh burning was not directly implicated in marsh losses, and indeed was found to increase marsh production. They concluded that marsh burning should serve to stabilize marsh soils. Pendleton and Stevenson (1983) reported almost twice the Olney three-square bulrush live culm density, and over twice the live, below-ground biomass in burned versus unburned plots on Blackwater NWR.

Fire would increase the soil nutrient levels. Immediately following burning, increases would occur in soil pH, phosphorus, exchangeable potassium, calcium and magnesium. Nitrogen would not increase; it presumably is volatilized (Hoffpauer 1968; USDA 1978). Hoffpauer (1961) found increased nutrients in Louisiana marshes following burning, but also reported that the increases were short-lived in the soil, which he attributed to rapid uptake by plant regrowth and wave action. In Blackwater NWR marshes, Pendleton and Stevenson (1983) found equal rates of plant growth between burned and unburned plots, which they felt discounted the theory that burning resulted in greater nutrient availability. However, their observations were limited to nitrates, nitrites, and ammonium.

Prescribed burning in woodland habitats under this alternative would have no deleterious soil effects because of the relatively low fire intensity in the woodland setting and the lack of high heat penetration. In agricultural lands, prescribed burning would to used to conserve soil by consuming rough vegetation and litter, which reduces the amount of tillage necessary to prepare a proper seed bed for planting.

For the 1,035 acres of marsh and 339 acres of woodlands scheduled for 3-year, 10-year, and no burn rotations, there would be greater potential for soil involvement. Increased fuel loads in these less frequently burned areas would result in prescribed and wildland fire of greater intensity. However, under prescriptive criteria (soil moisture, fuel moisture, temperature, relative humidity, and wind speed) established for prescribed burns in these habitats, heat penetration into the soil would not be deleterious. Wildfires that occur in these areas would likely occur outside prescription limits and would have a greater potential for soil damage and increased erosion, greater sedimentation, and reduced soil fertility. In the marsh, slightly more organic matter might be available for export to the estuary or for vertical accretion on the marsh surface, particularly in

the 10-year rotation and no burn areas. This alternative would present the best opportunity to evaluate the effects of burn intervals on soils, particularly in the marsh. The analysis of monitoring data in the various burn study areas would help determine which burn interval produces the best vegetative response and which interval would contribute to soil stability through above-ground and below-ground structure.

Hydrology

Under this alternative, burning would result in slightly increased erosion and sedimentation. During the time that burned areas are devoid of vegetation, they would be more subject to erosion from rain and wind, which would result in increased sedimentation in the water courses. Also, mechanically constructed fire breaks in woodland areas would be more subject to erosion due to lack of vegetative cover until revegetated following the fire. However, since the topography of the area is relatively flat (averaging less than 2-percent slope), the area would be less subject to run-off than areas of steeper slopes. Clark (undated) reported from literature surveys that level areas were unaffected by rainfall run-off. He further reported that sediment yields on flat areas were minimal six months following the fire, whereas there was a ten-fold increase in sedimentation on moderate slopes (8–20 percent). Rapid revegetation, particularly in the marsh, further aides in controlling sedimentation. Therefore, any impacts on hydrology from prescribed burning would be expected to be minimal and temporary.

Ash deposition on the marsh surface would be carried into the estuary by tidal action, which would result in a temporary increased nutrient load. Hoffpauer (1961) found that water samples from burned marsh areas exhibited increased sodium, potassium, chlorinity, total alkalinity, and pH, which he attributed to the ash. These nutrients were quickly depleted and diluted by tidal flooding.

Under this alternative, fewer acres will be subjected to annual burning since some of the acres now burned annually would be placed in the longer rotations. For the longer burn and no burn rotations, there would be less potential for erosion and sedimentation than under the annual rotation, because the area would be devoid of vegetation less often. This burning alternative may require more mechanical firebreak construction in the woodland setting to separate different rotation blocks than under the Annual Fire Regime, but negative effects would be minimal and temporary. Marsh-specific effects, such as dilution of nutrients in the ash resulting from tidal flooding would be somewhat less than under the Annual Fire Regime since some areas would be burned less often. In the 10-year and no burn rotations, saltwater intrusion may be somewhat arrested, given the marsh is still intact, since less potentially accretable material would be burned annually. However, if marsh accretion also depends on increased plant biomass, including below-ground biomass, then the 10-year and no burn sites would just as easily suffer from increased saltwater intrusion. Pendleton and Stevenson (1983) demonstrated that live biomass was significantly higher on burned versus unburned areas of marsh on Blackwater NWR. Wildfires occurring outside of prescription parameters and in unscheduled burn rotations would be aggressively suppressed, but negative hydrological effects would be slightly greater from wildfires under this alternative due to greater fire intensity from higher fuel loads in areas not burned annually.

Air Quality

The primary effect on air quality resulting from burning would be particulate matter emission that results in visible smoke. Particulate emissions limit visibility, absorb harmful gases, and can aggravate respiratory conditions in sensitive individuals (Johansen, et al. 1985). Smoke production is directly related to the amount of fuel consumed. Burning technique and efficiency of combustion also influence the amount of smoke produced. Under this alternative, the particulate matter emissions for the current burning program have been calculated to be 203,175 pounds for the 3,000 acres of marsh lands; 19,025 pounds for the 110 acres woodlands; and 5,418 pounds for the 80 acres of agricultural fields. Burning in these various areas is conducted in burn units. Therefore, all acreage is not burned simultaneously, resulting in emissions greatly reduced from the aggregate totals given above. The refuge's burning prescription would require transport wind speeds of 9 to 20 miles per hour and a mixing height of 1,700 to 6,500 feet that would rapidly disperse the particulates and smoke generated from burning. Prescribed burning in the various units would also be conducted with wind directions that would carry the emissions away from residences, roadways, and smoke-sensitive facilities. Therefore, particulate emissions from prescribed burns would be short-term events expected to have little adverse impact on air quality.

For the burn monitoring areas included in the moderate and occasional fire rotations, particulate emissions and the resulting smoke would likely be greater than under the annual burn rotation because of increased fuel loading. However, burning under these rotations would still be conducted according to the refuge's prescription for wind speed, direction, mixing heights, and fuel moisture to maximize dispersion away from smoke-sensitive areas, thus minimizing impacts on air quality. Suppression of wildland fire occurring in the no burn rotation areas and in areas not scheduled for burning would be accomplished as quickly as possible in an attempt to reduce adverse effects, but increased fire intensity due to greater fuel loading would increase smoke emission effects compared to prescription fire.

Biological Impacts

Vegetation

Implementing this alternative affords the best opportunity to evaluate the effects of various burn rotations on the refuge's marsh and woodland vegetation and the resultant benefits or detriments to associated wildlife populations.

Fire would increase primary plant production (Nyman and Chabreck 1995; Christensen and Wilbur 1993; Hackney and de la Cruz 1981) and metabolism in wetlands (Johnson and Knapp 1993). Burning would remove the above-ground plant material, allow quicker warming of the soil, and would also return nutrients to the soil.

Pendleton and Stevenson (1983) reported almost twice the Olney three-square bulrush live culm density, and over twice the live, below-ground biomass in burned versus unburned plots on

Blackwater NWR. Individual plant culm height was taller in burned versus unburned areas, although growth rates were similar during the peak of growing season. Pendleton and Stevenson (1983) also reported that total plant biomass was similar in burned versus unburned areas because the amount of dead biomass in unburned areas compensated for the reduced amount of live biomass in the burned areas.

For Blackwater marshes, whether the site–species relationship or burning frequency is the ultimate factor that controls plant species dominance is unknown. Pendleton and Stevenson (1983) maintained that salinity gradients and marsh elevation were key elements in plant zonation. Following a burn, marsh species such as those found on Blackwater have been documented to quickly resprout from roots and rhizomes that were protected by being buried deep in the soil and also possibly covered by water (Uchytil 1990, 1992a, 1992b, 1992c, 1992d; Walkup 1991a, 1991b).

Olney three-square bulrush has rhizomes buried 3 to 6 inches in the soil, which may allow it to quickly recover from the fire, typically sprouting within a week (Uchytil 1992c) and thus out-compete other species, such as saltmarsh hay and smooth cordgrass, whose root systems are shallower in the soil. Olney three-square bulrush dominates the cordgrasses for 2 to 3 years following burning (Walkup 1991a, 1991b). Its ability to quickly resprout and dominate the post-burn marsh may explain why total standing Olney three-square bulrush biomass and live biomass were significantly larger in the burned than unburned plots and live below-ground biomass on burned sites exceeded unburned sites by 3.7 kg m^2 (Pendleton and Stevenson 1983).

They also documented that the greater biomass of Olney three-square bulrush produced after burning reflected increased plant density rather than increased or enhanced plant growth. Therefore, burning annually would favor Olney three-square bulrush over other species, such as black needlerush, saltmarsh hay, and smooth cordgrass, which have less food value for waterfowl. However, burning would also destroy cover, which can also be a limiting factor to wildlife if not considered when planning the burn (Nyman and Chabreck 1995). However, the pattern of burning would intentionally be uneven, which would leave patches of protective cover for wildlife (Bendell 1974).

The effect of marsh burning on organic matter export and deposition is not known, but should be examined because exported detritus from marsh grasses is an important food source for juvenile fish (Nyman and Chabreck 1995). The increase in Olney three-square bulrush production and deposition, especially in below-ground roots and rhizomes, may be equal to or greater than the potential deposition of organic matter lost due to combustion (Pendleton and Stevenson 1983). Hackney and de la Cruz (1981) also found that giant cordgrass and black needlerush production in coastal Mississippi increased following burning, resulting primarily from the removal of standing crops that shaded new growth. Pendleton and Stevenson (1983) concluded that annual marsh burning was not directly implicated in marsh losses and was found to increase marsh production. The amount of organic matter consumed by fire (0.46 kg m^{-2}) or the increase in live below-ground biomass by fire (3.7 kg m^{-2}) may be insignificant to the 13.8 kg m^{-2} $year^{-1}$ of net sediment exported from the marsh (Stevenson, et al. 1985). However, it is unknown whether marshes export or accumulate the same amount of organic material as unburned marshes (Nyman

and Chabreck 1995). Thus, the effect of fire on marsh loss, whether positive or negative, would likely be secondary to the effects of sea-level rise.

Therefore, it seems clear that the deleterious effects of burning on the ecological components of the marsh and adjacent estuary would be small in comparison to the effects of marsh loss itself. The main threat to the biotic integrity of the wetland ecosystem would be the rapid conversion of the marsh to open water as a result of the combination of relative sea-level rise, hydrologic alteration, salinity intrusion, and excess herbivory (nutria and geese), rather than fire. Marsh deterioration is allowing saltwater to penetrate farther into the Blackwater marshes. With the increased salinity comes increased dissolved sulfate concentrations which, in turn, allow sulfate-reducing bacteria to degrade the peat in anaerobic marsh soils, resulting in a breakup of the highly organic marsh substrate. The release of soil organic matter also results in depleted oxygen concentrations in adjacent water bodies. While the breakup of extensive marshes may, in the short term, facilitate secondary production of fish and shellfish by increasing the marsh-water interface, as marsh deterioration continues, the secondary production that depends on this habitat may be expected to decline precipitously (Brower, et al. 1989).

Annual burning in the woodlands would result in less accumulation of downed debris and woody undergrowth. This would lessen the fuel load and contribute to less severe wildfires. It would reduce production of woody species and increase herbaceous growth potential, thus contributing to a more open understory. However, fuel accumulation in most woodland sites would probably be inadequate to support an annual burning of the same woodland acres. Of the 110 acres of woodlands scheduled annually for prescribed burning, tracts being burned for the first time would need several years of consecutive annual treatments to achieve the desired conditions. Afterward, these tracts would be burned on an as-needed basis to maintain desired conditions in the understory. Although 110 acres would be scheduled for annual burning, it would not be the same 110 acres from one year to the next.

Willow oak and sweetgum are susceptible to fire because of their thin bark, and would be more likely to die from disease or insect infestation following a wildfire than more fire tolerant species. These species quickly resprout from roots or stumps, but seedlings and saplings would usually be top-killed by even low severity fires. Large trees are more tolerant of low-severity fires, but can be affected by high-severity fires. (Carey 1992b; Coladonato 1992). White oak and loblolly pine are more fire tolerant because of thick bark. Fire would promote regeneration of oaks because fire favors seedling establishment and reduces competing vegetation (Tirmenstein 1991). Loblolly pine is quite fire resistant; mature trees can survive low to moderately severe fires. Crown damage to loblolly pines results in more tree deaths than basal damage, and seedlings germinate on soils exposed by fire (Carey 1992a). Thus, annual burning would promote woodlands comprised of large, mature trees dominated by oaks and loblolly pine with an open understory. Seedlings and saplings of less hardy species, such as willow oak and sweetgum, would be eliminated, thus contributing to an open understory. In regenerating areas, annual burning would favor loblolly pine over the hardwood species in the woodlands.

Annual burning of vegetation in agricultural units would remove heavy loads of dead litter or rough vegetation to facilitate site preparation. Use of fire would reduce the amount of plowing and disking operations necessary to prepare a proper seed bed. It is unlikely that all the 80 acres

subject to burning would ever be burned or that the same acreage would be burned in consecutive years. In moist soil impoundments, use of fire would be beneficial for removal of matted or standing dead vegetation and would encourage growth of desirable wetland herbaceous species.

For the 3-year, 10-year and no burn rotations (1,035 acres marsh; 339 acres woodlands), fuel build-up would be greater, which would result in more intense prescribed and wildfires. However, burning under the refuge's prescription of soil moisture, wind speed and temperature, would result in little damage to marsh regrowth. Less frequent burning might reduce the predominance of Olney three-square bulrush and increase the occurrence of saltmarsh hay and smooth cordgrass if the site conditions (elevation, hydrology, soils, salinity, etc.) favor the latter species. Bulrush species tend to out-compete the cordgrass species for the first few years following the application of fire (Walkup 1991a, 1991b). It is anticipated that the proposed monitoring plan would help determine whether the site-species relationship or burning frequency is the primary factor that controls plant species dominance in the Blackwater marshes.

Varying burn regimes have been recommended by researchers. Pendleton and Stevenson (1983) recommended rotations of every year, every second year, every third year, and a no burn control to study the effects of burning on the marsh. Hackney and de la Cruz (1981) recommended that an entire marsh should never be burned at one time, but rather large blocks in varying rotations to yield sections of the marsh in every stage of succession. This would promote a mosaic pattern and maintain plant and animal community diversity. Further supporting this approach, Nyman and Chabreck (1995) also recommended that an entire marsh should not be burned simultaneous in order to maintain all stages of burn, regrowth, and litter accumulation cycles. However, as the burn rotation lengthens, plant production would be expected to decrease as litter buildup occurs, which shades new growth and maintains cooler temperatures at the soil surface. Fires every 4 to 5 years were found to maintain the vigor of black needlerush marshes in Mississippi (Hackney and de la Cruz 1981). The 10-year and no burn rotations would promote woody brushy invasion into treatment areas decreasing traditional marsh vegetation values for wildlife. In the 3-year, 10-year, and no burn rotations, nutria and muskrat control by trappers would be less successful because of habitat conditions. If these herbivores intensify their foraging in these areas, greater damage to the marsh would result.

In the woodlands, the proposed burn treatments would have varying results, depending on the rotation. Greater debris accumulation in the 10-year and no-burn rotations would result in hotter fires. Increased severity of fires would result in a greater degree of tree stress and mortality through scorching and greater risk of disease and insect infestations. Typical recommended rotation for woodland burns in the southeastern U.S. is 3 to 5 years. Prescribed burning in refuge woodlands would result in the stimulation of herbaceous growth and recruitment of desirable woodland species, including white oak. Burning under the refuge's prescription limits would minimize adverse impacts on desirable woodland vegetation.

Wildlife

Direct mortality to wildlife species during or subsequent to a fire would be uncommon. Few negative impacts would be expected under this alternative. This alternative would afford the

greatest opportunity for evaluating the effects of various burn intensities on marsh and woodland vegetation and the resultant beneficial or deleterious effects on the associated wildlife species.

The longer burn rotations would provide additional habitat diversity by maintaining some habitat in varying stages of succession. Edge and escape cover during periods of regrowth would be more common. Increased plant production in burned marshes has been documented at Blackwater NWR (Pendleton and Stevenson 1983). This alternative would improve wildlife habitat by increasing diversity, stimulating desirable growth for food, cover, and nesting. Fire wopuld remove the dead, standing biomass and stimulate new growth, which would benefit wildlife by providing food and cover. However, it would also remove cover that is important during the winter to numerous wildlife species. Nutria and muskrat control would be less successful in the three-, ten-, and no-burn areas. Therefore, these areas would experience higher muskrat and nutria use, possibly resulting in more intense damage to the marsh. Protection of wildlife habitat features such as eagle nest trees, eagle roosts, and Delmarva fox squirrel forest foraging and nesting habitat would continue to benefit endangered, migrating, and resident species. The impacts on bald eagles and Delmarva fox squirrels were determined by our Ecological Services Division as “Not likely to adversely effect.” A Intra-Service Section 7 Consultation was completed and is available upon request.

Socioeconomic and Cultural Impacts

People live, work, recreate, and have a personal interest in the public wildlands of Dorchester County. Winter marsh wildland fires have been a historical occurrence in Dorchester County for centuries, and will continue to be a feature of the regional landscape in the future. From 1990 to 1996, 12,345 acres were burned on the refuge by wildfires and 53,470 acres were treated with prescribed burnings. Many arson fires set in the marsh in the winter were deliberate attempts to improve furbearer trapping efficiency, but others appeared to be simple arson, without motive. To most Dorchester residents, fire in the marshes is a way of life and is socially acceptable. Marsh burning is synonymous with winter, and experience has proven that marshes will be burned either by professionals or by arsonists.

Public policies are not only to manage fire to achieve land management objectives, but also to protect human life and property. This requires Federal and state agencies to address appropriate actions for wildfires on or near agency lands. Firefighter and public safety are of paramount concern in deciding on appropriate wildfire management responses. Subordinate priority is give to protection of values at risk, which include human structures as well as protection of natural resources. Appropriate suppression actions are based on firefighter safety, suppression costs, and available personnel. Appropriate actions to protect public safety, property, and natural resources also include preparedness activities (e.g., hazard fuel reduction, public education, and law enforcement). All of these actions are currently being used to some degree in Dorchester County.

The harmful effects of fire on the human environment are many and varied, and include: direct (fire) and indirect (smoke) health and safety effects, personal property damages, and public use and recreation inconveniences. Nationally, citizens and firefighters are far too frequently killed or

injured by wildfires. Wildfire smoke has been attributed to highway accidents, and is a recognized human health risk. Personal property damage from wildfires totals millions of dollars annually, and wildfires inconvenience thousands of people using public lands each year.

In Dorchester County, the refuge's burning program would have an effect on various socio-economic resources. Over 200 residences in close proximity to the refuge boundary can be affected by a prescribed or wildfire on the refuge. Burning on an annual basis would reduce fuel build-up, which would decrease the amount of smoke produced. Reduced fuel loads also would minimize. the potential of wildfire that could damage homes and endanger firefighters and the public. Three transportation routes—Shorters Wharf Road, Route 335, and Key Wallace Drive—transect the refuge and could have reduced visibility resulting from smoke. Several sensitive resources, including two hospitals and the county airport, can be affected by smoke and reduced visibility; however, these are a minimum of 8 miles north of the refuge. Fire on the refuge could affect visitor use, thereby having an effect on the local economy.

However, under the prescriptive criteria of the refuge's burning program, adverse impacts on these resources would be minimized. Burning parameters would be chosen to protect local residences from fire and smoke and to carry smoke away from roadways and sensitive resources. Burns also would be timed to minimize any potential negative impact on visitor use. There are only a few areas where visitors and prescribed burning would be in close proximity. During any potentially hazardous situations, e.g., smoke across a roadway or the Wildlife Drive, these areas would be closed to vehicular traffic until the smoke subsides and passage is safe. These inconveniences would be temporary. Actually, the opportunity would be created for the public to witness prescribed burning (from a safe distance), to become more informed about the practice, and therefore, to better understand the refuge's management practices. Historically, prescribed burning has had little to no impact on visitor use. Trapping in the marshes would be unaffected under this alternative, since annual burning would continue.

Despite the lack of good objective assessments as to the cost-effectiveness of any of the preparedness actions, public lands managers, fire control specialists, and law enforcement specialists have agreed that pre-season fuel reduction through the use of prescribed burning is the most cost-effective technique for preventing wildfires. Comparative wildfire and prescribed burning costs for Region 5 of the Service were $909 vs. $15 per acre per incident, respectively (Omi, et al. 1995). The relationship between decreasing wildfires by increasing prescribed burning seems intuitively to exist, but analysis of existing data has not been able to demonstrate this link (Omi, et al. 1995).

Alternatives to hazard fuel reduction prescribed burnings, such as education and law enforcement, would be far less effective. The public's values and attitudes concerning wildland fire policy are strong and not easily changed (Manfredo 1993). This is particularly true in an area where wildland fires have been a common feature for many generations. The application of fire prevention campaigns such as Smokey Bear can be successful, but it has taken Smokey 50 years of work to achieve today's success. As repeatedly described by law enforcement specialists and arson investigators during three days of testimony before the interdisciplinary panel, law enforcement is even less effective: Arson is one of the most difficult crimes to prove.

Land management agencies and their cooperators currently are using various strategies to suppress wildfires. Which strategy is used where and under what conditions is determined through planning and public involvement. Through the sharing of resources, suppression costs can be minimized. The establishment of the Delmarva Fire Management Group has facilitated interagency planning and the sharing of resources (Carowan 1992). The interagency fire program infrastructure established in Dorchester County is the model currently being advocated by the wildland fire management community.

For the longer rotation burns, increased fuel loading would increase smoke production and the potential for more intense wildfires. However, prescribed burns would be conducted within the refuge's prescription parameters, which are designed to minimize the adverse impacts of smoke and fire escape. Trapping in the longer burn rotations would be more restricted because the areas would be less accessible; however, the areas affected do not represent a substantial portion of the trapping units. Therefore, little adverse impact on socioeconomic resources are expected from this alternative.

Cultural Impacts

Little adverse effect on the refuge's cultural resources will result from this alternative. Additional construction of fire breaks would occur under this alternative in order to maintain the integrity of the various treatment areas; however, no known cultural sites are located within the areas where mechanical construction of fire lines might occur. Plans for fire breaks would be reviewed by the Regional Historic Preservation Officer before construction begins. Should a presently unknown site be found during any construction, work would be discontinued and the site would be evaluated by qualified archaeologists.

Habitat Management—Exotic, Invasive, or Injurious Species

Background

The Refuge Complex has set a goal of maintaining a healthy and diverse ecosystem with a full range of natural processes, natural community types, and the full spectrum of native plants and animals. This is an ambitious goal, since 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 these 38 species are known to occur within the

Refuge Complex (see table 6, "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 6, 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). Although strategies are discussed in the following evaluations for the three alternatives, they are presented only for background to the reader. There is no intention for the CCP to accept any action other than alternative B, our preferred alternative for the control of nutria.

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. Although different strategies are discussed in the following evaluations for the three alternatives, they are presented only for background information to the reader. There is no intention for the CCP to accept any action other than alternative B, our preferred alternative for the control of resident Canada geese.

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.

Three management alternatives are presented. Alternative A involves limited control of six of the eight exotic, invasive, or injurious species; purple loosestrife and resident populations of the Canada goose are not controlled. Alternative B is the 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. Alternative C proposes to monitor populations of eight exotic, invasive, or injurious species; no control measures would be implemented.

Alternative(s) Considered But Dismissed

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 would be a futile gesture. However, if certain communities are identified as rare within the proposed 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.

Table 6. 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	abundant
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

Alternative A. Species–specific Management

Management Strategies

Nutria would be controlled by continuing the trapper rebate program that was initiated at Blackwater NWR in 1989. Commercial trappers would bid for the privilege of trapping in one of 15 management compartments during the 3-month Statewide trapping season. The Refuge would offer a rebate of $1.50 per nutria to offset the cost of the bid (up to the full bidding price). Additionally, refuge staff would shoot nutria opportunistically in the marshes and within the impoundments.

Mute swan control would comply with the recommendations of the Atlantic Flyway Council, which endorses the following actions regarding mute swans: (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) where feasible, egg addling programs 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; and (8) states should strive to manage mute swan populations at levels that will have minimal impacts on native wildlife species or habitats.

In cooperation with Blackwater NWR, the U.S. Forest Service would continue to conduct annual gypsy moth egg mass surveys to determine population densities, recommend control treatments, assist with the protection of forest pest management funding, conduct post-treatment aerial-defoliation surveys, and prepare annual reports. Under this alternative, the preferred methods for controlling gypsy moth populations would be aerial application of Bt (*Bacillus thuringiensis*) or Gypcheck. Silvicultural prescriptions to improve the health and vigor of the forest would not be considered (see alternative B).

Phragmites would be controlled by limited (<60 acres annually) aerial- and hand-spraying with glyphosate (Rodeo®) within moist soil impoundments and along some roads. Johnson grass and Canadian thistle would be controlled with the spot application of glyphosate. These two noxious weeds 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.

Physical Impacts

In alternative A, failure to control the resident Canada goose population would result in increased erosion along shorelines and dikes. There would be increased potential for long-term negative impacts related to fecal contamination, and there would be increasing numbers of complaints about the odor associated with these overpopulations.

Biological Impacts

Under alternative A, the program to manage exotic, invasive, and injurious species would prevent catastrophic defoliation and mortality of forest due to gypsy moths, prevent the establishment of a breeding mute swan population at Blackwater NWR, and minimize the spread of Phragmites, Canadian thistle, and Johnson grass in the system of moist soil impoundments and croplands at Blackwater NWR. Control of nutria populations would be minimal, and populations of Phragmites, purple loosestrife and resident Canada geese would become problematic.

Resident Canada Geese

In the absence of population control, resident Canada geese would continue to increase in abundance over time in their protected environment, would continue to displace other wildlife, would eventually preclude the refuge from planting any agricultural crops to meet the nutritional needs of migrating and wintering wildfowl, and would exacerbate the loss of marsh that is already imperiled by sea-level rise, land subsidence, and overgrazing by nutria. Water quality will be negatively impacted because of the increase in fecal droppings. Increased erosion from excessive grazing would negatively impact water quality and cause increased sedimentation and the destruction of freshwater impoundment dikes. Without control, the resident Canada goose population would eventually keep the refuge from accomplishing the purpose(s) for which it was established, and would adversely affect other wildlife species diversity and abundance.

Nutria

The nutria rebate program and incidental take by refuge staff have removed almost 58,000 nutria from Blackwater NWR in the past 15 years. However, this likely represents a very small fraction of the extant population. Limited mark-and-recapture estimates of tagged individuals have suggested that populations have been as high as 50,000 nutria on the refuge (B. Giese, pers. comm.). Using these values as averages, less than 8 percent of the nutria population has been removed annually by this program on Blackwater NWR. 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.

Failure to adequately control nutria populations will contribute to the continued degradation and loss of tidal marsh at Blackwater NWR. Nutria are large, surface feeding herbivores that can be extremely destructive to marsh vegetation. Nutria forage directly on the vegetative root mat, leaving the marsh pitted with digging sites and fragmented by deep swim canals. In the face of rising sea levels, nutria damage is particularly problematic because it accelerates the erosional processes associated with tidal currents and wave action. The situation is extremely delicate within the tidal marshes of the Blackwater River because much of the 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 National Wildlife Refuge has been a rapid conversion of emergent marsh to open water.

Mute swans

Aggressive control of mute swans on the Refuge Complex should prevent the establishment of a breeding population on Blackwater NWR and reduce the impacts of nonbreeding subadults to SAV on the Chesapeake Island Refuges. Mute swans occur in all Maryland tidewater counties, but are most common from Rock Hall (in Kent County) south to Hoopers Island (Hindman 2000); this includes Barren Island, part of the Chesapeake Island Refuges. Large groups congregate among these islands where they severely damage SAV beds. Mute swans graze and uproot underwater plants in water up to 4 ft deep and consume 4–8 lbs of plant material per day. Food habits data show that mute swans rely heavily on SAV; 82 percent of the fecal content from the Chesapeake Bay mute swan was SAV (Fenwick 1983). Nonbreeding swans also displace colonial waterbirds. A flock of 600-1,000 molting, nonbreeding mute swans prevented black skimmers (State-listed as threatened) and least terns (listed as "Species in Need of Conservation") from nesting on oyster shell bars and beaches associated with Barren Island (D. Brinker, MD DNR, memo dated 8 June 1992).

Gypsy moths

Gypsy moth larvae prefer hardwoods, but may feed on several hundred different species of trees and shrubs. In the East the gypsy moth prefers oaks, apple, sweetgum, speckled alder, basswood, gray and white birch, poplar, willow, and hawthorn, although other species are also consumed. The effects of defoliation depend primarily on the amount of foliage that is removed, the condition of the tree at the time it is defoliated, the number of consecutive defoliations, available soil moisture, and the species of the host. If less than 50 percent of their crown is defoliated, most hardwoods will experience only a slight reduction in radial growth. If more than 50 percent of their crown is defoliated, most hardwoods will refoliate by midsummer. Healthy trees can usually withstand one or two consecutive defoliations of greater than 50 percent. Trees that have been weakened by previous defoliation or been subjected to other stresses such as drought are frequently killed after a single defoliation of more than 50 percent. Trees weakened by consecutive defoliations are also vulnerable to attack by disease organisms and other insects. For example, the *Armillaria* fungus attacks the roots, and the two-lined chestnut borer attacks the trunk and branches. Infected trees will eventually die 2 or 3 years after they are attacked. Although not preferred by the larvae, pines and hemlocks are subject to heavy defoliation during gypsy moth outbreaks and are more likely to be killed than hardwoods. A single, complete defoliation can kill approximately 50 percent of the pines and 90 percent of the mature hemlocks (McManus 1999).

The only biological insecticide currently registered and commercially available for gypsy moth control is the microbial insecticide, *Bacillus thuringienis* var. *kurstaki* (Btk). This insecticide is available through several manufacturers, and has been used extensively in suppression projects throughout the U.S. in both forested and residential areas. Btk is a bacterium that acts specifically against lepidopterous larvae as a stomach poison and, therefore, must be ingested. The major mode of action is by mid-gut paralysis, which occurs soon after feeding. This results in a

cessation of feeding, and death by starvation. Because Btk is a biological insecticide, the degree of population reduction varies and, at least in part, may depend on the selected application rate, relative health of the population (building vs. declining), population densities, weather (rain and temperature), the feeding activity of the larvae following treatment, and the actual potency of the product. Btk persists on foliage for about 7–10 days. Btk has been shown to impact other non-target caterpillars that are actively feeding at the time of treatment. The typical response is a reduction in lepidopteran species richness and abundance during and for at least 1 year after treatment (Miller 1990; Sample, et al. 1996).

A second microbial insecticide that is registered and available in limited quantities is the formulated nucleopolyhedrosis virus called Gypchek. This product is not available commercially, but is produced in limited quantities by a cooperative effort of the USDA Forest Service and the Animal Plant Health Inspection Service (APHIS). The active ingredient in Gypchek formulations has a very narrow host range (lymnatriids) and occurs naturally in gypsy moth populations. Normally the virus reaches epizootic proportions when gypsy moth populations reach high densities as a result of increased transmission within and between gypsy moth generations. The application of Gypchek to gypsy moth populations simply expedites this process by increasing the exposure of the virus at an earlier stage. Healthy, feeding gypsy moth caterpillars become infected by ingesting contaminated foliage and soon stop feeding and die. The efficacy of Gypchek treatments to reduce gypsy moth populations has been quite variable. Because of the short period of viral activity on foliage (3–5 days) as well as other biological factors, such as feeding activity and weather conditions, it has been difficult at best to project treatment efficacy. Most often, foliage protection can be achieved but significant reductions in gypsy moth densities do not always occur. Should inadequate population reduction occur, the areas would need to be treated again the following year. Gypcheck has been applied on forests at Blackwater NWR, with poor results.

The most recent surveys of gypsy moth egg mass, conducted by the U.S. Forest Service, indicate that heavy defoliation of the forest at Blackwater NWR is likely to occur on 1,169 acres and moderate defoliation on 490 acres in 2001 (Whiteman and Onken 2001). In addition to defoliation, vulnerability to disease, and potential mortality, studies cited in Gottschalk (1990) showed that moderate defoliation can reduce mast production by 50 percent and severe defoliation by almost 100 percent. Cumulatively, these are clearly significant impacts on the forest ecosystem if gypsy moths are not controlled.

In particular, Blackwater NWR is at the heart of the extant distribution of Delmarva fox squirrels and serves as a source for translocation efforts. Any degradation of forested habitat or reduction in mast production could have serious detrimental effects on the Delmarva fox squirrel population. The effects of past gypsy moth infestations are evident throughout the mixed hardwood and pine-hardwood forests on the refuge. Oak and other hardwood snags are prominent in areas where unmanaged Gypsy moth populations took their toll on these preferred food sources. Unfortunately, infestations prior to initial suppression efforts in 1993 resulted in the loss of significant acres of prime Delmarva fox squirrel habitat. Many of these areas have been converted to shrub scrub with a sparse canopy of low grade hardwoods. With the multitude of stress factors affecting the pine and pine–hardwood forests on Blackwater NWR, it is only a matter of time before this refuge also experiences outbreaks of southern pine beetles.

Blackwater NWR contains most of the large, contiguous forested tracts that remain on the Delmarva Peninsula. Those tracts host 22 species of forest interior dwelling birds (H. Armistead, pers. comm.). Several of these FIDs are highly area-sensitive; i.e., they seldom occur in small, heavily disturbed or fragmented forests. These species are most vulnerable to forest loss, fragmentation, and overall habitat degradation. Most are rare or uncommon on the Maryland coastal plain and many have highly specialized breeding habitat requirements. Clearly the loss or degradation of the forest at Blackwater due to gypsy moth infestation would impact a significant faunal community. Partners In Flight recognize at least seven of the FID species as "globally significant." While the prey base for some of these species would be reduced as a result of Btk or Gypcheck applications, it should also be apparent that these effects are relatively short-term compared to the more severe and long-term impact of habitat loss.

Phragmites, Canadian Thistle, and Johnson grass

In alternative A, Phragmites, Canadian thistle, and Johnson grass would be aerial-sprayed or hand-sprayed with glyphosate whenever they appeared in moist soil impoundments or adjacent croplands at Blackwater NWR. Occasionally, ground mechanical application would be used as well. Elsewhere in the Refuge Complex, particularly within the Chesapeake Island Refuges, Phragmites would be treated with glyphosate when it occurred on dredged spoil disposal areas. Glyphosate is the common name for the herbicide N-(phosphonomethyl) glycine. Commercially formulated in Roundup® for terrestrial use and in Rodeo® for aquatic use, it meets a variety of weed-control needs. Glyphosate inhibits an enzyme that is essential to formation of specific essential amino acids in the plant. When properly applied to the leaves and stems of actively growing vegetation, glyphosate-based herbicides are absorbed into the phloem, whence they translocate throughout the plant. This systemic action allows the glyphosate to reach underground rhizomes and roots. The U.S. EPA classifies glyphosate in Category E (evidence of non-carcinogenicity). It is not considered a typical organophosphate, and has not been reported to have anticholinesterase activity (Jones 1995).

Socioeconomic Impacts

In alternative A, failure to control resident Canada geese could have significant impacts on commercial croplands adjacent to Blackwater NWR. As resident goose populations increase, tidal marshlands, moist soil plants, and row crops on the Refuge Complex will be severely damaged by depredations. Ultimately, this loss of forage would force migratory and resident geese to adjacent private lands causing increased damage to property. There would be increased damage to lawns and turf at homes, businesses, and golf courses. Agricultural losses to small grain, corn, soybeans, milo, and other crops would increase proportionate to the population increase. As off-refuge populations increase, landowners will either accept the problems or be forced to pay private pest control or nuisance wildlife control companies to assist with damage management. Although there would be no implementation costs since there would be "no action" to control populations, the refuge would experience approximately $40,000 annually in crop depredation. The refuge would also experience a significant decline in the number of visitors,

which would proportionately affect the $150,000 the refuge receives annually from entrance fees and book store sales.

The potential threat to humans from contact with fecal materials would increase correspondingly with a growing population of geese. People would be less willing to use recreational areas because of the increase in fecal material. As more geese try to find nesting sites, more geese would nest along the Wildlife Drive and along refuge marsh trails, thereby increasing the threat of attacks on children and adults by nesting geese. Most of the public would be frustrated that the degradation of public facilities supported by taxpayer dollars would be allowed to continue, and that government officials would do nothing to minimize the potential for goose attacks on humans. High populations of flightless geese would pose a threat to automobile traffic when they are drawn across public roads, and would create serious safety hazards when they concentrate near airports.

Cultural and Historical Resource Impacts

In alternative A, the management of exotic, invasive, and injurious species would not impact cultural and historical resources on the Refuge Complex.

Administration, staffing, infrastructure, law enforcement, and other needs

As this alternative does not change the existing management regime on the Refuge Complex, additional staff or administrative support specifically for this purpose are not anticipated.

Alternative B. Conservation Biology for Trust Species Diversity

Management Strategies

We would 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 would also continue the nutria trapper rebate program at Blackwater NWR (see alternative A).

Resident Canada goose populations and depredation would be controlled by implementing the Integrated Wildlife Damage Management Plan (IWDMP), approved December 1999. This program would include nonlethal scare techniques, such as pyrotechnics, propane cannons, eagle effigies, reflective tape, balloons, and flags. Geese would also be excluded from certain areas with the use of perimeter fencing. Lethal components of this program would 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 would comply with the Atlantic Flyway Council's recommendations (see alternative A). 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.

Gypsy moth populations would be controlled using Integrated Pest Management techniques on the Refuge Complex. The IPM program would include coordination with the U.S. Forest Service to monitor gypsy moth populations and recommend treatments of Btk or Gypcheck (see alternative A). These efforts would be extended to forested lands protected on the proposed Nanticoke protection area. In addition, alternative B would included 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 would be controlled over more extensive areas of the tidal marsh under alternative B, 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, would be considered for use if feasible. Specific strategies to control Phragmites would be developed as part of the proposed Marsh Management Program.

Purple loosestrife, Johnson grass, and Canadian thistle would 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 would 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).

Physical Impacts

For alternative B, there will be no significant impacts on the physical environment, other than those already described in the previously completed EAs cited above.

Biological Impacts

In alternative B, full implementation of the program to manage exotic, invasive, and injurious species would have significant and mostly beneficial biological impacts within the Refuge Complex. The nutria rebate program alone (see alternative A) has removed almost 58,000 nutria

from Blackwater NWR in the past 15 years. It is premature to predict the possible impacts of implementing recommendations that resulted from the 3-year Nutria Damage Reduction Pilot Program. However, different control methods being used have already proved successful.

The control of resident Canada goose populations would reduce goose "eatouts" in the tidal marsh, depredation of crops (both on- and off-refuge), fecal contamination of moist soil impoundments, and the likelihood of disease transmission to migratory birds (and humans, in the case of West Nile Virus). Approaches used to control mute swan populations may be modified by the recommendations promulgated by the Maryland DNR-sponsored Mute Swan Task Force. However, the policy of the Refuge Complex would continue to be one of zero tolerance; consequently, the biological impacts would be similar to those described in alternative A.

The IPM approach to minimizing gypsy moth damage should reduce some of the short-term effects of Btk on nontarget lepidopterans by reducing the frequency and rates of Btk application (see alternative A). IPM practices use chemical and biological treatments only as a last resort. Efforts are directed at managing the pest, rather than trying to eradicate the pest. The old saying "prevention is the best medicine" holds doubly true for tree ailments. Vigorous trees are better able to survive an attack of insects or disease than those that are stressed. The IPM approach calls for the use of silvicultural prescriptions to improve forest health and vigor. Alternative B would result in a healthier forest system with less chemical application than the scenario described under alternative A.

Our controlling Phragmites over larger areas of tidal marsh would be beneficial to the marsh system, particularly on the Chesapeake Island Refuges. The invasion of Phragmites onto open beaches and dredge spoils associated with the islands can preclude their use as habitat for tiger beetles, some colonial waterbirds, and nesting diamondback terrapins. On Blackwater NWR, Phragmites is extensively but sparsely distributed over the open tidal marsh. However, Phragmites can be expected to increase in density and distribution until the salinity gradient is restored on the Blackwater River. The concern is that the current patchy distribution of Phragmites may coalesce into extensive, monotypic stands similar to those that are more typically seen on other national wildlife refuges along the mid-Atlantic coast. Under alternative B, this likelihood would be reduced.

Socioeconomic Impacts

Under alternative B, there are two significant but positive socioeconomic impacts. An aggressive control program for resident Canada geese would reduce loss of local income due to crop depredations. The IPM approach to managing gypsy moth damage will involve limited timber sales and contracted TSI on Blackwater NWR and, subsequently, on the proposed Nanticoke protection area (see Forest Management Plan). These sales would generate income for local loggers.

Cultural and Historical Resource Impacts

Under alternative B, managing exotic, invasive, or injurious species would not impact cultural and historical resources on the Refuge Complex.

Administration, staffing, infrastructure, law enforcement, and other needs

Our preferred alternative proposes several initiatives including implementation of recommendations stemming from the Nutria Damage Reduction Pilot Program, implementation of the IWDMP for resident Canada geese, expanded mute swan control, more extensive Phragmites control, and surveys for exotic flora. Staffing for this proposed alternative would best be served by fully staffing the Biological Program proposed under Inventory, Monitoring and Research. An extensive nutria population control or eradication program would almost certainly be contracted to USDA Wildlife Services.

Alternative C. Maximum Public Use with No Habitat Management

Management Strategies

Under alternative C, we would not control exotic, invasive, or injurious species on the Refuge Complex.

Physical Impacts

All populations of exotic, invasive, and injurious species can be expected to increase throughout the Refuge Complex. Uncontrolled damage by nutria, mute swans, and resident Canada geese (see alternative A) will lead to increased rates of marsh loss, SAV loss, and crop depredation. These habitat alterations would lead to increased soil erosion, water turbidity, and fecal contamination, and, generally, lead to decreased water quality.

Biological Impacts

Under alternative C, all populations of exotic, invasive, or injurious species can be expected to increase throughout the Refuge Complex. Uncontrolled damage by nutria, mute swans, and resident Canada geese (see alternative A) will lead to increased rates of marsh loss, SAV loss, and crop depredation.

Mute swans pose a particularly dire threat because of their territorial nature and size. Mute swan pairs will defend year-round a territory averaging 13 acres. In Maryland, mute swan pairs have been documented killing mallard ducklings, Canada goose goslings, and cygnets of other mute swan pairs (Hindman 2000). Nonbreeding mute swans may displace native waterbird colonies

(see alternative A). Their potential impact on native tundra swans is another serious concern. In the 13 years from 1986 to 1999, Maryland's mute swan population increased from 264 to almost 4,000; during the last 25 years, Maryland's population of wintering tundra swans has declined about 30 percent (Hindman 2000).

Although both species of swans feed heavily on the same SAV species, tundra swans will feed on waste grains left after harvest in early winter and on clams in late winter. The major difference, however, between the food habits of tundra and mute swans is that tundra swans do not occur in the Bay during the summer, when SAV is growing. Left unchecked, the average growth rate (15.6 percent) of Maryland's mute swan population means that the population can be expected to double by 2005. The biomass of SAV removed by mute swans will increase in direct proportion to the increase in population size and range expansion. Declines in the species diversity and total biomass of local SAV beds, habitats critically important as nursery areas and escape cover for invertebrates, shellfish, and fish, can be expected.

The uncontrolled spread of Phragmites, purple loosestrife, Canadian thistle, and Johnson grass would clearly impact native floral communities on the Refuge Complex. Invasive species often become problematic in disturbed environments, such as moist soil impoundments, croplands, and islands or uplands created by dredge spoils. These artificially created environments offer some of the most intensely used habitat for breeding and wintering waterfowl and colonial waterbirds. Failure to eradicate or control incipient populations of Phragmites, Canadian thistle, purple-loosestrife, and Johnson grass would result in the fairly rapid degradation of these enhanced habitats.

Failure to control gypsy moths would be catastrophic for the existing forest ecosystem on Blackwater NWR. Increased defoliation, mortality, and infestation by other insect pests (southern pine bark beetle, in particular) would destroy the existing age structure and species composition. Succession over much of the forest would be set back 80 years. Forest-dependent wildlife, such as forest interior dwelling birds and Delmarva fox squirrels would be imperilled. See alternative C in "Forest Management Program" for more discussion.

Socioeconomic Impacts

Under alternative C, loss of income due to crop depredation and lawn damage by increasing populations of nutria, resident Canada geese, and mute swans could be substantial. Loss of SAV due to expanding mute swan populations would lead to declines of local SAV beds, habitats critically important to commercially harvested shellfish and finfish populations.

Mute swans can be a problem for humans. Some birds may directly attack humans, especially small children, who get too close to their nests or their young. Often this territorial behavior is directed at swimmers or persons in small boats. Although the potential for serious injury is low, their aggressive, territorial behavior may be a nuisance, and can render some large land or water areas inaccessible to people during the nesting season (Hindman 2000).

Cultural and Historical Resource Impacts

In alternative C, the absence of exotic, invasive, and injurious species management would not impact cultural and historical resources on the Refuge Complex.

Administration, staffing, infrastructure, law enforcement, and other needs

As this alternative actually reduces the existing management regime on the Refuge Complex, we do not plan on added staff or administrative support specifically for this purpose.

Habitat Management—Inventory, Monitoring, and Research

Background

The Refuge Complex is a diverse ecosystem encompassing palustrine forested wetlands, upland forests, freshwater to polyhaline estuarine marshes, SAV beds, tidal and nontidal river systems, agricultural fields, the Chesapeake Bay islands, xeric dunes, and Atlantic white cedar swamps. Over 270 species of rare, threatened, or endangered plants and animals (G1-G5, S1-S3) have been documented within the Nanticoke-Blackwater watersheds including four Federal-listed species (bald eagle, Delmarva fox squirrel, sensitive joint-vetch, and swamp pink). The Maryland Natural Heritage Program has designated several Natural Heritage Areas in the Study Area (see chapter 3, “Affected Environment”).

Within this diverse system, 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 these concerns, there are three alternatives. Under alternative A, the Refuge Complex would continue at least the current level of biological monitoring described in the 1991 Station Management Plan; the monitoring of gypsy moth populations would also be included because it was initiated in 1993. Under alternative B, the Refuge Complex would 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). Under alternative C, the I&M program would be implemented and surveys that are specific to the mandates of the Refuge Complex (e.g., migratory waterfowl) would continue; however, because no active management would be occurring under this alternative, management-based research and monitoring would not occur.

Alternative(s) Considered But Dismissed

The alternative to not monitor populations of mandated species (specifically migratory waterfowl) or to not allow any research from being conducted on the Refuge Complex was considered but dismissed. These were viewed as the minimal obligations of any national wildlife refuge.

Alternative A. Species–specific Management

Management Strategies

In alternative A, the following surveys would continue to be conducted by Blackwater NWR staff: aerial waterfowl surveys, ground counts of waterfowl and shorebirds, water quality monitoring, breeding forest bird survey, muskrat house count, muskrat and nutria harvest data, spotlight deer survey, DFS benchmark site monitoring, wood duck brood counts, and eagle roost

counts. The Midwinter Waterfowl Inventory, Mid-Winter Eagle Survey, aerial reconnaissance of nesting bald eagles, colonial waterbird exit surveys, and data reporting at the hunter deer-check station would continue to be conducted in cooperation with MD-DNR. The U.S. Forest Service would continue surveys of gypsy moth egg mass and defoliation on Blackwater NWR. The UM-sponsored study of the effects of four prescribed burning regimes on above-ground biomass and species composition in the marsh would continue at Blackwater NWR (see Fire Management Plan). The Christmas Bird Count would be allowed to continue on Blackwater NWR. The banding of American black ducks, ospreys, wood ducks, brown pelicans, and other designated bird species would continue as needed on the Refuge Complex.

Physical Impacts

In alternative A, there would be no significant impacts on the physical environment. However, failure to conduct some of these surveys could result in the late detection of population changes and their effects on the physical environment. In particular, failure to monitor salinity changes and muskrat and nutria populations could result in increased marsh loss and associated erosion, turbidity, and other water quality degradation. Similarly, failure to evaluate the effects of the Fire Management Plan on marsh vegetation could perpetuate an inappropriate prescription and contribute to additional marsh loss and subsequent water quality degradation.

Biological Impacts

In alternative A, there would be no significant impacts on the biological environment due to the continued implementation of this program. However, failure to implement certain aspects of this program could be catastrophic. Failure to monitor gypsy moth populations would lead to delays in Btk or Gypcheck application and would almost certainly cause undue defoliation, decreased mast production, and tree mortality. Failure to evaluate the effects of the Fire Management Program on marsh vegetation could perpetuate an inappropriate prescription and contribute to additional marsh loss. Failure to monitor target populations, in general, can lead to the perpetuation of poor management practices.

Similarly, the failure to monitor the effects of management practices on nontarget species could be detrimental and perhaps even catastrophic in certain situations (see alternative B). For example, prescribed burning could negatively affect the quality of habitat for Neotropical passerines that nest in the forest understory, kill black rails in the estuarine marsh, or contribute to the spread of Phragmites. As described here, additional monitoring would be warranted (see alternative B).

Socioeconomic Impacts

There are no significant socioeconomic impacts under this alternative.

Cultural and Historical Resource Impacts

There are no significant impacts on cultural and historic resources under this alternative.

Administration, staffing, infrastructure, law enforcement, and other needs

As alternative A does not change the existing management regime on the Refuge Complex, additional staff or administrative support specifically for this purpose are not anticipated.

Alternative B. Conservation Biology for Trust Species Diversity

Management Strategies

In this alternative, the Refuge Complex would 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).

Given these needs, the Refuge Complex would continue those inventory and monitoring actions identified in alternative A. Additionally, alternative B would 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 would be implemented on a 500m-interval grid system for selected flora and fauna. Forest stand inventory (particularly of regenerated sites and newly protected lands) would continue. MAPS (Monitoring Avian Production and Survivorship) stations would be established on Blackwater NWR to monitor the avian response to implementation of the Forest Management Plan. The water quality monitoring program would 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 would be contracted. Similarly, one-time surveys of anadromous fish in the Nanticoke and Blackwater Rivers would be contracted.

A number of research projects would be initiated to facilitate adaptive management. As part of the Forest Management Program, funding would 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 would 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 would be evaluated. As part of the Integrated Wildlife Damage Management Plan, the use of goose repellants (FlightControl®) to reduce crop depredation would be tested. As part of a larger Region 5 initiative, Blackwater NWR would 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 would 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 would be developed to fill information gaps. In particular, this alternative would 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 would be more aggressively pursued.

Lastly, a Geographic Information System would be developed for the Refuge Complex. As base layers, this GIS would include DOQQs, DRGs, DLGs, vegetation classifications under the National Wetland Inventory and National Vegetation Classification System, and USDA soil types. Hyperspectral imagery would be used to delineate wetland communities (including invasive Phragmites and purple loosestrife distribution). LIDAR would 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, would be maintained in the GIS.

Physical Impacts

Same as alternative A.

Biological Impacts

As described in alternative A, the negative impacts on the biological environment would result from not implementing a comprehensive inventory, monitoring, and research program. In the long run, it is simply more cost-effective and biologically sound to do so. For example, Fofonoff, et al. (1998) note that 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 region. However, only 12 of the 38 species have quantitative data available on their impacts despite the fact that 21 of the 38 appeared to have potentially threatening or otherwise serious impacts on native biota. The poor quality of existing information poses a significant problem for management of introduced species since efficient management must evaluate trade-offs between impacts of exotic species, and the cost and environmental

disturbance associated with control methods. Consequently, a significant component of an integrated management program for exotic, invasive, and injurious species would be to seek funding for, and initiate, a comprehensive I&M program.

For alternative B, the proposed I&M program for the Refuge Complex would (1) determine the occurrence, distribution, and relative abundance of selected flora and fauna on the refuge unit; (2) assess long-term trends in occurrence, distribution, and relative abundance of selected flora and fauna on the refuge unit; (3) determine the occurrence, distribution, and relative abundance of selected flora and fauna within selected habitats; and (4) model habitat-species relationships. A well-designed I&M program should ensure that data are representative of the refuge as a unit, be adequately standardized to allow data to be rolled-up into regional and national databases, be robust enough that planned and unplanned habitat changes will not invalidate the baseline data, and be sufficiently sampled to permit statistical evaluations of habitat-species relationships. Such a program would allow the Refuge Complex to evaluate its contribution to the biological landscape at scales other than local, e.g., regionally or nationally. Just as significantly, such a program would cross over into the research arena by creating the opportunity to develop habitat-species models from field-collected, remote-sensed, GIS data sets.

Socioeconomic Impacts

There are no significant socioeconomic impacts under this alternative.

Cultural and Historical Resource Impacts

There are no significant impacts on cultural and historic resources under this alternative.

Administration, staffing, infrastructure, law enforcement, and other needs

In addition to the inventory and monitoring actions identified in alternative A, our preferred alternative B proposes several initiatives including the development of an ambitious Refuge Complex-wide inventory and monitoring plan, the implementation of several surveys following national and regional protocols, the development of the GIS, and the development and funding of several research endeavors. Refuge Complex staff will conduct much of the additional work proposed in alternative B under an expanded biological program. Full staffing under this alternative includes:

Supervisory Wildlife Biologist (GS-12/13) for Refuge Complex . . . . . 1 FTE
GIS/Database Manager (GS-9/11) for Refuge Complex . . . . . 1 FTE
Wildlife Biologists (GS-7/9) for Nanticoke, Chesapeake Islands, Blackwater . . . . . 3 FTEs
Biological Technicians (GS-5) for Nanticoke, Chesapeake Islands, Blackwater . . . . . 3 FTEs

Alternative C. Maximum Public Use with No Habitat Management

Management Strategies

For alternative C, the I&M program would be implemented, but only surveys that are specific to the mandates of the Refuge Complex (e.g., migratory birds, threatened or endangered species) would continue. Monitoring for selected exotic, invasive, and injurious species would continue. Forest stand inventory of newly protected lands would continue. In addition, one-time surveys of tiger beetles and migrant Neotropical birds and lepidopterans on the Chesapeake Island Refuges, and of anadromous fish in the Nanticoke and Blackwater Rivers would be contracted. Lastly, a Geographic Information System would be developed for the Refuge Complex, as described in alternative B. However, because active management would not occur under this alternative, management-based research and monitoring would be eliminated.

Physical Impacts

Same as alternative A.

Biological Impacts

Same as alternative B.

Socioeconomic Impacts

No significant impacts would occur under this alternative.

Cultural and Historical Resource Impacts

There are no significant impacts under this alternative.

Administration, staffing, infrastructure, law enforcement, and other needs

Under alternative C, the inventory and monitoring program proposed in alternative B would be implemented with Refuge Complex staff. Research would not be expanded under this alternative; however, research does not generally involve refuge staff. Consequently, this alternative would best be served by fully staffing the Biological Program proposed under alternative B, including the following:

Supervisory Wildlife Biologist (GS-12/13) for Refuge Complex . . . . . 1 FTE
GIS/Database Manager (GS-9/11) for Refuge Complex . . . . . 1 FTE
Wildlife Biologists (GS-7/9) for Nanticoke, Chesapeake Islands, Blackwater . . . . . 3 FTEs
Biological Technicians (GS-5) for Nanticoke, Chesapeake Islands, Blackwater . . . . . 3 FTEs

Habitat Management—Land Protection

Introduction

The CCP applies the concept of protection areas to a comprehensive land protection strategy. The criteria for these protection areas include (1) habitat and resource values of interest of the Service; (2) strategic importance to accomplishing Refuge mission and goals; (3) landowner interest in conservation; and (4) potential threat from development or other factors diminishing resource values.

The environmental consequences are essentially a comparison between two approaches. The first approach assumes that no comprehensive land protection strategy is in place within the protection areas that will result in additional lands being placed in conservation status or otherwise protected. This is embodied in alternative A; the proposed Nanticoke protection area will not, in fact, be created. In alternative A, all of the various technical and financial assistance programs and land protection mechanisms administered in the region will not be coordinated to maximize their conservation value and program efficiency. Land protection will remain ad hoc within the protection areas, and landowners will not be widely informed about available programs.

Conversely, alternatives B and C will utilize all opportunities to conserve, manage, and protect additional habitats, including partnerships with private landowners, as well as state and local governments. Further, a systematic approach will be leveraged with partners to ensure that landowners have access to a variety of technical and financial assistance programs specific to resource conservation. The proposed land protection strategy outlined for alternatives B and C will follow five operational principles. Table 7, “Land protection consequences by alternative,” below, summarizes the impacts of land protection associated with each of the alternatives.

1. Focus and leverage the resources and expertise of both public and private entities.

2. Use all available incentive-based conservation programs.

3. Produce either temporary conservation benefits in order to buy time, or permanent conservation benefits in order to provide certainty.

4. Positively influence the economics of watermen, woodlot owners, and farmers to ensure sustainability.

5. Produce a simple, efficient delivery system for private landowners interested in linking conservation and economic objectives.

Table 7. Land protection consequences by alternative

	Alternative A Strategies	Alternative B Strategies	Alternative C Strategies
Blackwater NWR and its Divisions	Approved protection boundaries remain unchanged; only inholdings protected.	Same as alternative A: Acquire 15,500 acres remaining in the boundaries approved in 1995.	Same as alternative A
		Use fee-simple protection, easements, landowner agreements, and other types of landowner incentives or conservation mechanisms to protect 16,000 acres in the Nanticoke protection area.	Same as alternative B
	Limited outreach to landowners regarding incentive programs.	Comprehensive outreach and technical assistance to landowners within protection areas	Same as alternative B
	Other partners leading coordination.	Service leading coordination	Other partners leading coordination.
	No systematic land protection strategy with other partners. Ad hoc use of programs.	Systematic land protection strategy with other partners. Integrated and coordinated use of programs.	Same as alternative B
Martin NWR and its Divisions	Refuges and divisions remain essentially the same size. Only inholdings acquired.	Same as alternative A	Same as alternative A
	Limited outreach to landowners regarding incentive programs.	Comprehensive outreach and technical assistance to landowners within focus areas.	Same as alternative B
	Other partners leading coordination.	Service leading coordination.	Other partners leading coordination.
	No systematic land protection strategy with other partners. Ad hoc use of programs.	Systematic land protection strategy with other partners. Integrated and coordinated use of programs.	Same as alternative B

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 Serive 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.

Programs outlined herein will be designed 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 the 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. It is 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. There is an unfortunate irony to this. 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 program areas to ensure that landowners within the protection areas are informed and educated on options available to them with respect to the endangered species issue, 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).

Alternative A. Species–specific Management

Introduction

Alternative A conveys the following basic environmental costs: (1) accelerated loss and fragmentation of habitats and wildlife populations as they presently exist, (2) continued degradation of water quality and faunal carrying capacity in Tangier Sound, and the Nanticoke and Blackwater River watersheds, and (3) loss of surrounding undeveloped farm land and upland forested areas from increasing development and commercial pressures.

Without any formal land protection strategy, we expect the rate of land fragmentation to increase, and only limited protection and enhancement of habitats for endangered species or other Federal trust wildlife to be undertaken. This will be due in part to funding limitations and the lack of long-term management by other agencies or organizations.

Although some of the management strategies, such as land protection and other forms of resource protection, will continue under alternative A by private conservation groups and existing state or local programs, conservation of the Service's trust resources and their supporting habitats as identified in this CCP relies upon the strength of existing Federal, state, and local regulations, and upon the strength of the conservation interest of the affected landowners (usually without technical and financial assistance of government-sponsored conservation programs).

Despite heightened environmental awareness, acreage is still being lost or severely degraded when existing laws prove inadequate under intense development pressure, and where insufficient and uncoordinated technical and financial assistance resources are available to landowners interesting in simultaneously conserving wildlife and achieving their economic objectives. Population growth and its associated development, particularly for waterfront property in the Chesapeake Bay region, are accelerating. In many instances, conservation-oriented landowners are often unable to maintain their property as open space because of financial pressure, tax laws, and lack of knowledge regarding incentive programs.

As undeveloped land becomes increasingly scarce, pressures for recreational, residential, commercial, and industrial development on environmentally sensitive areas will intensify. The underlying assumption of alternative A is that destruction and degradation of the wildlife habitat identified by this EA will accelerate commensurate with population growth. Local officials might consider placing a cap on building permits, assessing impact fees, or assessing a real estate tax, as possible means of controlling growth. Monies generated could be used to purchase conservation lands. A brief generic discussion of the potential development impact on selected environmental factors follows.

Physical Impacts

Topography and Soils

A prediction of the specific consequences for the physical environment under alternative A is difficult, since the degree of the impact and time involved in their occurrence ultimately depends on the density of human population and associated economic pressures and demands. However, general conclusions can be surmised. Without additional Federal-led protection of important lands, we would anticipate continued growth and development, resulting in increased traffic, housing, and population, with attendant decreases in air quality and increases in noise levels. Existing soil structure and topography are altered by development both at work sites and adjacent lands. Construction and land clearing practices on uplands create erosion and sediment transport via runoff into wetland and aquatic areas. The extensive excavation required for a subdivision layout results in the removal or covering of large areas of topsoil. Site preparation, filling, and dredging activities alter the character of the surface soils at project sites. Grading and filling operations increase the compaction of subsurface soils, decrease soil fertility, and change permeability and drainage characteristics.

It is entirely possible under alternative A that the existing owners of the islands within the protection area of the Chesapeake Island Refuges will not choose to protect themselves from the encroaching effects of sea-level rise and land subsidence. This will have substantial adverse effects as these islands are gradually submerged.

Water Quality

Despite good intentions, many landowners are forced to sell to developers or otherwise subdivide their land. Development within the watersheds, especially in the critical edge between uplands and marsh, can result in non-point source pollution. Buffer strips mandated by the Maryland Critical Areas Commission help filter pollution but do not eliminate it entirely. Amendments to existing zoning and other land use regulations often occur, permitting development on these sites.

Proposed development trends are clearly in the direction of increased residential and commercial development specifically targeted at water-, river- or bay-front-related amenities. Major development on non-wetland areas adjacent to these aquatic environments will increase surface water runoff. This will result in an increase of nutrients and effluent entering local watersheds. Home-site development produces a variety of effects on water quality. These range from the use of fertilizers and pesticides to the discharge of septic waste leachates and petroleum residue into aquatic environments.

Sea-level rise, land subsidence, salt-water intrusion and other physical changes from larger external forces will continue to act upon the lands and resources in protection areas. Service actions intended to combat, minimize, or mitigate the resulting consequences may or may not occur - decisions such as these would be retained by the many dozens of private entities that currently own or control lands within the protection area. If no programs are in place, which we

believe is the most likely outcome in the absence of Service leadership, then physical changes to the land would ultimately occur from the combined effects of sea-level rise, land subsidence, and salt-water intrusion. This would release soils into the water column, further degrading ambient water quality throughout the Chesapeake Bay.

Within the Nanticoke and Blackwater watersheds, we believe, on balance, that current agricultural, poultry, and hog production would slowly be replaced with residential developments that focus on water-dependent recreation. Additional development may occur to provide affordable housing to the growing population centers of Federalsburg (MD), Cambridge (MD), Salisbury (MD) and Seaford (DE). Lastly, sand and earth mining operations will remove rare ecological communities along the Nanticoke River. As this shift in land use occurs, future water quality conditions may degrade further from existing conditions, including increasing eutrophication and additional nutrient and sediment loading of the river and its tributaries and adverse impacts on hydrology from excessive groundwater withdrawals. Several regulatory and incentive programs administered by the State and local governments would afford some protection to water quality (surface and ground), but we believe that substantial progress will be made towards reversing or mitigating present sources of water quality degradation in the watershed and Tangier Sound with implementation of the land protection strategy as outlined in alternative B.

Air Quality

Air resources in the watershed would change from the effects of urbanization and changes in land use (human density). This is difficult to predict, but we predict that air quality would slowly degrade from increased emissions and loss of habitat, which reduce the ability of forests and fields to absorb pollutants, heat, and greenhouse gases.

Biological Impacts

General Habitat

Tiner (1994) reports improved conditions, when analyzing the national status of estuarine wetlands (salt and brackish tidal marshes). While wetlands are no longer being wantonly destroyed, tremendous pressures still exist to convert them to alternative uses. Prior to the enactment of state coastal or tidal wetland laws and strengthened Federal regulation under the Clean Water Act, these wetlands were dredged or filled at high rates.

Conversely, palustrine vegetated wetlands continue to be destroyed at alarming rates. Despite the existence of Federal regulations, nontidal freshwater wetlands continue to experience heavy losses. Nationally, Tiner (1994), reported a 12-fold increase in the net annual loss rate of forested wetlands. From 1982 to 1989 the annual loss rate was about 2,000 acres versus about 200 acres from an earlier period between 1950 to 1980. Much of this loss is attributed to increased timber harvest. In addition, almost 15,000 acres of palustrine forests were destroyed through conversion to drylands and open waterbodies (e.g., reservoirs and ponds). However, an applicant is required

to apply for a 401 permit certification through the Maryland Department of the Environment, which determines the potential for impacts on aquatic and wetlands habitats. As with the Federal permit process, certain activities are excluded or exempt. Therefore, expected future growth of residential subdivisions and water supply needs may result in further wetland losses within the Nanticoke and Blackwater river watersheds and their tributaries absent additional land protection of these important habitats.

Further, we would expect further fragmentation and short-term changes of the forested habitats in the protection areas due to residential and commercial developments and the effects of non-sustainable silviculture operations, respectively. Riparian buffers and corridors immediately adjacent to the river would be especially at risk due to the high demand for river-front or waterfront developments.

Sea-level rise, land subsidence, salt-water intrusion and other physical changes from larger external forces will continue to act upon the lands and resources in protection areas for each of the refuges in the Refuge Complex. Service actions intended to combat, minimize, or mitigate the resulting consequences may or may not occur. Decisions such as these would be retained by the many dozens of private owners of land within the protection areas of each refuge. If no programs are in place, which we believe is the most likely outcome in the absence of Service leadership, then aquatic resources would be especially impacted. For example, submerged aquatic vegetation would be smothered with sediment released from island loss. The basis of the aquatic food chain for many Service trust resources would be adversely affected by these habitat losses and their subsequent ecological effects.

With forested lands remaining in private ownership; as forest resources in the watershed become more mature, the economics of harvest will likely result in more commercially oriented logging operations. Forest health might suffer with high-grading or the application of other intensive silvicultural practices. Further, although private landowners' activities will employ forestry BMPs , a Federal owner will result in even higher protection and conservation of these terrestrial habitats. The loss of the islands' limited upland habitats would be especially harmful to their resident wildlife populations, as these habitats would likely not be replaced once inundated.

Fish and Wildlife Populations

Since there is no coordinated land protection strategy in alternative A, we would anticipate that fish and wildlife populations would be adversely affected by continued development and land conversions within the protection areas. These land use changes would also likely accelerate invasions of injurious and non-native species, further compounding the quality and extent of habitat for resident species. Most importantly; without a Service presence, it is unlikely that many specific wildlife management programs targeting Service trust resources would be deployed in a coordinated manner within the protection areas. The existing conservation ethics of private landowners in the watershed would continue to benefit a selected group of wildlife, likely those of commercial, consumptive, or recreational value, but many other species would not be the recipient of intensive management programs, habitats, and other beneficial consequences of a systematic and comprehensive land protection strategy.

Wildlife carrying capacity and species diversity decreases proportionally to the decrease of available habitat. The alteration, fragmentation, or elimination of surrounding upland and riparian habitats, and associated transition zones has a pronounced adverse impact on resident and migratory wildlife, including Service trust resources. Many species can be displaced and overall biodiversity of an area can be reduced.

Human disturbance to wildlife might increase, as protection of important habitats would be managed such that only compatible and wildlife-dependent recreation would occur. This mandate is not applicable to other entities, nor do private landowners generally focus public access programs with that goal in mind. With an eroding "natural" lands base, wildlife populations would be subjected to all of the anthropogenic influences of modern society, most notably noise, pollution, and disturbance to nesting, feeding, and sheltering areas. Without Federal or state technical assistance and financial aid to private landowners, opportunities for landowners interested in helping wildlife and participating in wildlife enhancement activities would be limited.

Lacking a comprehensive land protection strategy will led to the continued uncoordinated and disparate management of the effects of invasive, injurious, and over abundant species on native and migratory fish and wildlife populations - both on private and on public lands within the protection areas.

No new intensively managed wetland and water management systems would be created or likely come under conservation status in Alterative A, neither would any systematic attempt made to create, restore or protect additional wetland habitats. Landowners might create intensive wetland and water management systems but it would be only a ephemeral benefit to the species as a whole - as the likely focus of these actions is to offer waterfowl hunting areas. Without Federal or state technical assistance and financial aid to private landowners, no attempt would be made to comprehensively address degraded wetlands habitats or those wetlands threatened by sea-level rise and land subsidence (e.g., repair hydrological modifications, restore hydrology, replant riparian forests, protect island shorelines, remove sedimentation sources to SAV beds, etc). At best, a patchwork of various habitat management programs would be in place, each determined by the individual decisions of dozens of separate landowners.

The waters surrounding the islands support the most expansive SAV beds in the tidal portion of the Bay. Tangier Sound alone accounts for 16 percent of those beds. Without the wave buffering effect of the islands, much of this valuable aquatic habitat type will be lost. SAV provides food and habitat for fish and crustaceans, numerous other aquatic organisms, and waterfowl. The presence of SAV also indicates good water quality and the general ecological health of the Bay and its tributaries.

Despite the efforts of incentive programs for private landowners such as CREP, Maryland Tree Farm, Maryland Environmental Trust (MET), Maryland Agricultural Land Preservation Foundation (MALPF) and the Eastern Shore Land Conservancy (ESLC), very little forested habitat on the Eastern Shore could be considered permanently protected from development. Similar to the land protection benefits of those programs, Maryland's Critical Area Law does provide some protection of forest habitats. However, these incentive programs, habitat protection

programs and conservation laws cannot be applied in a strategic or comprehensive pattern to produce and protect large contiguous tracts of riparian, wetland, and upland forest habitats for FIDS and other Neotropical migratory songbirds. Over time, and as a result of increasing development, area-sensitive FIDS would likely decline. Similarly, these wildlife might suffer adverse consequences from the loss of forest acreage from uncontrolled gypsy moth or southern pine beetle infestations. The unique assemblage of species that migrates through the islands' habitats would likely be permanently lost as their habitats are lost to the combined effects of sea-level rise and land subsidence.

Limited protection for threatened and endangered species would be provided under the Endangered Species Act. However, cumulative habitat loss and lack of habitat management are identified as the primary and secondary threats, respectively, to protection, conservation, and recovery of the Federally protected threatened and endangered species. Without targeted deployment of Federal or state technical assistance and financial aid to private landowners within the protection areas, the ability for these species to recover would be diminished as no new lands would be managed specifically to their needs. Similarly, the ability to establish population management, monitoring, research, and recovery programs would be limited as compared to programs outlined in alternatives B and C. Although current wildlife laws do provide some habitat and population protection, at best, we could expect existing population levels to slowly decline as habitat quality and quantity are reduced from the effects of habitat conversion, invasive species, sea-level rise, and land subsidence.

Socioeconomic Impacts

The natural resource values of the protection areas are still very much present, because the region is still generally rural and the full pressures of development and population growth have yet to be felt. The signs for change are there, however, and recent and proposed development projects could bring more people from the Washington D.C. metropolitan area, as well as from the entire eastern seaboard. Existing zoning permits reinforce a growth pattern of scattered development along existing roadways and near navigable waters. Commercial and industrial strip development is evident on Route 50.

Under the assumption that land use character will fundamentally change as a result of the lack of a comprehensive land protection strategy, the resultant development can produce the following economic impacts:

1. County and town tax bases increase. (As demand for land intensifies and real estate values increase, the local tax base grows).

2. Demand for municipal services increases. Police, fire protection, education, road, and utilities service costs may offset tax revenue gains.

3. Construction and related service industry employment temporarily increases.

4. Tourism and recreational industry demands increase. Because of its heavy reliance on rural open space atmosphere, loss of open space negatively affects tourism.

5. Employment decreases for those whose livelihood depends on agriculture, forest and water environments. This category includes farmers, hunting guides, watermen, and foresters, and the commercial enterprises that depend upon those industries.

6. Reduction of open space.

7. Real estate and land values appreciate.

8. Property taxes increase.

9. Rates of municipal and county spending may exceed rate of growth of personal income.

The presence of homesites, marinas, and other potential developments would negatively impact the aesthetic qualities of natural areas and open space lands. The feeling of solitude and uncrowded surroundings that these lands offer would be lost.

As lands are lost to the production of food, fiber, wood, and other natural resources, changes to the economics of the rural land base occur. Jobs in forestry, agriculture, trapping, hunting, fishing, and crabbing would be lost and replaced with a suite of vocations and professions emphasizing a service industries economy. Traditional employees would be displaced.

Cultural and Historical Resource Impacts

Under private ownership, the landowner is responsible for protecting and preserving cultural resources in the study area. Residential and commercial development may destroy archaeological artifacts, historical data, and research opportunities. Research investigations conducted on private lands may be discontinued at any time at the discretion of the owners. Appropriate surveys will be conducted on a tract by tract basis.

Without a comprehensive land protection strategy, the islands in the Chesapeake Bay may essentially disappear and with them, their historical and cultural significance. An entire culture (e.g., waterman) may be lost. Landowners continually express the desire to see their properties remain undeveloped as they have for generations. However, with few exceptions, the next generation of owners no longer has similar ties and values of land stewardship. Family farms and natural habitat areas will be sold, subdivided, and developed. Just look to the areas of Harford, Cecil, and Kent Counties as the harbinger of things to come. The historic settlements of Bloodsworth, Shamps, and Holland Islands have already been lost. Smith Island, home to Martin NWR, represents the last settled island waterman community in the Maryland portion of the Chesapeake Bay.

Administration, staffing, infrastructure, law enforcement, and other needs

Under this alternative, we would not anticipate any need for additional resources (e.g., dollars and staff) applied specifically to land protection strategies. The existing staff in the Regional Office and at the Refuge Complex likely would be able to accomplish any minor protection activities (e.g., inholdings, land transfers, etc.). Regarding only land protection, the consequences for the administration and infrastructure capability of the Service would be relatively few. However, that would not be the case with our interest in protecting Federal trust resources. As development in the watershed proceeds, more and more potential conflicts between wildlife and humans will arise. The ability of the Service to successfully reduce these conflicts would be severely hampered without facilities and staff located in the watershed. In this alternative, the closest Service law enforcement response would originate from Baltimore, creating time delays and leading to coverage gaps in our resource protection programs.

Alternative B. Conservation Biology for Trust Species Diversity and Alternative C. Maximum Public Use with No Habitat Management

Because the environmental consequences of implementing a land protection strategy as envisioned are similar, the analysis of effects for alternatives B and C can be assimilated across all refuges and divisions. Therefore, they are combined for the purposes of this analysis.

As previously outlined in the introduction to the land protection strategy, it is important for the reader to recognize that no single entity can effectively protect land in all cases and circumstances. In order to achieve long-term habitat protection for the Nanticoke and Blackwater River watersheds and the islands of the Chesapeake Bay, a coalition effort has been developed and is encouraged to share both the funding and protection responsibilities. Both alternatives B and C consider the possibility that other conservation-oriented agencies or organizations, including state resource agencies, may provide long-term protection to those habitats susceptible to land use change without Service involvement. This could be accomplished individually or through the combined efforts of a variety of agencies and groups. This is currently the case where the Nature Conservancy, the Chesapeake Bay Foundation, the State of Maryland, and The Conservation Fund hold real property or perpetual easements. Similarly, other Service programs and USDA programs are in place and offer on-the-ground financial and technical assistance in support of land protection goals embodied herein.

In alternatives B and C, a variety of land protection mechanisms may be employed by members of the above-identified coalition. They 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.

The main distinction between alternatives B and C is the relative importance of Service leadership in overall land protection, in context with our other partners. In alternative B, 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. For alternative C, the Service will take an active role in the partnerships land protection efforts with other agencies, but will be less aggressive in seeking opportunities to protect, restore, or otherwise conserve lands and instead differ to the leads of other entities. Both alternatives B and C will result in essentially the same level of land protection, but alternative B will likely result in more land protected specifically through Service programs or Service aid to private landowners. Lands protected in alternative C will most likely result primarily from the efforts of our partners, as noted above.

Physical Impacts

Water Quality

A land protection strategy within the protection areas will enhance, restore, and create aquatic systems, as the Service land management focus will incorporate or exceed existing agricultural and forestry best management practices. Additionally, efforts to remove or reduce the effects of wetland and island losses would be expected to occur, thereby improving water quality. Once the management strategies outlined in alternatives B and C are in place and operating, it is likely that water quality conditions will further improve within the protection areas.

Topography and Soils

Land managed through the land protection strategy will not be subjected to the development pressures and the associated impacts on topography and soil loss, as previously described in alternative A. Minor localized disturbances from land management programs to topography and soils have been previously discussed. We do not anticipate any impacts on these features of the physical environment.

Geology and Hydrology

Land protection strategies will result in beneficial consequences for the hydrology of the protection areas, as ground and surface water quality and quantity should improve. Management programs in place after protection will address historical impacts on hydrology in the watershed. We do not anticipate any consequences for the geology of the watershed.

Air Quality

Land protection strategies will protect habitats and provide for the ability of forests and other natural lands to absorb heat and produce oxygen, thereby positively affecting ambient air quality.

Land protected for Service management and conservation will not be subjected to the development pressures and the associated impacts on air quality from vehicle emissions. Minor, temporary effects on air quality may result where prescribed fire is used as a habitat management tool. These effects are previously discussed in the Blackwater NWR Fire Management Plan, and we anticipate that this discussion applies to newly protected lands in the protection areas, where they are in Federal or non-Federal ownership.

Biological Impacts

General Habitat

Land protection strategies will focus on protecting, restoring, and enhancing more than 10 miles of the Nanticoke River and 5 additional miles of the Blackwater River, providing benefits to aquatic systems and the fish and wildlife populations that depend on them.

Approximately 15,300 acres of additional wetlands at Blackwater NWR could be potentially protected, along with 16,000 acres on the Nanticoke River by the Service. Cumulatively, this would result in substantial benefits to Service trust resources, and conserve the functions and values these wetlands provide (e.g., flood control, water quality filtration, etc). Protected palustrine forests and marshes will be managed to maintain optimal wildlife values consistent with recreational and traditional uses, where compatible.

Fish and Wildlife Populations

Overall the Service would protect 16,000 acres on the Nanticoke River and 15,300 acres on the Blackwater River. Protection of these important habitats will result in beneficial effects on fish and wildlife populations. The effects of disturbances from human development in the protection areas will be reduced, as these species will have protected lands upon which to breed, feed, and obtain shelter. Traditional land uses will be maintained to the extent possible in alternatives B and C. Landowner stewardship will continue and be rewarded via financial and technical aid. The effects of noise and excessive human intrusion will likewise decrease. Migratory waterfowl populations should rise as wetland and riverine systems are conserved, and as intensively managed wetland and water management systems are developed. Similarly, as forest tracts are managed and forest health improves, so should the population status and distribution of Neotropical migratory songbirds, forest interior dwelling species, and raptors. Colonial waterbirds, shore birds, marsh and wading birds should all benefit from conserved nesting areas free from human disturbance and ample habitat areas being managed to provide optimal forage and cover needs. The control and management of predators will enhance Populations of Service trust resources.

Populations of rare, endangered and threatened species will be conserved and opportunities to expand into previously unoccupied areas created with the use of the Safe Harbor Agreements.

Socioeconomic Impacts

With the exception of waterfront property, real estate values for the region dropped during the late 1980s and 1990s. With an increase in the desire for second homes on the Eastern Shore and recent economic activity, the trend has reversed in the last several years, with property values increasing from 6 to 20 percent annually for those lands with potential for waterfront-oriented residential and commercial developments. Statewide, land values for agricultural lands have increased about 10 percent in the last 5 years (1996-2000) (Source: Maryland Agricultural Statistics webpage 2000). Forest lands have also seen moderate increases in value, but a troubling statistic is the continued trend to smaller and smaller ownership patterns (Source: Maryland Forest Service webpage 2000).

Land protection, particularly by acquiring lands through either fee title purchase or conservation easements, is unlikely to adversely affect land values within the region or county in which the land is protected. The demand for residential living opportunities and employment or retirement opportunities within the region will continue, with or without additional acreage enrolled in the land protection strategy envisioned above.

It is possible that the reduction of developable land will cause property values of similar properties outside of the protection areas to increase marginally as the same level of demand for residential and commercial locations will have to be satisfied by a relatively smaller supply of vacant land. However, since refuge protection is based on willing sellers and uncertain annual funding appropriations, any change will be gradual. Other elements of the land protection strategy will provide economic and regulatory incentives to landowners interested in retaining the conservation value of their land, or retaining it in a wildlife-compatible economic enterprise. Some landowners may wish to parse, or parcel, areas of the lands where these conservation programs apply and omit other areas; that is their prerogative. We expect that this will represent only a small percentage of the available lands within the protection areas, and that a percentage of this land will not have substantial resource value (e.g., adjacent to roads, disturbed lands, or land outside of the protection area). Therefore, we do not expect property values to change significantly inside the protection areas.

Developers and officials often argue that by adding ratables to the local tax base, their proposed development will reduce local property taxes. They neglect to mention or analyze the cost to the community of providing services toward that development. Taxes must be raised to pay for services. It must be realized that the profit to a town for a piece of property is the income received (i.e., taxes) minus the cost of the services. Services include schools, garbage removal, water supply, sewage disposal, health and welfare, police, fire protection, roads, utilities, and local administration. Raising taxes has and is forcing farmlands in Maryland and Delaware into the realty marketplace. Nation-wide, approximately 90 cents of the tax dollar today goes for schools. In a report on local tax savings from open space preservation, Gooenough (1965) reports that in 1960 the village of Mamaroneck, New York, approved the construction of a large garden apartment Refuge Complex on vacant land, which ultimately resulted in higher taxes for <u>all</u> property owners. The development was said to have paid $43,415.00 in school taxes, but the

Board of Education figures showed a cost of $107,800.00 to educate the children living in the apartments.

The American Farmland Trust (AFT), a national organization for the preservation of farmland, initiated a 1986 study of the fiscal impact of development in rural Loudoun County, Virginia. Between the years 1972 and 1982, Loudoun County lost more than 25,000 acres of prime farmland to development. The AFT study concludes that "in virtually all cases, the increased public cost for education, health, welfare, safety, and other public services associated with new residential development have been shown to exceed the increased public revenues generated by them." Three subsequent AFT studies, including communities in Connecticut and New York produced similar results.

The AFT also reports that studies in four southern New England towns exhibited a similar pattern. Farm, forest, and open lands more than paid for themselves. In fact, it was found that they helped support residential services. For every dollar of revenue raised from the residential sector, the towns spent $1.11 on residential services. But for every farm, forest, and open space dollar, only 34 cents was spent on public service, leaving 66 cents to offset other municipal expenses.

On Nantucket Island, Massachusetts, studies by the Nantucket Land Council show that the taxpayers subsidize development. The building boom of the 1980s caused the town's operating budget to increase more than 26 percent a year. As a result, property taxes more than doubled between 1982 and 1988. Town revenues could not match the expenditure growth because the average cost of servicing a new dwelling unit exceeded the taxes paid by that additional unit by $269.00. Simply stated, new dwellings, in this case, did not carry their weight in the tax rolls, and the rapid growth forced the Town of Nantucket to borrow money, resulting in a debt that is now six times that of 1982.

One should not conclude from the cited studies that all residential development is financially threatening to a county or town. Well planned and sited developments can have a positive fiscal impact on local revenues. People with high incomes and retirees who are financially secure are attracted to the Eastern Shore because of its low property taxes and relatively inexpensive land. Such people may be willing to pay a rather substantial price for waterfront property and proceed to build homes, which will more than pay for the municipal services required. However, low density, large lot developments often cost communities an average of three times more in service costs than cluster development. Naturally, cost will vary depending on the extent of services provided.

Caputo (1979) has identified five economic benefits associated with open space preservation (e.g., parks, refuges, recreation areas). First, lands adjacent to public parks or natural areas were found to increase in value faster than the respective municipality average. Property values and appreciation here in the Northeast generally increase 20 to 30 percent for residential property immediately adjacent to state or Federal wildlife management areas or refuges. The actual percentage increase, however, will vary from town to town and state to state. A survey of 15 lakes and reservoirs in Pennsylvania that evaluated impact on local land values (EPP 1971) showed that the total taxable land value of an area that develops recreational sites will increase

over time and will increase more rapidly than comparative taxable land that does not develop recreational resources. The lakes survey studied range in size from 160 acres in two state parks to more than 21,000 acres in the Corps of Engineers Kinzua Reservoir. As property values increase, assessments increase and more property tax revenues are realized.

There could be some problems in land protection efforts because of the roll-back of tax exemptions. The counties would have to make a formal decision on a case by case basis, guided by state law. Preliminary inquiries by the Service, however, have indicated that this would not be a problem as land use would essentially remain the same. Revenue sharing payments for the counties would compare favorably with or exceed current tax rates. When fully funded, the revenue-sharing rate is three-quarters of 1 percent of fair market value.

Due to community concerns about the removal of lands from agricultural production, the Refuge Complex long ago instituted an approach that existing land uses will be maintained, consistent with a compatibility determination. This policy will extend to most agricultural lands protected or protected within the protection areas (exceptions are noted in the next paragraph). Further, where feasible and appropriate, most prior-converted wetlands will be developed into moist-soil impoundment units or otherwise managed for agricultural production to benefit migratory and wintering waterfowl populations. Landowners always have the option of maintaining lands in wildlife-compatible uses, including certain farming and forestry operations. Agricultural production and farm income statewide or on the Eastern Shore will not be significantly affected by the implementation of the land protection strategy as envisioned.

Open space farms and wildlands are resources that are declining in the region and nationwide. Some areas can be kept in a manner that is usable for wildlife and recreation, but creation of new wild open space in the true sense is impossible. Under Service protection, there would be little or no major change from present land-use patterns. Some prior-converted wetlands will likely be allowed to revert to palustrine forest in order to prevent erosion to adjacent riverine and aquatic systems and to assist in many of the goals and objectives as outlined. Agricultural practices on some remaining lands will be modified to provide feeding and sheltering areas for migratory birds, with programs and strategies similar to those already employed on the Blackwater unit of the Refuge Complex. Protection monies can be used to purchase conservation easements from landowners who are interested in continuing their current use, while selling their development rights. Such a program would allow former landowners or tenant farmers to continue raising crops on certain protected lands, or portions thereof, while also providing wildlife benefits. Lease back agreements are also possible, which would give the seller or others who rent the property an opportunity to continue using the land for crop production. Agricultural land could remain in production, thus, helping to maintain the livelihood of the farmer. The farmer or landowner would have the first refusal option to enter into a lease back agreement, while the tenant or party renting the land would be given the second option.

Property Taxes and Refuge Revenue Sharing

If the Service were to purchase property that has been in a land use program, the seller could be liable for any back taxes that he was excused from paying under the plan. The Department of the Interior’s Solicitor has ruled that these payments are not part of the protection cost and are,

therefore, not reimbursable to the seller. In the open market, when a landowner sells and knows that the land is going to be developed, the cost of the back taxes is added to the selling price. Preliminary talks with county officials, however, indicate that roll back taxes will not be applied to transactions involving land sales for refuge and conservation purposes where the land use will essentially remain the same.

Any lands the Service protects in fee ownership would be removed from the tax rolls. To offset that fiscal impact, the Refuge Revenue Sharing Act of 1935, as amended in 1978, provides for payments in lieu of taxes. the following formulas determine the annual refuge revenue sharing entitlement for the taxing authorities: (1) 75 cents per acre; (2) three-quarters of 1 percent of the appraised market value of the land; or (3) 25 percent of the net receipts of the revenue produced from the land, whichever is greatest.

Formula 2, calculated at three-quarters of 1 percent of the property's fair market value, results in the highest rate of return to the local taxing authorities and, thus, would be the formula from which revenue sharing payments would be calculated. The level of payment(s) that would be generated under formula 2 is based on land use classification and purchase price. The amount of payments on those lands classified for agricultural and timber could range from 40 to 60 percent higher than the actual taxes now assessed.

Land subject to Refuge revenue sharing payments is reappraised every 5 years. The appraisals set the fair market value of the land, based on its highest and best use. If the appraiser determines that the land's highest and best use in the absence of a refuge were residential or some other type of developed use, the appraised market value is based on the value of similar parcels in that use. The appraised market value of the lands owned in fee by the refuge, and, therefore, the revenue sharing payments, would change over time as the value of non-refuge lands change.

Table 8. Revenue sharing payments by county (1994–2000)

County	FY 2000	FY 1999	FY 1998	FY 1997	FY 1996	FY 1995	FY 1994
Dorchester	$73,510.00	$78,304.00	$78,095.00	$81,436.00	$79,878.00	$60,972.00	$70,479.00
Somerset	$3,272.00	$3,730.00	$4,006.00	$4,257.00	$4,663.00	$8,766.00	$10,287.00
Harford	$153.00	$174.00	$187.00	$198.00	$217.00	$197.00	$307.00

Revenue sharing payments are calculated at 75¢ per acre, three-quarters of 1 percent of appraised value, or 25 percent of net revenue, whichever is greatest.

Population, Employment, and Area Income Levels

The use of our land protection strategy within the identified protection area, including any use of fee-simple or easement protections, would not materially change the projected level of population, employment, or income growth within the region, although it could affect the distribution of this growth. For example, it would preclude residential and other development on

waterfront parcels. However, the demand for residential development is not expected to decrease; only its distribution within the region or within a particular county may change.

One main purpose of our land protection strategy is to preserve unimproved lands of high quality habitat. Relocation of property owners is not anticipated and will be avoided. However, if circumstances dictate, relocations would be conducted according to the provisions of the Uniform Relocation Assistance and Real Property Protection Policies Act of 1970, as amended. The Act differentiates by length and type of occupancy (owner or renter) as to the exact benefits to be received. In general, however, an owner-occupant of more than 180 days will be reimbursed for reasonable moving expenses and will receive a payment for replacement housing cost differential, including the difference between protection price and purchase price of comparable new housing, inclusive of differential interest costs and closing costs, up to a specific limit.

Agricultural operations are entitled to additional benefits related to the costs incurred in identifying suitable replacement property and moving the business or agricultural operation, up to a specific limit. Because the lands to be protected have not yet been identified, beyond defining them as protection areas, it is not possible to estimate the number of residences or agricultural operations that may be affected or costs of relocation. Most of the land being considered for inclusion within the refuge does not contain improvements. Thus, relocation is not anticipated.

The marshes, SAV beds, and other wetland habitats of the protection areas support an extremely valuable commercial and recreational finfish and shellfish industry. For example, the Nanticoke River at one time contributed 12 percent of the striped bass production in Maryland waters that historically yielded approximately 10 percent of the entire the Chesapeake Bay landings. Oysters and blue crabs are also important commercial fishery resources that depend upon the protection and management of these important wetlands. Collectively, the habitats of the Nanticoke and Blackwater River watersheds and Tangier Sound (surrounding Martin NWR) are the most significant nursery area for blue crab larva in the Chesapeake Bay. Blue crabs support a multi-million dollar commercial and recreational finfishery. Finfish species of commercial and recreational value include striped bass, weakfish (trout), summer flounder, and herring.

The natural resources of the Chesapeake Bay and the waters surrounding the Chesapeake Island Refuges of the Refuge Complex make a substantial contribution to the economic health of the State of Maryland and the Nation. Protecting, restoring, and enhancing these habitats will provide opportunities to support, and may, over the long term, maintain or even restore the economic vitality of these industries and the quality of life of State residents and others, and provide for the continuation of the cultural heritage of Maryland’s watermen, by generating:

1. $60 million in commercial fin fish and shell fish landings;

2. $275 million in direct expenditures for recreational fishing, with a total economic impact on Maryland of $524 million; and,

3. $1 billion in expenditures and 18,000 jobs related to Chesapeake Bay boating activities

The Dorchester County Department of Tourism estimates that Blackwater NWR visitors annually spend $15,000,000 in the county, and have a tremendous impact on local restaurants, hotels, retail merchants, and other businesses. With the opening of the Hyatt Regency Conference Center, these figures will likely double. Approximately 70 percent of adjacent county motels are rented to people who visit Dorchester County. Almost 10 percent of all Dorchester County residents derive their income from natural-resource-related jobs that are affected directly or indirectly by the refuge. Both Dorchester and Wicomico counties will realized additional economic benefits from the additional public use planned in alternatives B and C. The existing staff and operational budget of the Refuge Complex also contributes to the local economy through their purchase of goods and services.

In summary, the effects on the socioeconomic environment from implementing either alternative B or C will be, at worst, neutral or benign. We think it more likely that beneficial effects will occur, and that the Service will continue to expand its positive influence on the regional economy. Alternatives B and C require a much larger operating and maintenance budget than at present, which would also provide jobs and income to the local and regional economies.

Cultural and Historical Resource Impacts

The implementation of our land protection strategy will enhance cultural and historical resources by providing direct protection and management, dovetailing with the existing shoreline restoration projects for the Island Refuges. Smith Island's culture is shaped by its history, its location in the Chesapeake Bay, and its environmental resources. The island's unique culture and relative isolation continue to be strong influences on the recreation activities of its residents. When not actually crabbing, oystering, or fishing, watermen and their families spend considerable time maintaining and preparing their boats and equipment. These tasks, such as making crab pots, require time and care that might otherwise be invested in more recreational crafts, such as wood working and carving wooden decoys. Bicycle riding is a popular form of recreation as well as a practical way to get around on the island's narrow lanes. Island residents report that gardening and raising the rose bushes common in earlier times has been more difficult as the land has become wetter. Based on conversations with tour boat owners and island residents, we estimate that approximately 40,000 tourists visit Smith Island each year, drawn by its natural beauty and quiet charm. By participating in a comprehensive land and habitat protection plan, the Service will help preserve the waterman culture. The community of Tylerton dates back to the early 1600s, and has a long and rich cultural heritage. It remains a unique community within the Chesapeake Bay area, and attracts tourists, journalists, students, and writers.

Administration, staffing, infrastructure, law enforcement, and other needs

Notwithstanding the development and implementation of any management programs, the result of our land protection strategy will place more land in conservation status within the protection areas. The Service envisions utilizing existing staff and NGO assistance to organize the

comprehensive landowner outreach and education component of the land protection strategy. Concomitant organizational and logistical support (e.g., vehicle, computer, office space, outreach materials) will be necessary for the Refuge Complex. Overall, having one dedicated person available to orchestrate and facilitate the efforts of the various parties already in the business of land protection, landowner financial aid, and landowner technical assistance will be crucial for its success.

Additional staff or contractor support is needed immediately to implement management programs on lands enrolled in the land protection strategy, including boundary posting, habitat and species inventory and monitoring, creating restoration plans, outreach, and other, similar responsibilities.

Public Use Management—Hunting

Introduction

This section discusses the environmental consequences of providing hunting opportunities in each of the alternatives for managing the Refuge Complex. The three management alternatives discussed below are also discussed in full detail in chapter 2, "Alternatives."

- Alternative A would restrict hunting to a 4-day shotgun season for white-tailed and sika deer on Blackwater NWR only.

- Alternative B would increase hunting opportunities to include archery deer hunts, youth deer hunts, muzzle-loader deer hunts, and shotgun deer hunts for Blackwater NWR and Nanticoke protection area; spring turkey hunting on both refuges; spring resident goose hunting on the entire Refuge Complex; and, migratory waterfowl hunting on 40 percent of the newly protected areas of the Refuge Complex.

- Alternative C would increase hunting opportunities even more, to include forest game, small game (except squirrels), big game, and waterfowl in all areas of the Refuge Complex, with no quota system, but in conformance with State seasons, species, hunting methods, and bag limits. Please note, however, that the Secretarial Order closing Martin NWR to the taking of waterfowl would remain in effect.

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.

Alternative A. Species–specific Management

Strategies for Blackwater NWR

Big game hunting for white-tailed and sika deer would be permitted for 4 days of shotgun hunting (generally Mondays and Fridays of the 2-week State season) annually on Blackwater NWR, in accordance with State regulations. Deer hunting would occur on approximately 7,000 acres, which is 30 percent of the refuge and 70 percent of the habitat occupied by sika and white-tailed deer. The white-tailed deer is more abundant in the higher woodland areas near agricultural fields of corn and soybeans. Sika deer are more common in the lower and wetter areas of the refuge woodlands and, at times, in the marsh.

Hunting areas would be located in upland forest and forested wetland habitat, away from public use areas, away from high-density waterfowl use areas, and away from most of the marsh and open water. Portions of the marshes adjacent to forested wetlands would be hunted for sika deer; however, these areas would not be intensively used by waterfowl, as evidenced by past biweekly aerial waterfowl surveys. No other hunting would be available for the public on Blackwater NWR. The Wildlife Drive would be closed to other, non-hunting visitors during the 4-day shotgun hunt. The remainder of the Blackwater NWR hunt areas would be closed to other types of public entry throughout the year. A check station would be operated by staff to collect biological data on harvested deer.

The refuge would be divided into hunt areas defined by readily identifiable boundaries. Hunter densities in each hunt area would be no more than one hunter per 20 acres, and could range as high as one hunter per 40 acres.

Strategies for the Chesapeake Island Refuges

There would be no opportunities for hunting on the Island Refuges.

Physical Impacts

Impacts from the 4-day shotgun hunt on Blackwater NWR would be anticipated to be minimal, as demonstrated by closely monitoring the impacts of annual hunts during 1972 and from 1985 to present. Impacts on habitats would be expected to be minimal and then only temporary, as trampled ground vegetation would recover. During the firearms season, vehicles would be restricted to designated roadways. There would be no off-road vehicles or ATV use allowed during any hunting season.

Biological Impacts

Impacts on wildlife would include the harvest of deer. A regulated deer hunt would be essential to accomplish the goal of managing a healthy deer population. Deer would be managed to minimize the potential for serious habitat alteration or degradation and density-dependent diseases. It would also help reduce crop depredations on refuge and adjacent landowner’s crops. Other species of wildlife would experience temporary negative impacts in the way of minor disturbances from hunters in the area. On the other hand, reduction in the size of the deer herd would benefit other species of wildlife (Delmarva fox squirrel and waterfowl) in that competition for food would be reduced.

Without natural predators or some means of population control, the deer herd would exceed the carrying capacity of refuge environments and would be regulated by natural means of disease and starvation. Over population would cause crop depredation problems, over-browsing within native hardwood stands and reforested tracts, and damage to trees from rubbing of antlers on trees.

Habitat degradation by deer would negatively impact other wildlife that depend on this habitat. Deer hunting would help keep deer within the carrying capacity of their habitat.

When the population exceeds the carrying capacity, biological parameters within the herd (APC's weight, antler size, reproductive rates, etc.) indicate the deterioration of the herd quality. Stress factors associated with overpopulation would become acute, causing diseases and high mortality. Dickerson (1983) noted the drastic effect of the "no hunting" approach to deer management. He examined harvested deer from a state park in New York where hunting had been prohibited for 71 years. Through these observations, he concluded that due to the lack of hunting, the deer herd was in the worst physical condition of any he had observed in New York and possibly the northwest. Hunting seasons would be adjusted annually to take into consideration changes indicated in herd quality by biological monitoring. Blackwater NWR would continue to limit the number of hunters and number of hunt days, based on the yearly evaluation.

Impacts on threatened and endangered species and their habitats would be minimized by taking several precautions. In accordance with the "Management Guidelines for Bald Eagles in the Chesapeake," hunting near eagle nests would be restricted to a minimum radius of 250 yards. Open marsh areas, where eagles typically feed, would be entirely closed to hunting, and eagle roost sites would be protected by a ¼–mile minimum buffer zone where no entry would be permitted. Eagle activity usually increases in late December and nesting begins in early January, well after hunting seasons would end.

Delmarva fox squirrels are found in the upland hunting areas, but hunter–squirrel encounters would be expected to be brief and generally non-disturbing. Almost 100 percent of white-tailed deer hunters use deer stands (tree stands must not damage the tree), when questioned during hunter check-in at past Blackwater NWR hunts. Consequently, most hunter movement involved going to and coming from their stand. Law enforcement patrols during past hunts observed very little movement from deer hunters. Furthermore, sika deer are hunted primarily in wet forest, where Delmarva fox squirrels are seldom observed. Deer hunting would have little impact on the Delmarva fox squirrel.

Waterfowl, shorebirds, and marsh and water birds use areas, such as the moist soil impoundment system, adjacent cropland, and marsh, would be closed to hunting, and would not be impacted.

Hunting, while maintaining herd numbers within acceptable levels, would provide opportunities to utilize a renewable resource. Hunters would be oriented to Blackwater NWR rules before going into the field. They would receive a copy of the hunting regulations with their application. The hunting would be zoned to minimize contact between hunters and non-hunters. Areas along the Wildlife Drive would be closed to the public during the 4-day shotgun hunt.

Socioeconomic Impacts

Closing the first half of the Wildlife Drive and associated self-guided trails on Blackwater NWR during the 4-day shotgun season would produce a negative impact on visitors. Although the

Visitor Center would remain open and would be unaffected by the deer hunt, visitors who had traveled some distance to see Blackwater NWR would be disappointed and, possibly, irate at not being able to see most of the only area open for public observation. However, weekday only hunting would not seriously affect many visitors.

Cultural and Historical Resource Impacts

There would be no cultural or historical resource impacts.

Administration, staffing, infrastructure, law enforcement and other needs

With only one ORP and one collateral duty law enforcement officer, staff would not be able to do a good job managing and enforcing the hunt program. Preparation and mailing applications and regulations; collecting, recording, and depositing hunt fees; processing applications; conducting a complicated 4-day drawing for the hunt area selection; maintaining hunt areas and signs; conducting the hunt; and recording hunt results by the biology staff would involve a great deal of time that would not be available to the ORP or law enforcement officer. Other duties and the hunt program would suffer causing a negative impact on the program, the hunters, and the visiting public.

Alternative B. Conservation Biology for Trust Species Diversity

Strategies for Blackwater NWR

The number of hunting days and types of hunts at Blackwater NWR would be increased, as would the acreage available for big game hunting (approximately 10,430 acres, and increasing with protection). Big game hunting for white-tailed and sika deer would 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 would be prohibited, and hunters would walk in from existing designated parking areas. During the firearms seasons, vehicles would be restricted to designated refuge roadways. There would be no off-road vehicle or ATV use allowed during any hunting season. There would be no access allowed by boats during any of the big game hunting seasons. The first section of the Wildlife Drive would 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 would 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 would 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 would honor the commitments related to Blackwater NWR protections where the Service assured the public that the historical tradition of hunting deer would be permitted if compatible with the objectives of Blackwater NWR. With the protection of additional property, the refuge would open other areas suitable to hunting with the number of hunters per acre the same, and would increase the number of total hunters accordingly. Check stations would 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 would be required to be checked at a Maryland DNR certified checking station. An annual hunt program would be prepared and submitted for review prior to July 1. Summaries of the biological information would be published in the Annual Narrative Report. Administrative fees would be charged for the permits. Senior citizens and youth would receive a 50-percent discount on these fees. Fees would be utilized to hire a hunt program coordinator and maintain parking areas and signs.

One area of the refuge would be designated for certified wheelchair-bound big game hunters. Hunt leaflets, regulations, and maps would be prepared and published annually, and distributed to hunters. Refuge-specific regulations would be published annually in the Federal Register and codified in Title 50, Part 32. A hunter database would be maintained to facilitate mailings and distribution of information. Blackwater NWR would continue the same precautions for threatened and endangered species and migratory waterfowl as in alternative A. Hunting would 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 would continue to ensure that the deer hunt remained biologically sound.

Deer hunting, while maintaining herd numbers within acceptable levels, would continue to provide opportunities to use a renewable resource. Hunting seasons would be adjusted annually to take into consideration changes indicated in herd quality by biological monitoring (APCs, antler size, reproductive rates, etc.).

By April 2003, Blackwater NWR would be open to spring turkey hunting in accordance with State season regulations. Spring turkey hunting on a quota basis would be open Tuesdays and Saturdays for 4 weeks (8 days) during the State season (April 18 to May 16). Turkey hunting would 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 would not occur as specified in the Annual Hunt Plan. Scout days would be authorized the day before each hunt day. New areas would be evaluated and considered as they are protected that would not conflict with public use areas or endangered and threatened species (bald eagle) and would not have a negative impact on other wildlife and habitat resources or public safety. A compatibility determination would be completed for the Blackwater NWR turkey hunt before it would be initiated.

By December 2006, Blackwater NWR would 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 would occur in areas that would not conflict with public use or endangered and threatened species (bald eagle) and would not have a negative impact on other wildlife and habitat resources or public safety. Boating access to the hunt areas would be closed to non-hunters during the hunting season. Resident goose hunting would 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 would 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) would be issued providing 810 recreational waterfowl hunting opportunities. New areas would be evaluated and considered as they are protected that would not conflict with public use areas or endangered and threatened species (bald eagle), would not have a negative impact on other wildlife and habitat resources, or adversely affect public safety. Retrievers would be permitted.

Waterfowl hunting, in accordance with state seasons, species, bag limits, and hunting methods, would be permitted on 40 percent of all new protections. This proposed hunting opportunity would 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 would make it impossible to conduct the increased programs and activities. Therefore, new Law Enforcement Officers would be hired to enforce hunting regulations in addition to their other duties.

A Hunt Coordinator would 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 prepare record of hunt statistics. With the increased deer hunts, a spring turkey hunt, a spring resident Canada goose hunt, a new waterfowl hunting program, and expansion of hunting in newly protected property, a full-time Park Ranger would be required to fulfill all the duties necessary for the Hunt Program.

Strategies for the Chesapeake Island Refuges

With more than 5,000 acres available on the Island Refuges, waterfowl and rail hunting would be proposed where compatible in areas not affected by Secretarial Closing Order. Quota waterfowl and rail hunting, in accordance with state seasons and bag limits, would 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 would be no hunting on Martin NWR as stated in the Secretarial Closing Order. There would be no hunting on Bloodsworth Island for human safety.

Physical Impacts

Impacts on physical resources are expected to be minimal and only temporary, as trampled ground vegetation would recover. Personal observation by Blackwater NWR staff of the habitat during hunting season would lead a biologist to suspect that the deer population, especially bucks, damage more vegetation than the hunters would. Trampled vegetation would still have ample time to recover between the additional turkey hunt in the spring and the deer hunt in the fall. The resident Canada goose hunt and migratory waterfowl hunts on 40 percent of newly protected areas would be in marsh, fields, and on open water. The hunters would only travel to and from their blind site, disturbing a minimal amount of vegetation that would recover quickly after the hunt season. For impacts associated with the spring hunt of resident Canada geese, see the EA for an Integrated Wildlife Damage Management Plan.

Biological Impacts

That big game hunting would have little impact on other wildlife has been demonstrated for many years on these lands, whether in Federal or private ownership. Deer would be killed, but hunting would serve as the major control mechanism to keep a healthy herd with less stress and mortality from diseases caused by overpopulation. The size and locations of areas for hunting would be designed to balance opportunities for hunting while still maintaining substantial areas as sanctuaries for all species of wildlife. All sensitive areas important to endangered species would be closed to hunting.

The total acreage for migratory bird hunting would be within the 40-percent limit prescribed by the Migratory Bird Conservation Act. The hunting of resident Canada geese in the early spring would occur after the migratory waterfowl have left the area, and would not occur in sensitive nesting areas for colonial, marsh, and water birds, or endangered species. Removing these highly injurious species would greatly help the restoration of the fragile marsh ecosystem, eliminate the depredation of important food resources during the growing season, and minimize the transmittal of disease to migratory waterfowl. Since waterfowl hunting would only occur on 40 percent of newly protected lands on the Complex, inviolate sanctuaries with no disturbance would remain on more than 23,000 acres of Blackwater NWR, more than 3,000 acres on the Chesapeake Island Refuges, and a minimum of 10,000 acres on the proposed Nanticoke protection area. Waterfowl harvests would occur, but the overall numbers would not adversely affect refuge purposes or State or Atlantic Flyway populations.

Limited spring turkey hunting in accordance with the restrictions and numbers of hunters proposed would have insignificant impacts on biological resources, except that, obviously, a few turkeys would be killed. However, their removal from the population would not have significant impacts on the species or its abundance.

Socioeconomic Impacts

The increase in hunting would provide recreational opportunities for more than 4,000 to 5,000 hunters at Blackwater NWR, and, eventually, that many on the proposed Nanticoke protection area. These activities and programs would produce a positive impact on refuge management, visitor attitudes, and local economy. The local purchases of gas, food, lodging, hunting licenses, equipment, and supplies by the increased number of hunters, especially those from other areas like Pennsylvania and Western Maryland, would contribute substantially to the local economy. They would spread the word to their friends, encouraging them to come to the area to take advantage of the high quality recreation and, thus, positively affect the economy of the area. Deer hunting would also contribute to the reduction of vehicle damage and human injury from collisions between deer and vehicles.

We expect favorable support from hunters and hunting clubs, especially those desiring to hunt sika deer, but there may be some unfavorable reaction from hunters who own or lease lands adjacent to refuge property, who have possessive feelings about the refuge deer, since deer are often shot as they move off the refuge. Others may favor the refuge hunts, since they offer additional opportunities increased success as deer move off the refuge onto their properties. Adjacent landowners and farmers generally would favor the deer hunt as helping to reduce crop depredation.

We expect unfavorable responses from anti-hunting and animal welfare groups. Generally, the local community is hunting oriented and, in the past, has supported refuge hunting. Some negative impact may arise from conflicts among refuge user groups, but most areas have been properly zoned.

Increased hunting opportunities would increase the number of licenses and duck stamps sold, as well as the amount of locally purchased hunting supplies. According to Dorchester County Tourism and Economic Development Office statistics, hunters would contribute more than $1,500,000 annually to the local economy by participating in the proposed hunts.

Cultural and Historical Resource Impacts

There would be no impacts on cultural or historical resources predicted.

Administration, staffing, infrastructure, law enforcement, and other needs

Having full-time permanent Law Enforcement Officers and a full-time permanent Hunt Coordinator would definitely have a positive impact on the refuge staff and the public. Law enforcement positions would provide compliance with refuge regulations, year-round protection for wildlife and their habitats, and better safety for hunt participants. A Hunt Coordinator would provide administration for the increased hunts; provide visitor assistance for the hunt programs, improve customer service, make a positive impression to customers and the public, provide

maintenance of signs and parking areas, and otherwise assist hunters in following regulations and enjoying a good hunting experience.

Alternative C. Maximum Public Use with No Habitat Management

Strategies for Blackwater NWR

Hunting would increase: forest game (150 hunting days); small game except squirrels (150 hunting days); big game (105 hunting days); and waterfowl (184 hunting days), in conformance with State species seasons and bag limits, and with no quota system. Hunters would be authorized to use refuge roads during all hunting seasons. The seasonal restrictions and waterway closures on Blackwater NWR would be eliminated. Waterfowl hunting would be authorized for the maximum 40 percent of all respective refuge areas. Recreational turtle trapping would be permitted in all areas according to State seasons and regulations.

Kiosks and parking areas would be constructed for each hunt area to provide hunt maps and hunting information. Signs would be installed to provide hunting information for hunters. Vehicles would be restricted to existing roads. Two additional full-time Law Enforcement Officers would be hired to enforce hunting regulations for the increased number of hunters and increased hunt areas and other refuge regulations. In accordance with the Management Guidelines for Bald Eagles in the Chesapeake, the refuge would continue to restrict hunting near eagle nests to a minimum radius of 250 yards. Eagle roost sites would be protected by a ¼–mile minimum buffer zone where no entry would be permitted.

Strategies for the Chesapeake Island Refuges

Approximately 5,000 acres would be approved for both waterfowl and rail hunting, in accordance with state seasons and bag limits, with no quotas on the number of hunters. Under the Secretarial Order against the taking of waterfowl, there would be no hunting on Martin NWR, or on Bloodsworth Island, because of safety issues.

Physical Impacts

An unlimited number of hunters, for 150 days of the year, unrestricted by time or space, would destroy vegetation in some areas if they chose to concentrate there. Roadways and parking areas would consistently be over-used, rutted, and subject to increased erosion.

Biological Impacts

Alternative C would create the potential for increased negative impacts on non-target species of wildlife and their habitats. There would be no sanctuary areas. The alternative would increase stress on wildlife species, and increase the potential for conflicts between hunters and other

refuge users. Increased human activity in general would be expected to cause greater disturbance to wildlife and wildlife habitat at varying degrees depending on the intensity of the activity. Hunter quality and success would most likely be much reduced.

Waterfowl, forest, and big game species should remain healthy if hunting limits continued to be established by state regulations based on previous harvest and populations. Restricting waterfowl hunting to 40 percent of newly protected areas would have a minimal effect on the total waterfowl population already restricted by state regulations. Annual turnover rates for small game species (e.g., rabbit and raccoon) are generally high due to natural mortality. As a result, normal hunting mortality would not affect the annual breeding population. The annual hunting occurring under this alternative would not affect the overall status of these species.

The incidental take of the endangered Delmarva fox squirrel would become more likely with the addition of small game hunting. Although the Refuge Complex would restrict hunting near eagle nests and roosts, increased types of hunting, especially waterfowl hunting, would include areas in the open marsh where eagles typically feed, and when eagles are nesting. This could cause a negative impact on the threatened bald eagle.

In comparison with the other, more restrictive alternatives, hunting on this scale would modify the distribution and use of various habitats by migratory birds, affect their activity budget, reduce their foraging time, adversely affect their ability to store fat reserves necessary for migration and breeding, disrupt pair and family bonds, and contribute to increased hunting mortality.

Socioeconomic Impacts

Hunting in all refuge areas would discourage, if not prevent, birders, photographers, and other visitors from using refuge properties during hunting seasons. Non-hunters would be irate, extremely disappointed, and upset after having traveled to these refuges to find they were unable to take advantage of the wonderful opportunities to observe wildlife in their natural habitats. Visitation for activities other than hunting would decrease, while visitation for hunters would increase up to a point, and then most likely even hunter numbers would decline as hunt quality and success declined. As a result, visitor use of restaurants, lodging, service stations, and other facilities would decline. Hunters are not as likely to take an interest in other tourist industry activities as the wildlife observer, and would not be as likely to visit other attractions, thereby creating a negative effect on the tourist industry.

Cultural and Historical Resource Impacts

There would be the likelihood of cultural or historical resource impacts associated with vandalism of historical structures (primarily graveyards), and, potentially, some effect on archaeological sites by artifact collectors who take advantage of the lack of limitations in this alternative.

Administrative, stuffing, infrastructure, law enforcement, and other needs

Hiring three additional full-time permanent Law Enforcement Officers would have a positive impact on the refuge staff and hunters. Additional law enforcement positions would provide staff to help conduct the increased number and types of hunts, and provide year-round protection for the wildlife, habitat, participants in the hunts, and other visitors to the refuge. More law enforcement staff would increase visitor entrance fee compliance, thus increasing entrance fees. Adequate staff would give hunters a good hunting experience. Adequate law enforcement would also be available to help resolve any anti-hunting protests and conflicts that might result from increased hunting opportunities.

Public Use Management—Fishing and Boating

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 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 would not be subject to refuge regulations, should a national wildlife refuge be established there. Fishing and its associated boating activities would fall under the sole jurisdiction of the State of Maryland. Similarly, the jurisdiction for regulating these activities on the Island Refuges would reside completely with the State, 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, even with limited opportunities, limited fish populations, and problems with access, the public requested more boat ramps and fishing opportunities during our scoping process. This section presents three management alternatives.

- Alternative A would continue the existing limited fishing opportunities April 1 to September 31 with no water access or facilities available on Blackwater NWR.

- Alternative B would provide additional access and fishing facilities, parking areas, signs, maps, and interpretation programs for all the refuges in the Refuge Complex.

- Alternative C would allow a great deal more fishing than alternative A or B, with bank fishing from the shorelines year-round, pond stocking, boating access, additional parking, and interpretation programs.

Alternative A. Species–specific Management

Strategies for Blackwater NWR

Fishing and crabbing would only be permitted by boat, and only from April 1 through September 30, dawn until dusk, on waters owned by the refuge. No refuge permit would be required. Fishing and crabbing would be in accordance with State seasons, size and creel limits, methods, and any other restrictions or regulations. Persons fishing would be required to possess a valid State of Maryland Tidewater Fishing License. There would be no license required for recreational crabbing when conducted in accordance with State regulations, unless Maryland DNR changes its regulations.

Crabbing and fishing in State-controlled waterways would continue from county or State roadways and bridges, and would remain unregulated by Blackwater NWR. Authorization to control recreational fishing within the refuge boundary would apply only to those waters where title vested in the United States in fee simple absolute, and where the State did not exert its claim during original protection (approximately 5,788 acres of waterways). The refuge would not be authorized to regulate fishing or other waterborne activities within the navigable waters of the State or within areas where water bottoms are State-owned, unless authorized to do so by special State regulations. Shoreline access from Blackwater NWR lands to waters within the Service's jurisdiction and control would not be authorized. Access to the approximately 5,788 acres of regulated waters would be limited to one currently owned public boat ramp at Shorter's Wharf Bridge adjacent to Tract 52, or from any other off-refuge location.

Strategies for the Chesapeake Island Refuges

Fishing and crabbing would be prohibited from refuge shorelines. The refuge would have no authority to control fishing and crabbing in State-owned waters below mean high tide.

Physical Impacts

The continuation of a very limited number of fisherman using canoes and small boats would have very little, if any, effect on refuge wildlife, waterways, and adjacent habitats. Any potential effect on submerged aquatic vegetation, turbidity, or shoreline erosion from fisherman in small motorboats from April 1 to September 31 when fishing would be allowed, would be limited to

the few who may stray away from the channel where the depth is greatest. Since there is little to no submerged aquatic vegetation and the shallowness of the water would prevent speeding, there would be little to no effect.

Biological Impacts

Fishing and crabbing on Blackwater NWR waters during the fall and winter would have a negative impact on the migratory waterfowl and nesting bald eagles. Thus, the refuge would not allow fishing and crabbing on its waters from October 1 through March 31. With the closure and only a limited amount of fishing and crabbing in these areas due to the shallow water and unmarked channels at other times of the year, there would be little to no impact on fish and crabs.

Socioeconomic Impacts

Fishing is a major recreational interest in Dorchester County. However, as long as access would not be permitted from Blackwater NWR shorelines, and boating would not be permitted from October 1 through March 31, most fishing would continue to be limited to the Little Blackwater River Bridge, Route 335 Bridge, and Shorter's Wharf Bridge, which would not be regulated by the refuge.

Cultural and Historical Resource Impacts

There would be no cultural or historical resource impacts.

Administration, staffing, infrastructure, law enforcement, and other needs

Year-round fishing from Key Wallace Drive and the Little Blackwater Bridge, the Route 335 Bridge, and Shorter's Wharf Bridge has not been well regulated by the State of Maryland or Dorchester County officials. There has not been enough law enforcement staff with time available to regulate fishing and boating on Blackwater NWR throughout the year. Fortunately, this has not been a major problem in the past. However, the increase in Dorchester County Tourism advertising would bring more people to the refuge interested in fishing and crabbing, and would eventually cause problems. A shortage of staff and funding has prevented posting of signs and mapping of waterways. Although a Fishing, Crabbing and Boating leaflet is distributed, it has not been available outside the Blackwater NWR Visitor Center. A shortage of interpretation staff has eliminated refuge participation in special events, and special programs for National Fishing and Boating Week.

Alternative B. Conservation Biology for Trust Species Diversity

Strategies for Blackwater NWR

In addition to alternative A strategies, increased fishing opportunities would be proposed through the construction of a canoe ramp on Route 335 with a parking area, an accessible boardwalk, and 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) would 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 would be made available to visitors. Canoeing and boating activities would be monitored and, if necessary, restricted to reduce disturbance to wildlife and impacts on habitat.

Additional staff would 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 proposed Nanticoke protection area

Fishing access would be by boat only. There are adequate public boat ramps at many locations along the Nanticoke River within the proposed protection area. According to the Nanticoke River Watershed Boating Assessment Study in August 1997 (Nanticoke Boating Study), fishing and cruising (sightseeing) are dominant boating activities on the Nanticoke River. The Nanticoke protection area would 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 would 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.

Physical Impacts

In this alternative, the continued closure of boating from October 1 to March 31 and the proposed increase in the size of the seasonal closed area at Blackwater NWR would have a positive impact on the physical environment. Since no additional facilities would be proposed for the proposed Nanticoke protection area or the Island Refuges, there would be no impacts on physical resources.

Biological Impacts

The increase from 5,788 acres to 6,223 acres of closed area (marsh that has been changed to open water) would prevent the disturbance of migratory waterfowl. There would be little to no direct impact on fish and crabs.

Socioeconomic Impacts

Although there are 34 million anglers in the United States, few would come to the Blackwater NWR to fish simply because the refuge is not noted for its sport fishing. Most of the people who canoe would be looking to observe wildlife rather than fish. However, the proposed accessible boardwalk and pier, kiosk, and parking area near the Little Blackwater Bridge would provide a popular fishing area not found anywhere else in the county. It would draw many people who do not own or have access to a boat to fish. It would eliminate the parking problem and safety hazards along the county roadway. It would also provide an accessible fishing area where presently there are none on the refuge and few, if any, in Dorchester County. New interpretation signs, maps, and river channel markers would increase safety and prevent physical impacts by allowing the fisherman and boater to follow the channel instead of getting lost in the unmarked shallow water.

Cultural and Historical Resource Impacts

We expect no impacts on cultural or historical resources.

Administration, staffing, infrastructure, law enforcement, and other needs

Additional staff would provide fishing 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, thereby producing a positive impact on refuge wildlife and resources, and visitor enjoyment of refuge facilities and resources.

Alternative C. Maximum Public Use with No Habitat Management

Strategies for Blackwater NWR

There would be year-round fishing and crabbing opportunities. Bank fishing from any refuge shoreline would be authorized. Ponds would be stocked with fish. Parking areas, trails to fishing and crabbing areas, and island camping platforms would be constructed to provide increased fishing opportunities. Kiosks providing fishing and crabbing information would be constructed in all fishing and crabbing areas, particularly on Route 335, Key Wallace Drive, and on the Wildlife

Drive. The public would be able to access the Little Blackwater River on the refuge from the refuge boat ramp near Pool 1.

Additional staff would provide fishing, crabbing, and safe boating interpretation programs; National Fishing and Boating Week activities; development 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. Interpretive canoe tours would be developed for spring, summer, and fall visitors.

Strategies for the proposed Nanticoke protection area

For this alternative, there would be year-round fishing and crabbing opportunities; bank fishing from any refuge shoreline would be authorized. Ponds would be stocked with fish. Parking areas and trails to fishing and crabbing areas would be constructed to provide increased access to fishing and crabbing areas. Kiosks providing fishing and crabbing information would be constructed in all fishing and crabbing areas.

Additional staff time would provide fishing, crabbing, and safe boating interpretation programs; National Fishing and Boating Week activities; the development of canoe trails, maps, kiosk information, and signs; the posting of navigation signs and boundary signs; and the enforcement of fishing, boating, and crabbing laws and regulations within the Nanticoke protection area. Interpretive canoe tours would be developed for spring, summer, and fall visitors. These activities would require, in addition to the staff hired in alternative B, two full-time Park Rangers.

Strategies for the Chesapeake Island Refuges

For this alternative, there would be year-round fishing and crabbing opportunities, and bank fishing from any refuge shoreline. Trails to fishing and crabbing areas would be constructed to provide increased access to fishing and crabbing areas. Kiosks providing fishing and crabbing information would be constructed in all fishing and crabbing areas. Piers would be constructed on the islands to facilitate easy docking and fishing for visitors who arrive by boat.

Additional staff time would provide fishing, crabbing, and boat safety interpretation programs; National Fishing and Boating Week activities; the development of canoe trails, maps, kiosk information, and signs; the posting of navigation signs and boundary signs; and the enforcement of fishing, boating, and crabbing laws and regulations within the Island Refuges. Interpretive canoe tours would be developed for spring, and summer visitors. These activities would require the additional staff from alternative B, including a full-time Law Enforcement Officer, full-time Outdoor Recreation Planner or Park Ranger, and seasonal interns.

Physical Impacts

The increased boating access and fishing and crabbing from refuge shorelines would increase the adverse effect of these activities on refuge waterways and adjacent habitats. The potential effect on submerged aquatic vegetation and turbidity from the increased number of fishermen and crabbers using small boats year-round would continue to be limited to the few who may stray away from the channel, where the depth is greatest. Fishing from refuge shorelines would increase shoreline erosion and destroy vegetation. The accumulation of litter would be unsightly and, possibly, create chemical reactions in the water causing detrimental problems to fish, crabs, and other wildlife. Parking lots and trails to fishing areas would impact 10 acres of uplands. Litter, fishing lines, lead weights, and shoreline erosion would negatively impact water quality.

Biological Impacts

Boating, fishing, and crabbing from October through March at Blackwater NWR would have a negative impact by disturbing migratory and wintering waterfowl. Greater access to the water, fishing and crabbing along refuge shorelines, and trails to fishing areas would result in greater disturbance to other wildlife, especially osprey, wading birds, and other wetland birds. Fish hooks and monofilament line left in the water or on the shoreline would be a safety hazard to visitors, fish, waterfowl, and other wildlife. Although no longer limited by boating closures, fishing and crabbing would be limited by State regulations. Visitor fishing and crabbing would have minimal impact on the fish and crabs.

Socioeconomic Impacts

Visitors would appreciate the increased opportunities to fish and crab in a natural environment, but would soon find that the number of biting insects and summer heat far outweigh the increase in fishing and crabbing opportunities. There would be minimal effect on the local economy. The visitors who came to Blackwater NWR to observe wildlife would find wildlife hidden because fishermen and crabbers were disturbing the shorelines and ponds. Instead of increasing visitation to the area and increasing the use of local lodging and service industries, visitors would be inclined to look elsewhere for wildlife observation experiences, the principle ecotourism activity offered by these refuges.

Cultural and Historical Resource Impacts

Allowing visitors free rein to fish and crab would negatively impact shorelines that have cultural or historical resources.

Administration, staffing, infrastructure, law enforcement, and other needs

This alternative would require more staff time for construction and maintenance, law enforcement, and interpretation programs.

Public Use Management—Environmental Education and Interpretation and Wildlife Observation and Photography

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. FB 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.

Given those concerns, three management alterative are presented. Alternative A would continue the existing single environmental education program and the limited wildlife-oriented interpretation and outreach programs; maintain the outdated exhibits, the Visitor Center, and the existing wildlife observation facilities, including the Wildlife Drive and two walking trails (one with guided leaflet); and provide no additional photography facilities. There would be only one ORP to plan, manage, conduct, and operate the public use program.

Alternative B would continue the strategies of alternative A and, in addition, would 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, conduct, and operate the public use program.

Alternative C would include the strategies of alternative B, but additionally, would open all areas of the refuge to wildlife observation and photography, increase environmental education and interpretation programs, provide outreach for all local events and organization, and hire even more staff to carry out these strategies.

Alternative A. Species–specific Management

Strategies for Blackwater NWR

The existing environmental education and interpretation infrastructure would be maintained. There would be no additional permanent, full-time staff. No new environmental education or interpretation facilities or programs would be created. The number of public use programs would remain limited by available staff, volunteers, materials, and outdated facilities. Outreach would be limited annually by staff and volunteers to off-site programs on request if staff or volunteers were available. No new observation or photographic facilities would be established.

Approximately 2,000 students would annually participate in environmental education through contacts with officials at Dorchester, Talbot, Caroline, Wicomico, and Somerset County School Districts. Refuge staff would provide activities and specific information to teachers prior to their visits. There would be only one environmental hands-on program. Staff or volunteers would meet environmental groups and give a brief orientation at the Visitor Center prior to the teacher-led activities. When they were available, volunteer environmental educators would give tours along the Wildlife Drive. The Marsh Edge Trail pavilion, Marsh Edge Trail, and boardwalk would be made available for environmental education activities. Items used to assist in environmental education activities, such as bird books, binoculars, dip nets, etc. would be purchased and loaned to students. A Memorandum of Understanding would be maintained with the Chesapeake Bay Foundation to utilize refuge property for conducting environmental education to 700 students annually, but most of this use would occur on the Bishops Head Division.

Environmental education visits would be scheduled in advance, in order to stay within the following capacity limits. Only one busload of students would be scheduled at one time at the Visitor Center. School groups that visit the refuge would be limited to three single buses or two double buses at one time. No more than three environmental education groups would be scheduled in one day. Only one environmental education group would be scheduled at the Marsh Edge Trail and pavilion or Woods Trail at any one time. The maximum number of environmental education and interpretation programs would be 130, with a maximum of 5,000 students annually.

The recommended strategies would be implemented in such a way as to be compatible with refuge objectives and wildlife needs. The only hands-on environmental education program would be conducted on the high marsh at the observation area, in late spring or early fall at a time of the year that would not adversely impact migrating waterfowl or habitat. The program would be limited to two groups of 25 or 30 students per day and no more than 10 groups per year. Activities would be scheduled to stay within the capacity limits of refuge facilities and habitats. Activity sites would be regularly monitored for signs of physical overuse, and action would be taken as necessary to avoid habitat or facility deterioration.

There would be approximately 60 volunteer-conducted environmental education programs with approximately 1400 students participating each year. Teachers would be provided activities and specific information prior to their scheduled visits. Habitat Teacher Packets would be provided,

but in insufficient numbers to meet demand. A one-day teachers' workshop would be held annually. Bird books, binoculars, dip nets, etc. would be provided on loan.

Staff and volunteers would provide interpretation for bus tours and other groups, and present slide talks and show films, as requested and as time permits. Except for bird walks, most of the conducted programs would be limited to special groups, such as schools, colleges, dignitaries, other agencies, and foreign visitors.

A full-service accessible Visitor Center with 2,500 square feet of exhibit space, a 45-seat auditorium, paved entranceway, and parking area would be maintained, complete with exhibits, films on various wildlife and their management, orientation programs, interpretation displays, and a retail sales concession operated by the FOB. The Visitor Center, with paved entrance and parking area, would be sited among fields planted with crops for wildlife and a view overlooking the moist soil impoundments and the Wildlife Drive. The Visitor Center and visitors would be shielded by fences, trees, and shrubs planted for wildlife, preventing disturbance to wildlife. Visitors would experience a wonderful view of the impoundments through the glass observation windows. The Visitor Center would be closed on weekends in June, July, and August, and on Federal holidays.

More than 100 volunteers would assist in staffing the center. Film presentations, slide programs, and videos would be offered on request. Brochures would be provided to supply visitors with information on the refuge and other areas of interest in the county. A paved 3½–mile (6½–mile loop) Wildlife Drive would be available for the public. The auto tour route would be self-interpreted with numbered stops and accompanying leaflet, and an audio tour tape would also be available for purchase at the Visitor Center. A self-guiding interpretation tour of the Marsh Edge Trail would be maintained. This ⅓–mile accessible paved trail would have a self-guiding leaflet corresponding to numbered stops. A self-contained accessible restroom would be maintained at the Marsh Edge Trail. Four interpretation kiosks would be available with a variety of interpretation panels to orient visitors and describe management programs, activities, and strategies. Seven interpretation brochures would be printed and published. Interpretive signs, describing on-going management activities, permitted and prohibited activities, entrance fee information, speed limit signs, closed area signs, dates and times the refuge is opened to the public, etc., would be posted around the Wildlife Drive. The public's increase in understanding wildlife, their needs and requirements, and how they might have a negative impact on the wildlife, would enable them to enjoy Blackwater NWR and wildlife while being aware of how to do so without producing a negative impact on the wildlife.

The observation and photographic areas would be restricted to the Visitor Center with viewing areas and spotting scopes, pull-offs on the Wildlife Drive, the paved and accessible Marsh Edge Trail, the Woods Trail, and public roads. All would be maintained to provide access for wildlife and wildlands observation. All other areas of Blackwater NWR (approximately 95 percent of the lands and waters) would be closed to wildlife observation and photography. Entrance to the Wildlife Drive and trails would be restricted by an electric gate that opens at dawn and closes at dusk. Normally open 365 days a year, the Wildlife Drive and observation trails would sometimes be restricted by weather. As many as 25,000 visitors would use the walking trails either for observation or educational programs.

Used primarily by migratory songbirds and, to a lesser degree, a few shorebirds and marsh and water birds near the boardwalk on the Marsh Edge Trail, these primarily forested areas would not be in habitats of major importance to migratory birds. Bus tours and trail walks would be provided on request if a staff member or volunteer were available to assist the visitor in observing wildlife. Guided bird walks would be offered four to six times a year with an experienced volunteer birder providing observation opportunities and techniques for visitors. Osprey platforms, bald eagle and other raptor roosting snags, wood duck and mallard nesting boxes, tree swallow and bluebird houses, and barn owl nesting boxes would be installed to demonstrate their design and effective use in areas where the public may observe wildlife activity. The Wildlife Drive or portions of the Wildlife Drive would be closed when eagles nest too close to the Drive.

Wildlife and wildlands observation would also be allowed by canoe, kayak, motor boat, and bicycle. The refuge would be highlighted on the Maryland Bicycle Touring Map published by the Maryland Association of Bicycle Organizations. The refuge would also provide cyclists with alternative bicycle routes throughout the lower county that travel over public roadways that transect or parallel refuge properties. Wildlife and wildlands observation by canoe, kayak, or boat would be prohibited on Blackwater NWR from October 1 to March 31, when large numbers of waterfowl are present. Boat launching would not be permitted on the refuge.

Photography would be permitted from the Wildlife Drive, the Marsh Edge Trail, the Woods Trail, the Visitor Center, and along public roadways that bisect the refuge. Newspaper, magazine, TV, and independent photographers would utilize the refuge to photograph wildlife and often write unsolicited articles supporting the refuge, its mission, and the mission of the Service.

Outreach activities would inform the public of wildlife needs, and help to prevent visitor conflicts. Outreach methods would include continued interactions and relations with congressional entities, local businesses, news media, constituent groups, local communities, schools, state and local governments and agencies; as well as information products such as brochures, leaflets, and videos (USFWS 1997). These methods would provide ways for the public to be involved with the Refuge Complex during the planning processes and beyond.

In this alternative, Blackwater NWR staff would continue to conduct outreach through interactions with the public. The Service would participate in special events and programs, public meetings, presentations and speeches, and cooperative outreach partnerships. Most of the outreach would be done by a mobile tabletop display at local events. Staffed by volunteers and, occasionally, by staff, the exhibit would make the public aware of activities and management practices at the refuge. If a community group were to request a Blackwater NWR program at their regular meeting, the refuge would oblige if time and staff were available, thus increasing good community relations and developing more interest in tourism for the county. Refuge staff would avoid any conflicts with local merchants by working closely with local retailers and the FOB when they are considering sales stock items for the FOB bookstore. They would provide a good resource that is not available elsewhere for wildlife books for the community.

News releases would be issued to the local and regional print and electronic media when newsworthy events occur, to announce scheduled activities, and to keep the public aware of

refuge management activities. Refuge staff would present programs on- and off-site to audiences throughout Maryland's Eastern Shore as requested and as staff time and funds permit. Regular contact would be maintained with private, state, local, and other Federal agencies, environmental groups, congressional offices, and other interested parties. Written, phone, and personal inquiries from the public would be routinely responded to by refuge staff.

The refuge staff and volunteers would regularly display exhibits at special events on Maryland's Eastern Shore. Current leaflets, consisting of a general brochure, bird list, reptile and amphibians list, mammals list, Wildlife Drive guide, endangered species guide, interpretation leaflet for the Marsh Edge Trail, FOB brochure, handout on entrance fees, deer hunt information and map, and a brochure on the Canada goose, would be maintained and distributed to the public. The general brochure would be distributed in welcome centers, travelers visitor centers, and other public facilities. The FOB would issue a quarterly newsletter to their membership and discuss refuge management programs. Audio visual programs would be regularly offered on request to visitors in the Visitor Center Auditorium. Informational material would be presented in the Visitor Center through the use of a menu board, exhibits, brochure racks and personal contact.

An active volunteer program of 100 volunteers contributing more than 8,000 hours annually would be administered. The refuge would annually participate in the Cambridge Christmas Parade. Refuge staff would annually participate in career days, assist in judging science fairs, and play an active role in sponsoring training for the Dorchester County Envirothon. The FOB, would be maintained, and they would annually raise an average of $15,000 for special projects. Refuge staff would periodically conduct special seminars on wildlife management issues, techniques, and problems. Staff would regularly be called upon by the Washington Office and others to provide tours to VIPs, foreign dignitaries, and foreign resource professionals. The refuge would continue to be used frequently as a model example of the Refuge System.

Strategies for the proposed Nanticoke protection area

In alternative A, there would be no management because there would be no refuge established. However, even though there would be no refuge presence on the Nanticoke River, there would be consequences of this action, which are discussed below.

Strategies for the Chesapeake Island Refuges

The existing contact station, the Middleton House on Martin NWR, would continue to provide the few existing displays and mounts that fail to capitalize on the human inhabitants' unique island culture, fishing and crabbing industry, or the islands' crucial role in the Chesapeake Bay ecology. No staff would be available for environmental interpretation.

Self-guided interpretation would be limited to the visitor contact station on Martin Refuge, which would be open during working hours, Monday through Friday, each week of the year. The Middleton House is located at the administrative center for Martin NWR, in Ewell, Maryland, and is geographically isolated from the main body of Martin NWR and the other divisions. Approximately 900 square feet of marginal, second hand, self-guided exhibits, maps, displays,

and brochures would be available to the public. The visitor contact station would remain inaccessible to disabled visitors. A kiosk describing the refuge would be available to interpret refuge activities and its location to visitors when the visitor contact station is closed. Brochures that describe only Martin Refuge would be made available to the public at the State maintained visitor center in Ewell, operated by the State of Maryland Department of Tourism. A limited number of guided tours would be conducted for peers, other wildlife professionals, private groups and individuals, and foreign conservation interests when these activities would not disturb wildlife.

A Memorandum of Understanding would be maintained with the Chesapeake Bay Foundation (CBF). Quality environmental education programs would be offered by CBF to approximately 700 gifted and talented students annually at their Karen Noonan Environmental Education Center on the Bishops Head Division. CBF would provide trained naturalists and environmental educators who spend three days with each student on refuge property studying various aspects of the Chesapeake Bay environment. Refuge staff would continue to be responsible for assisting with maintenance of the 4-mile access road to the Education Center, and completely responsible for maintaining the dock at Bishops Head.

Physical Impacts

The restricted number of environmental education programs at Blackwater NWR would impact less than 1 acre of marsh. This very limited number of students would have little to no impact on the overall physical environment (water, air, soil, topography). All other environmental education, interpretation activities, wildlife observation, and photographic activities would be held at the Blackwater Visitor Center, inside vehicles that serve as photo blinds for wildlife, on the paved surfaces of the Wildlife Drive or Marsh Edge Trail, or chipped surface of the Woods Trail, and would have no further physical impact on the environment.

The Wildlife Drive at Blackwater NWR was first established over 45 years ago because the dike system that created the freshwater impoundments represented a “ready made” infrastructure, the only real interior infrastructure that could be considered for such use. There is no other location that gives the visitor a better representation of all refuge habitats within such a short distance, yet restricts use to only 10.08 acres of Blackwater’s 23,053 acres.

The Marsh Edge Trail at Blackwater NWR begins at the environmental education pavilion parking area, and extends through approximately 10 acres of pine woods to the marsh where it connects to a 40 foot observation deck that is constructed along the edge of the Little Backwater River. The trail is paved to accommodate handicapped access. Uses would be restricted to the 6'–wide paved area and to the boardwalk, a total area of direct impact on approximately 0.2 acres.

The Woods Trail at Blackwater NWR begins at a parking lot along the Wildlife Drive, and extends in a 0.5-mile loop through the center of 50 acres of loblolly pine woods. The uses of the

Woods Trail would be restricted to the chipped trail, an area of direct impact on approximately 0.3 acres.

These trails were constructed more than 25 years ago, with minimal disturbance of the habitats within the already existing Wildlife Drive area. With the exception of improvements made for handicapped access (paving) and interpretation and education (signing and numbered stops), the trails have not changed. The trails provide a sample of Blackwater NWR's diverse habitats for interpretation and education, yet directly impact only 0.5 acres. The total area impacted by all supporting structures at Blackwater NWR would be approximately 10 acres of refuge habitat. These uses would, therefore, directly impact less than 0.05 percent of the total acreage of the refuge that supports these particular activities. It should be noted that, even if the subject uses were eliminated, refuge management and administrative uses of these acres would not change; i.e., the roadway would remain paved and the dikes would continue to be maintained just as they now are, to support migratory bird management purposes.

The fact that the proposed Nanticoke protection area would not be established in alternative A does not mean that no consequences would ensue for Service trust resources in the Nanticoke protection area. Not establishing the division would negatively impact public understand and support of the various resource management issues that affect this pristine, ecologically significant area. The likelihood of adverse impacts on its physical and biological resources would increase, because there would be no environmental education and, therefore, the public would lack information about the important wildlife resources that inhabit it.

In the absence of these management programs, we would anticipate generally adverse consequences for all the categories evaluated in the sections treating the Nanticoke watershed. Certainly, without the benefit of these four types of non-consumptive, wildlife-dependent public use, the Service, the Refuge Complex, local governments, and NGOs would not be able to garner as much public support for protecting and conserving Federal trust resources or for addressing sea-level rise, habitat loss, fragmentation, etc. Furthermore, the socioeconomic benefits of these programs to this rural and impoverished community would suffer, while foreclosing opportunities to educate the public about their cultural, archeological, and historical heritage in this remarkable part of the Eastern Shore.

Biological Impacts

The existing self-guided interpretation facilities at Blackwater NWR were originally designed and located in areas that would least conflict with the needs of wildlife. The Compatibility Determination for these uses at Blackwater NWR in 1994 found that the frequency and duration of human presence and the numbers of students present were so few that these activities would have little or no effect on the migratory birds and other wildlife resources at the refuge. Since, in this alternative, no photo blinds would be built at Blackwater NWR or the Island Refuges, photographers might sometimes wander off the existing trails and roadways or trespass by boat to get closer to their subject, causing the temporary negative impact of disturbing wildlife.

Assuming a zone of visitor influence of 50 feet on either side of the trails in the forested areas at Blackwater NWR, the maximum area of human disturbance along the two hiking trails that would be expected from these uses would be approximately 9 acres, or less than 0.05 percent of the total acreage managed for migratory birds and threatened or endangered species.

Given the critical distance of 80 meters (the greatest distance that similar migratory bird species were not as likely to be disturbed by the same types of uses being proposed) described for J.N. "Ding" Darling NWR's 8-km Wildlife Drive (Klein 1989), the maximum area of human disturbance along the 5-mile Wildlife Drive at Blackwater NWR that would be expected from these uses would be approximately 300 acres, less than 1.5 percent of the total acreage managed for migratory birds.

The current impoundment system at Blackwater NWR has a series of contour sub-impoundment dikes that parallel the Wildlife Drive and screen foraging and resting migratory water birds from visitors, thereby decreasing their disturbance. Alternate closely adjoining extremely high quality migratory bird feeding and resting habitats have been protected and developed at Blackwater NWR in areas where no public use would be authorized. Most public use would occur from 9:00 a.m. to 5:00 p.m., when most migratory birds are less active. The trails are not located in habitats of major importance to migratory birds. In the past, wildlife have paid little attention to approximately 110 motor vehicles per month serving as moving photo blinds for visitors on the Wildlife Drive at the refuge. Bicyclists and pedestrians have had a greater temporary impact on wildlife close to the Wildlife Drive.

Socioeconomic Impacts

Blackwater NWR, the largest tourist attraction in Dorchester County, historically has contributed substantially to the economy of the area by attracting people who use county facilities, service stations, restaurants, and lodging. Dorchester County is now developing a Heritage Tourism Management Plan that would promote tourism and would attract more visitors to the area. In alternative A, maintaining the existing environmental education and interpretation infrastructure and the number of public use programs (limited by available staff, volunteers, materials, and outdated facilities), would have a negative effect on Dorchester County's tourism development. The refuge would be unable to provide increased programs and activities for the increased number of visitors, disappointing some of them.

If the trend continues, there would be an increase in visitation to Blackwater NWR and a continued interest in observing and photographing wildlife. Dorchester County Tourism is encouraging bus tours to the county, more recreation, and especially ecotourism. Although Blackwater NWR is presently the largest tourist attraction in the county, Dorchester County Tourism is also promoting other recreational interests, such as fishing, hunting, camping, historical tours, and special interest tours, that would continually increase visitation to the county and the refuge. Visitors to Blackwater NWR may be disappointed or irate to find the Visitor Center closed due to the unavailability of volunteers, limited facilities for observing and photographing wildlife, and no guided walks or interpretation programs to learn about the

wildlife and the refuge. The limited refuge and volunteer staff often would not be available to inform the public about other facilities and activities in the county.

Over the last 10 years, 5,000 to 6,000 people each year have signed the register book at Blackwater NWR. Of these, only 3 to 5 percent were from the local area of Dorchester County, and only 5 to 17 percent were from the Eastern Shore of Maryland. According to "Banking on Nature: the Economic Benefits to Local Communities of National Wildlife Refuge Visitation," non-resident spending generates new income and new jobs, and the regional economy cannot grow without importing some income from outside the region. It is quite obvious that most of the visitors who sign at Blackwater NWR have been coming from outside the area. If non-resident visitors are not aware of local facilities and available activities, or do not enjoy their experience to the refuge because of the lack of facilities and activities, they most likely would not spend money in the local area and would cause a negative impact on the economy.

More than 135,000 people annually use the Wildlife Drive at Blackwater NWR, and nearly all visitors do so for some form of wildlife or wildlands observation or photography. The Wildlife Drive has no path or trail to separate foot traffic from vehicular traffic resulting in a potential safety hazard that could contribute to a pedestrian–vehicle accident.

Cultural and Historical Resource Impacts

With no increase in facilities and programs, the overall impact of alternative A to cultural and historical resources Complex-wide would be minimal to non-existent. However, there could be a negative impact on the Staplefort Cemetery at Blackwater NWR if uninformed visitors wandered into the area out of curiosity. There could also be a negative impact on the remains of the steam engine on the Woods Trail at Blackwater NWR, if visitors were not made aware of the importance of what appears to be a pile of scrap iron to the side of the trail.

Administration, staffing, infrastructure, law enforcement and other needs

In alternative A, unfortunately, the public would not always get a good impression of Blackwater NWR, the Island Refuges, or the Service, due to the shortage of staff and well trained volunteers. The staff shortage would prevent Blackwater NWR and the Island Refuges from carrying out the strategies in the current Public Use Plan that would potentially prevent negative impacts on wildlife and wildlife habitats and increase good associations with the community, media, schools, government agencies, and congressional representatives. Many requests would be denied because of lack of space, inadequate staff, and untrained volunteers. Visitor experiences would continue to be adversely impacted by outdated Visitor Center displays, lack of information or outdated leaflets, equipment, poor quality slides and videos, and inconsistencies in Visitor Center staffing.

Blackwater NWR lies within 30 miles of all the schools in Dorchester County. It is an ideal learning classroom for approximately 5,000 students in this county, as well as many more in the surrounding counties of the Eastern Shore of Maryland and elsewhere. For several years, a study

of migratory geese and a trip to Blackwater NWR was part of the curriculum of the second grade in Dorchester County. The fourth grade also included a trip to Blackwater NWR as part of their studies. Although the public use staff conducted approximately 10 trail walks, 16 bird walks, 40 Wildlife Drive tours, 35 refuge orientation talks, 10 environmental education programs, 8 workshops, 15 slide programs, and 180 slide and video presentations, reaching approximately 5,000 visitors a year, the public demand for more environmental education and interpretation programs continued.

The Blackwater NWR staff of one permanent full-time ORP and one intermittent temporary assistant (Recreation Aid, cooperative student, Student Conservation Association volunteer, or intern), would continue to be unable to provide all the requested programs. There have been 44 different temporary assistants to the ORP (usually for 3-month periods) from 1990–2000, requiring continual training, leaving an inconsistency in the Public Use Program. The inconsistency in the ability to provide environmental education and interpretation programs, Visitor Center staffing, answers to requests for information, recruitment, and assistance with other public events would continue to be confusing and irritating, and produce a negative impact on the public, wildlife and wildlife habitat, Blackwater NWR, the Chesapeake Island Refuges, and the Service. Staff and volunteers would continue to "burn out" and the Refuge Complex would be a frustrating environment in which to work.

Staff time would continue to be consumed by requests for information; volunteer recruitment, training, and coordination; staffing the Visitor Center; collecting, counting, and keeping records of entrance fees; keeping records and preparing end of year reports; conducting one special event that requires a great deal of advance planning; and continually recruiting staff. These duties would leave little time to promote the programs requested and expected by the public, thus resulting in negative impacts on Blackwater and the Island Refuges. The lack of staff for programs that inform the public of the importance of wildlife and wildlife habitats would cause a potential conflict to wildlife and wildlife habitats, if people were unaware of the harm they could do if they entered closed areas or went beyond the restricted areas of visitation.

The lack of information, misinformation, poor self-guided interpretation materials, the unavailability of refuge staff or trained volunteers for assistance, and a Visitor Center with outdated displays and information would leave visitors unaware of Blackwater NWR objectives and regulations. The same would be said of the situation at Martin NWR and the outdated exhibits and interpretation materials being distributed from there specific to the management of the Chesapeake Islands.

There would be negative impacts on the resource. Requests for the off-site refuge display would have to be limited and restricted. Conducted tours would not always focus on the refuge mission and goals. A self-guided leaflet for the Woods Trail at Blackwater NWR would remain unavailable. Sporadic closing of the Visitor Center at Blackwater NWR and routine closing of the Contact Center at Martin NWR would cause visitors to be irritated and miss out on assistance and information. An inadequately sized, poorly designed Visitor Center at Blackwater NWR, with poor heating and electrical systems, would continue to adversely impact visitor experience and ultimately affect the entire Public Use Program. Parking lots would remain too small to handle visitors, especially tour groups. Historical and museum items would remain susceptible to

fire and theft. Historical maps, narratives, slides, and photos would remain unorganized and unprotected.

The Volunteer Program Complex-wide would suffer for lack of someone to recruit and train volunteers, constantly provide updates, coordinate schedules, and make the best use of volunteers. Many people in the local community have never visited Blackwater NWR, do not realize the Blackwater NWR is part of the Refuge System, or are still unaware of what Blackwater NWR is or does. The same sentiments can be said of the other units of the Refuge Complex, and these problems would continue and likely get worse under this alternative.

The shortage of staff and trained volunteers would (1) prevent the Refuge Complex from participating in more community events and off-site program requests; (2) prevent the development of a greater association with the media and the publication of more news articles; (3) limit the number of public events to only one; (4) prevent recruitment of volunteers from the community; (5) minimize volunteer training; (6) prevent the development of more written information, such as fact sheets, updated brochures, and other interpretive information; (7) adversely affect updating self-guided leaflets, signs, and kiosk information, and maintaining trails; and (8) prevent participation in off-site school programs and career days, all important to reaching children in the community and developing interest in becoming Service employees.

The only two collateral duty law enforcement personnel on the Refuge Complex, who also hold other primary positions, would not have time to do compliance checks. With limited law enforcement, visitors would ignore “Closed Area” signs, or would be unaware of closed areas because of no signage due to no staff to install it. More than 30 percent of the visitors would continue to ignore the entrance sign requesting visitors to fill out the entrance fee envelope, losing much-needed funds for Blackwater NWR. Hunting and fishing in closed areas, trespassing, arson, vandalism, littering, harassing and disturbing wildlife, poaching, unauthorized boating, and other violations would continue and increase, as the recent trend has demonstrated.

Alternative B. Conservation Biology for Trust Species Diversity

Strategies for Blackwater NWR

In addition to the strategies in alternative A, alternative B would 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) would 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 be necessary as the environmental education and interpretation programs develop. Three full-time law enforcement personnel also would 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 would this prevent the public from causing a negative impact on the wildlife and habitat by making them aware of refuge regulations and closed areas, it would 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 would 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 would increase from 2,000 to 20,000 annually. These students would also receive a richer environmental education experience because of the expanded curriculum and additional contact with Blackwater NWR staff.

The increased public use staff would 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 2010; develop refuge activities for elementary age visiting groups by January 2007, for middle school groups by October 2008, and high school groups by October 2010; develop an MOU with Henson Scout camp and the 4–H Camp Thendera to work together on environmental education and interpretive programs by 2009; develop an Envirothon for middle and elementary schools by 2015; develop three changeable environmental education activities for the refuge web page by January 2008, alternating programs every 6 months; and, implement an environmental education manual (printing section1 by October 2007, section 2 by October 2008, and section 3 by October 2010).

The manual would be distributed to schools and feedback gathered one year after each section would be published. The environmental education manual would 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 would be taken to have the cemetery restored before it would be used as a learning tool.

Programs would 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 would occur at the newly constructed Environmental Education Outdoor Classrooms, the remodeled Visitor Center, or inside vehicles where there would 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) would be developed by October 2012; fostering of 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, would be proposed for protection as a site to construct an Environmental Education Outdoor Classroom. Another Environmental Education Outdoor Classroom would be constructed near the Visitor Contact Station on the Nanticoke protection area by 2015. Equipment and materials would be purchased to use for environmental education activities. The Environmental Education Outdoor Classrooms would be designed and located in areas that would minimize physical and biological impacts on the environment. The Service would 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 would provide trained professionals by providing the opportunity for Outdoor Recreation Planners and selected volunteers to attend appropriate environmental education training.

The staff would manage the interpretation programs, update kiosk information, order and install signs, and design, update, and order refuge leaflets. Projects would 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 2012; developing and constructing trail heads with kiosks at new hiking, canoeing, and biking trails by October 2012; installing interpretive signs in new hiking, biking, and canoeing areas and other areas as needed; producing new Refuge film by 2010, and a Nanticoke protection area film by 2012; 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 2010; endangered species leaflet and entrance fee leaflet by October 2012; self-guided trail leaflets as trails are developed, and other leaflets as needed.

Most of the interpretation programs would 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 needs of wildlife and wildlife habitat. This extensive education of the public on natural processes and cultural resources would result in satisfying the curiosity of the public who would otherwise unwittingly cause much damage by their explorations. A sign in the Woods Trail kiosk would explain the history of the steam engine. All items used in displays or held in storage would be properly accounted for and cataloged. Historical items would be placed in a fire safe storage area. Increased staff and trained Visitor Center volunteers would dispense information concerning cultural and historical resources as appropriate. Interpretive canoe trips on the Blackwater and Nanticoke rivers in the late spring

would generate public support and increasing public awareness of Blackwater NWR programs and mission.

An upgraded and remodeled Visitor Center with new exhibits would 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 would be remodeled and expanded by 2006 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 up-dated Visitor Center exhibits would be developed. A live action monitor of an eagle nest would be installed in the Visitor Center with educational exhibit on eagles by January 2007; an indoor interactive computer console installed by October 2006; an outdoor interactive computer console installed by 2012; a butterfly garden constructed by October 2006; a habitat demonstration area established by October 2007; and two travelers information stations installed on Route 50: one near Cambridge by January 2006, and one near the Nanticoke River in Vienna by 2010.

A Visitor Contact Station and Office would be constructed along Route 50, where more than 6 million people a year would 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 would be sited where the fewest physical impacts would occur, on a site yet to be determined. The facility would include administrative offices, a visitor contact station with interpretation exhibits, and a maintenance shop capable of housing refuge maintenance vehicles and boats.

Blackwater NWR would 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 2010; 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 would 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 would help protect the habitat and produce minimal impact on the physical habitat of Blackwater NWR and elsewhere. The refuge would 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 would be established specifically to support outreach and advocacy for the proposed Nanticoke protections and the Nanticoke River watershed. The Friends group would be members of the Nanticoke Watershed Alliance. The group would 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 2007, the Wildlife Drive would 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. This change would 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 would be converted to a bike trail that would 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 four to five mile bike trail. This trail would allow a separate area for wildlife observation for hikers and bikers that would not conflict with motorists . Physically separating motorized and non-motorized traffic on the Wildlife Drive would not only improve the safety of the visitor, it would limit the impact on wildlife to only one section of the drive (motorized vehicles would serve as a blind for visitors). Parking areas for visitors wishing to bike would be constructed.

By October 2015, a trail at the Nanticoke River, a demonstration forest trail, and an observation walking trail on the Newcomb tract would be constructed with associated parking areas for visitors. The wildlife observation trails would be constructed mostly in existing roadway, in a areas presently closed to visitors that would have minor physical impact on the surrounding forested habitat. Benches would be installed along the existing and new observation trails to allow visitors to rest and enjoy observing wildlife.

By January 2010, the observation tower that was removed in 1990 because of structural deficiencies and other safety hazards would 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 2006, three observation and photography blinds would be installed. They would be designed and constructed with natural visual and noise screen and buffer zones to minimize impacts on Blackwater NWR resources or wildlife. The first would be along the Wildlife Drive with a deck over the marsh and enclosed photo blind. The second would be near the entrance to the second half of the Wildlife Drive, and the third along the proposed 4-mile Gum Swamp observation trail. Photography programs would be provided for the public for each of the four seasons of the year. The construction of all new observation and photographic facilities would 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 would occur to insure that the change would not negatively impact the resource.

By January 2010, six observation and photography blinds would be installed. They would be designed and constructed with natural visual and noise screen and buffer zones to minimize impacts on Blackwater NWR resources or wildlife. The first would be along the Wildlife Drive with a deck over the marsh and enclosed photo blind. The others would be near the entrance to the second half of the Wildlife Drive, along the proposed 4-mile Gum Swamp observation trail, the proposed demonstration forest trail, and near the Nanticoke River. Photography programs would be provided for the public for each of the four seasons of the year. The construction of all new observation and photographic facilities would 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 would occur to insure that the change would not negatively impact the resource.

Strategies for the Chesapeake Island Refuges

In addition to the strategies in alternative A, environmental education and interpretation activities would increase. The visitor contact station at the Middleton House on Smith Island would 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 would be purchased to construct an Environmental Educational Center highlighting Island Refuge ecology in partnership with the Chesapeake Bay Foundation. Protection would focus on suitable properties nearby to the Middleton House.

A kiosk would 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 would be developed for the environmental education center. A professional video on the Island Refuge, other applicable videos, a video projector, and screen would 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 would be developed. An outdoor spotting scope would be installed. Signs would be installed where needed.

In association with the new Environmental Education Center, a wildlife observation trail or boardwalk would be constructed on Martin NWR. Resources profiled would include waterfowl, waterbirds, and saltmarsh ecology. In addition, an observation tower and viewing and photography blinds would be constructed in suitable locations. A needs assessment would be conducted in cooperation with partners to determine the scope, extent, and compatibility of proposed and additional facilities and programs.

An Outdoor Recreation Planner would 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 would 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 would 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 would be established to provide additional programing and educational opportunities for visitors. An MOU with The Chesapeake Bay Foundation would be maintained to work together on environmental education and interpretation programs and events. Outreach programs would 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 would be established. Upon completion of a compatibility determination, an interpretive canoe or kayak trail would be developed between Island Refuges. Guided estuarine interpretation tours would be provided for educational groups during the spring and fall months.

Physical Impacts

The construction of Visitor Centers, Environmental Education Center, and Environmental Education Outdoor Classrooms would occur in prior disturbed habitats. There are several opportunities for siting the administrative facility and visitor center at the Nanticoke protection area on properties that have been cleared and previously disturbed by construction. At Blackwater NWR, the Visitor Center expansion and remodeling would occur in close proximity to its existing footprint, in open agricultural fields requiring no clearing of trees or vegetation, and in areas previously disturbed by a historical CCC camp. The refuge Outdoor Education Classroom, proposed for siting on the Robbins Property, would be constructed within the footprint of a private residence that recently burned. The site has already been disturbed, and utilities exist, thus requiring no additional excavation or disturbance. During construction activities, best maintenance practices and storm water runoff and sedimentation plans would be implemented to minimize erosion or degradation to water quality. The additional observation trail at Blackwater NWR that would extend from Route 335 to Smithville Road would simply use existing roadways and dikes constructed in the 1970s. Overall, physical impacts should be very minimal.

Biological Impacts

Additional facilities would result in moderate disturbance to wildlife while under construction. These impacts would be short-lived, and should not significantly affect Federal trust resource species over the long term. The photo blinds may negatively impact a few wildlife while being constructed, but should have little or no impact on wildlife and their habitats after construction. These facilities would be sited to avoid endangered species habitats and sensitive areas. After construction, the photo blinds would actually help to minimize disturbance by focusing photographic opportunities on specific areas where photographers are out of view of wildlife and

where they are not as likely to wander into sensitive areas (see the discussion of the consequences of unrestricted photographic opportunities in alternative C). Impacts attributable to environmental education and interpretation would be mitigated by the benefits of educating the public about refuge resources and the environment.

Obviously, with improved facilities, there would be increased visitation. Disturbance, however, would remain minimal overall since most of the these public use facilities are already existent, and they would, for the most part, continue to be located on a very small portion (less than 4 percent) of the total Refuge Complex acreage. Also, the expanded activities would occur in areas where wildlife have habituated to human activities over the course of over a half century. On Blackwater NWR, for example, excluding the new observation trail from Route 335 to Smithville Road, all the public use would occur on about 1,000 acres of the refuge's more than 23,000 acres. The same overall effects would be predicted for the proposed Nanticoke protection area and the Chesapeake Island Refuges.

Socioeconomic Impacts

A remodeled Visitor Center at Blackwater NWR with new exhibits, Environmental Education Outdoor Classroom, and increased number of activities, materials, and facilities would reach a much greater segment of the public with up-to-date information that promotes Blackwater NWR and Service mission and goals and can create support for wildlife both on and off Blackwater NWR. As facilities are enhanced, the possibilities for a quality experience are enhanced. As more people enjoy quality experiences, visitation would increase. Thus, the communities surrounding Blackwater NWR would benefit through increased use of their facilities, service stations, lodging, and restaurants.

Providing a well-staffed Visitor Center on the proposed Nanticoke protection area that has the potential to reach over 6 million visitors a year; publishing a Nanticoke protection area film, interpretation tour guides and informative leaflets; providing proper signing; printing maps and brochures that convey the mission and goals of the proposed Nanticoke protection area and provide understanding of the proposed Nanticoke protection area and Nanticoke protection area management, would reduce potential conflicts while educating a more knowledgeable public. Working with the community, community organizations, tourism, schools, local businesses, news media, congressional entities, constituent groups, and state and local government agencies to develop programs, events, and activities, would only increase the good association with the community and help establish a better understanding of the Nanticoke protection area, its mission, goals, wildlife, and wildlife habitats.

The public interest in observing and photographing wildlife while walking, biking, canoeing, and driving has been steadily increasing. With the increased opportunities for wildlife observation at Nanticoke protection area, more facilities are provided, and better relationships with the community are developed, more visitors would come to the proposed Nanticoke protection area. The communities surrounding the proposed Nanticoke protection area would benefit with increased use of their service stations, facilities, lodging, and restaurants. If the current

$15 million a year in benefits to the local economy is any indication of what can be expected at the proposed Nanticoke protection area, these activities would significantly increase the potential for ecotourism related businesses.

Dorchester, Wicomico, and Somerset Counties are developing Tourism Management Plans that will increase and facilitate ecotourism. Developing environmental education programs with other educational institutions and groups in the community would create a good working relationship with the community and public, increasing their interest in working with Blackwater NWR to help develop ecotourism. Working with the respective County Tourism Offices and the community to increase ecotourism would help increase the economy of the local area even more.

Hiring Volunteer Coordinators would enable these refuges to make better use of volunteer talents and interests, make the best use of volunteers to meet refuge needs, and recruit additional volunteers from the local community, developing more support for the community. Working with the community, community organizations, tourism, schools, local businesses, news media, congressional entities, constituent groups, and state and local government agencies to develop programs, events, and activities can only increase the good association with the community and help establish a better understanding of these refuges, their missions and goals, wildlife, and wildlife habitats.

Public interest in wildlife observation while walking, biking, canoeing, and driving has been steadily increasing throughout the area. Refuge programs would add some structure and regulation to these activities that would be more compatible with wildlife and sensitive habitats. For example, after Blackwater NWR was listed in the Maryland biking travel guides, the number of bicyclists to Blackwater NWR increased from 842 in 1992 to 3,275 in 1995. Publications by Dorchester County, advertising Blackwater's trails, Wildlife Drive, and Visitor Center, have also attracted more visitors to Blackwater NWR seeking opportunities for wildlife observation. According to the Dorchester County Department of Tourism, Blackwater NWR visitors spend an estimated $15 million annually. Blackwater NWR is the most utilized tourist attraction in Dorchester County. With the new Dorchester County Tourism Plan and the nearly completed construction of a new Hyatt complex in Cambridge, MD, the county anticipates attracting many more visitors to the area. Their encouragement of bus tours to Dorchester County has already increased the number of bus tours to Blackwater NWR. Increased visitation to these refuges would have a positive impact on the local economy and would not adversely impact wildlife if properly planned.

As more people become aware of the boating, fishing, and crabbing opportunities available in Dorchester, Wicomico, and Somerset Counties, more people would visit the refuges. Canoeing is becoming a very popular recreation that enables visitors to fish and view wildlife. Many visitors are requesting canoe trail maps, navigational maps, leaflets on fishing and canoeing, canoe tours, canoe rentals, and directions to observe wildlife by canoes. A recent seminar on recreational activities in Dorchester County in preparation for the construction of the Hyatt complex to be completed in December 2001, also indicated a need for canoe rentals, canoe tours and guides. For example, where there were previously no canoe rentals in Dorchester County, the demand has encouraged establishment of at least one new rental company. A proposed new canoe ramp and associated parking area would be constructed in partnership with the State of Maryland and

Dorchester County at Route 335 to accommodate safe parking and launching from the State highway into the upper Blackwater River (waters unregulated by the refuge). These facilities would encourage more visitors to spend the night in Dorchester County, make use of canoe rentals, purchase fishing licenses and equipment, dine at restaurants, and shop at other facilities, thus continuing to increase the economy of the county.

Cultural and Historical Resource Impacts

There would be no negative impacts on cultural and historical resources, but there would be positive effects in understanding what the impacts might be and how to prevent them, if outreach strategies are implemented.

Administration, staffing, infrastructure, law enforcement, and other needs

As stated in alternative A, there has been only one permanent full-time Outdoor Recreation Planner (ORP); one irregularly hired temporary assistant with limited training and experience (Recreation Aid, cooperative student, Student Conservation Association volunteer, or an intern); and often only volunteers to manage the Public Use Program on the Refuge Complex. In spite of the lack of staff, there has been an increase in requests for environmental education and interpretation programs requested by schools, groups, and the general public. With an increase in requests for photos and slides from the media to support articles on wetland loss, invasive species, and endangered species articles; an increase in off-site activities, community events, community organization programs, and off-site educational programs; ecotourism programs, media involvement and news articles; FOB projects; Volunteer Programs; and construction of observation and photography facilities, a larger Public Use Staff would be needed to carry out the strategies of the entire Public Use Program that would produce a positive impact on the schools, the general public, the media, and the local community.

In addition to the supervisory ORP for the Refuge Complex, one additional permanent full-time ORP and one permanent full-time Park Ranger would manage the Public Use Program be responsible for the Entrance Fee Program, Volunteer Program, and Environmental Education and Interpretation Program with assistance from four seasonal or temporary ORPs or Recreation Assistants on Blackwater NWR. Only then would there be sufficient staff to provide the facilities, programs, and activities regularly requested and indicated in the CCP public comments for Blackwater NWR. The environmental education and interpretation programs provided by the larger staff would produce a positive impact on the wildlife and wildlife habitats as people become aware of wildlife, habitats, and their needs.

On the proposed Nanticoke protection area, a full-time Outdoor Recreation Planner and a SCEP student would be needed to conduct all the activities of the Public Use Program. The Refuge Complex's ORP would supervise, develop, plan, and organize the Public Use Program, including a Visitor Center and exhibits, environmental education and interpretive programs, outreach activities, wildlife orientation and photography, public events, and friends group. With assistance from a SCEP student, the ORP would develop a Volunteer Program, and recruit and

train 100 volunteers and interns to assist Nanticoke protection area staff in outreach, environmental education and interpretation programs, teacher training, public events, and other public use activities to carry out the strategies of alternative B. The environmental education and interpretation programs would produce a positive impact on the wildlife and wildlife habitats as people become aware of wildlife, habitats, and their needs. The new facility and observation and photography facilities would provide the facilities requested in CCP comments and produce a positive impact on schools, the general public, and the local community.

Presently without any public use staff, the Chesapeake Island Refuges would need an ORP to develop, organize, and supervise the public use programs. Interns and volunteers would be needed to assist with outreach and environmental education and interpretation programs providing a positive impact on impact on wildlife and wildlife habitats as people are made aware of the importance and uniqueness of the Chesapeake Island Refuges.

Three full-time Refuge Law Enforcement Officers would be hired for the Refuge Complex to ensure public safety and compliance with refuge regulations.

Alternative C. Maximum Public Use with No Habitat Management

Strategies for Blackwater NWR

In addition to the strategies in alternatives A and B, alternative C would significantly increase environmental education and interpretation, outreach, and wildlife observation and photography opportunities. All areas of the refuge would be open to wildlife observation and photography year-round. Visitors would be allowed to hike all roadways that allow access into refuge lands. Mountain bikes and three wheelers would also be allowed on designated roadways. Parking areas and kiosks would be constructed at all access areas for the public. Six additional photo blinds would be constructed on Blackwater NWR, at the Shorters Wharf Road eagle nest site, Pool 3, Pool 4 at Kuehnle, on the proposed hiking trail, demonstration forest trail, and Nanticoke protection area. Signs and leaflets would be developed to provide information on hiking areas, biking areas, and at photo blind observation areas. Other wildlife observation and photography facilities would be constructed with new protections.

Environmental education activities would be developed to take place in wetlands, forests, and fields that allow access by school groups on representative areas of the refuge that would least impact wildlife. Interpretation programs would be developed for hiking trails in different habitats for various subjects: forest, wetlands, birds, four seasons, ecology, and marsh loss. Interpretive canoe trips would be developed for spring, summer, and fall observations. All environmental education and interpretation programs would be developed for areas that would least impact wildlife and wildlife habitats. The Blackwater NWR mobile exhibit would be displayed in all local events. Off-site programs would be developed and presented to as many local organizations that can be scheduled.

Developing, coordinating, and conducting increased numbers of environmental education, interpretation, and outreach programs would require an additional permanent full-time ORP, a permanent full-time Recreation Aid, and two additional Park Rangers. Additional office space for five permanent employees would be included in the design and remodeling of the Visitor Center and the construction of the Nanticoke Contact Station described in alternative B. The opening of all refuge areas to wildlife observation and photography, and designated biking areas would require the hiring of an additional Law Enforcement Officer to provide year-round protection for wildlife, habitat, and visitors to the refuge.

Strategies for the Chesapeake Island Refuges

In addition to the strategies in alternatives A and B, the Middleton House would be expanded to include a small auditorium and a wet lab for researchers' and interns' use. Additional housing would be protected to provide lodging for overnight educational groups. Educational and outreach programs would be increased to involve Somerset County schools. An environmental education handbook would be developed and made available to local schools and educators outlining available educational and outreach programs, dates, times, and who to contact to schedule a program. Additional interns and volunteers would be recruited to assist in the increased environmental education and interpretation outreach programs for the Island Refuges.

An outdoor pavilion with outdoor displays and covered brochure holders to provide visitors with a place to rest, acquire information, and view the marsh would be constructed.. A needs assessment would be conducted in cooperation with partners to determine the scope, extent, and compatibility of proposed and additional facilities and programs.

Physical Impacts

Parking areas constructed at all access points on the Refuge Complex and the construction photo blinds would negatively impact approximately 16 acres of uplands. Use of best management practices and design and use of proper erosion and sediment control plans would minimize impacts on the physical environment. If large numbers of visitors strayed from the roadways into adjacent habitats, they would trample and negatively impact the adjacent vegetation. Unlimited numbers of environmental education and interpretation programs would eventually impact forest and wetland areas where groups of visitors would continually trample vegetation.

Biological Impacts

Year-round access to all areas of the refuge for these activities would negatively impact nesting and migrating birds in the spring, fall, and winter, especially in areas important to these birds. The purposes of these refuges would be adversely affected. Unlimited and unrestricted wildlife observation and photography activities would negatively impact wildlife by altering wildlife behavior, reproduction, distribution, and habitat (Purdy, et al. 1987; Knight and Cole 1995).

Wildlife observers actively seek out wildlife, which may result in encounters that are more frequent and longer in duration than non-wildlife-dependent activities. Knight and Cole (1995) pointed out that "nature viewing, by its very definition, has great potential to negatively affect wildlife. Avid wildlife viewers actively seek out rare or spectacular species. Some…strive for the most viewing opportunities in the lease amount of time. Because these activities may occur during sensitive times of the year, and because they often involve close approaches to wildlife for purposes of identification or photography, the potential for negative effects is large." Boyle and Samson (1985) concluded that human visits to passerine and waterfowl nests in unrestricted situations could increase the chances of nest losses through predation, as adults are flushed away from the nest (Dwernychuk and Boag 1972; Bart 1977; Lenington 1979).

Research has shown that colonial nesting birds are particularly susceptible to human disturbance, since breeding populations concentrate in small areas. Trampling has been recorded (Johnson and Sloan 1976), as has nest abandonment (Hunt 1972; Ellison and Cleary 1978), and nesting water bird relocation to less preferred habitat, in response to unrestricted human disturbance (Erwin 1980). Glinski (1976) notes that human visits to active raptor nests caused adults to waste energy circling the nest tree and calling at the intruders. He indicated that the taped vocalizations used by some wildlife observers can "disrupt the circadian rhythms that dictate performance of territorial calling and displaying during certain times of the day," thus prompting abnormal responses that not only waste the birds' energy, but also increase susceptibility of both nestlings and adults to predation.

Repeated approach by people can cause water birds such as sanderlings to avoid critical foraging habitat, reduce the birds' foraging time as they seek to avoid the approaching humans, or even switch to feeding at night (Burger and Gochfield 1991). Klein (1993), in a study at J.N. "Ding" Darling National Wildlife Refuge in Florida, noted that approaching wildlife on foot was the most disruptive aspect of all the refuge's usual public uses.

Refuge-wide visitor access would eliminate the possibility of selecting and designing wildlife observation sites and trails to minimize impacts on wildlife or habitat. Assessment of visitor impacts would be hampered because there would be no defined public use areas to monitor. Without monitoring, any negative visitor impacts, which might occur, would go undetected and therefore would continue to the detriment of wildlife and habitat. With no limits on visitor access, the refuge would be unable to provide sanctuary from human disturbance to the wildlife within its borders. This becomes especially important in seasons when wildlife is already at risk, such as during nesting, migrating, hunting seasons, or hostile winter conditions. Unlimited access would also put users in conflict with each other.

Socioeconomic Impacts

The increased number of environmental education and interpretation and outreach programs, and observation and photography opportunities would attract more visitors to the refuge which, in turn, would make greater use of the local community facilities, lodging, restaurants, and service stations increasing the local economy.

Cultural and Historical Resource Impacts

We expect no cultural or historical impacts.

Administration, staffing, infrastructure, law enforcement, and other needs

To provide all the strategies of alternative C would require hiring at least one additional full-time permanent ORP and a full-time permanent Recreation Aide for Blackwater NWR, two full-time permanent Park Rangers for the proposed Nanticoke protection area, and additional interns and volunteers for the Chesapeake Island Refuges. It would also require two more full-time permanent Law Enforcement Officers at Blackwater NWR, in addition to those in alternative B, to provide year-round protection for wildlife, habitat, and visitors. The additional staff would require additional office space to be included in the proposed remodeling of the Visitor Center at Blackwater NWR, the proposed Visitor Center and Administrative Complex at the proposed Nanticoke protection area, and the proposed Environmental Education Center on Martin NWR described in alternative B.

Cumulative Environmental Impacts

Cumulative impacts are those impacts on the physical, biological, and human environment resulting from the incremental effect of the proposed actions when added to other past, present, and reasonably foreseeable future actions. Cumulative impacts can also result from individually minor but collective actions taking place over a period of time. For example, the cumulative impact of development can be significant, even if the impacts from individual activities appear minor. The consideration of the cumulative impacts of land use actions on pollutant loading and habitat loss must not be ignored if we are to adequately protect the refuges' Bay environs.

Impacts on Bay Waters and Coastal Wetland Environments

In order for the reader to have an adequate understanding for evaluating proposed management actions on the refuges within the context of the ecosystem approach, it is important to include a brief discussion of the general threats facing coastal habitats and the Chesapeake Bay ecosystem. The realization of the impacts we humans have on the environment will provide a strong foundation to support restrictive and sometimes costly but necessary conservation measures on the Refuge Complex and surrounding lands.

An analysis of trends by the World Watch Institute's "State of the World 2000" indicates that the projected growth in populations over the next half century is the single most urgent trend we need to deal with. The continued high population growth is seen to have cumulative impacts on three negative trends: water shortages, reduced cropland per person, and rising disease rates. Add to these the significant and rapid reduction of our Nation's open space and energy supplies, global warming, and associated sea-level rise, and we are faced with the erosion of quality of

essential resources such as food, air and water. According to the latest U.S. census, the Nation grew faster during the last decade (1990s) than at any other time in history. From 1990 to 2000 the United States experienced a 13-percent population increase, or 33 million people. Over-development is one of the primary threats to the Chesapeake Bay ecosystem and, ultimately, the quality of life for those who live in or visit the Eastern Shore and Bay area. Excessive building threatens water quality by creating polluting nonpoint runoff. Nonpoint source pollution is the Nation's greatest water quality problem and a continuous serious threat to the Bay. Project-by-project impact assessments do not provide a basis for estimating watershedwide impacts of land development. Continued permitting of piecemeal development in the absence of regional ecosystem planning could impose devastating impacts on the entire Blackwater River and Nanticoke River watershed units and the Bay itself.

Recent research studies suggest that most wildlife reserves in eastern North America are too small. With development can come the isolation of wildlife refuges or management reserves. Fragmentation of the land restricts wildlife from life cycle requirements. Mammals and reptiles and amphibian species that cannot move between and among populations can die out as the gene pool is reduced. Additionally, development also lessens the ability of wetlands to purify water and to absorb high waters at times of flooding; destroys habitat for both endangered and non-endangered plant and animal species; diminishes our area's natural beauty; and, places an unacceptable amount of traffic on the roadways. These changes are cumulative and are occurring throughout the Chesapeake Bay region as well as other coastal regions in the United States. Pollution sources include septic systems, animal waste, urban runoff, construction, agricultural chemicals, timbering, hazardous and toxic spills, sand and gravel extraction, energy exploration or operations, junk yards, landfills, and litter and debris. Ecosystems such as the Chesapeake Bay consist of a maze of intersecting life cycles and even cycles within cycles. Biodiversity means stability of those cycles. Pollution reduces biodiversity and, therefore, stability in our natural world. When stressed, whether it involves a fish species, animal, plant or human being, we are living near the limits of our adaptability. Those that can adapt, survive; those that cannot, do not.

The coastal areas of the United States have and continue to undergo an unprecedented growth in human population. Coastal populations are said to be increasing at a rate three times the national average with corresponding population growth estimated at 1.3 million per year. In 1960, 80 million people lived within the U.S. coastal counties (Bush, et al. 1996). Today the number has grown to over 141 million with nearly 14,000 new housing units being built in coastal counties every week, even though these counties account for only 17 percent of the U.S. landmass (National Research Council 2000). In addition, beach areas are a popular tourist destination: 40 percent of Americans list beaches as their preferred destination for vacations (National Research Council 1995), and 100 million people visit the coast every year (National Research Council 2000). The results of urban development in our coastal areas has and is occurring at the expense of wetland, grassland, salt flat, dune areas, and maritime forest. A recent Fish and Wildlife Service survey revealed that during the past decade, urban and rural development has surpassed agriculture as the leading cause of wetland loss in the United States. As our Nation's population increases, continuous demands on both land- and water-based recreation in and around the Chesapeake Bay will also result in cumulative use impacts. Nitrogen loading from both point and non-point sources of agricultural wastes and fertilizers have rendered The Chesapeake Bay one of the most polluted bay ecosystems in the Nation.

The availability of natural resources, e.g., soil, water, or habitat, determines the carrying capacity of an environment for a given population, whether human, animal, or plant. Because of the finite availability of any resource, saturation and depletion effects operate to limit all processes. For example, the depletion of soil nutrients determines the carrying capacity of the land for certain crops; hence, the practice of crop rotation was introduced to allow soil recovery. The rate of fossil fuel energy and water use ultimately will determine the carrying capacity of the Earth's environment for people. The availability of habitat type, water, and associated food sources act to limit species populations. Once the density of a species population exceeds the natural carrying capacity of the land base it populates, predation, disease, and starvation counteract the reproduction rate to bring the population numbers back into balance with the natural resource capacity. Similarly, the density of human populations, coupled with extreme weather fluctuations, influences outbreaks of infectious diseases and plagues. Water shortages already threaten to reduce the global food supply by more than 10 percent, and groundwater contamination from salt water intrusion and pollutants threatens our drinking supplies. Enhanced water quality is probably the greatest economic benefit to a region in terms of recreation and tourism as well as quality of life. The habitat and wildlife management goals and objectives outlined in alternative B seek to counteract those negative cumulative impacts and maintain a healthy refuge and Bay ecosystem.

This proposed management plan for the Refuge Complex will have long-term cumulative benefits for the native and migratory wildlife species and habitats within the area. The protection of wildlife habitats within the Refuge Complex represents a cumulative benefit to the long-term conservation of endangered and other native wildlife species. Too, the Refuge Complex was established as a public benefit, and its continued management and expansion ensure a sense of place and enhanced quality of life for residents and visitors of the Eastern Shore.

Physical Impacts

The rate of sea-level rise and related impacts is cumulative. Sea-level rise could exceed the adaptive rate of species and habitat. The USGS (1998) reports that the rates for sea-level rise for the Bay and Mid-Atlantic coastal area is twice that of the worldwide average. Land subsidence, changing climate, and sediment compaction as a result of ground water extraction are some of the possible causes mentioned. Resulting impacts may include loss of saltmarsh and shallow water habitat, salt water intrusion into ground water supplies, loss of riparian habitat, alteration to the temperature, salinity and dissolved oxygen regimes within the Bay environs. Alternative B proposes various island and marshland restoration projects designed to produce positive cumulative effect that offset the negative cumulative impacts of higher water levels.

Sprawl development impacts are also cumulative with the most visible effect being that of the conversion of farm and forest lands into paved areas. The broad impacts on our landscapes from residential development are obvious. Not so obvious is the impact on our groundwater supplies, but decreases in the quantity and quality as well as the recharge rate are well documented in coastal communities. The land protection proposed in alternative B, with new protection along the Nanticoke River, will provide essential trust resource habitat, and will also serve to balance land use.

Maintaining healthy forest cores and protection and restoration of additional forested lands will result in improved air quality through the ability to absorb carbon dioxide. Additional land protection will ensure long-term enhancement and maintenance of air quality.

Alternative B is expected to have cumulative positive impacts on the Chesapeake Island Refuges and the Chesapeake Bay ecosystems, providing direct and incidental benefits to all island habitat types and their associated dependent species. Direct ecosystem improvements will be realized by reducing habitat erosion and encouraging SAV regeneration. By reducing turbidity and anchoring shorelines, water surrounding the islands will be more conducive to SAV growth, which will further reduce nutrients and slow wave energy, providing long-term benefits to the tidal portion of the Chesapeake watershed. In addition, if the catastrophic marsh and island erosion is reduced, the marsh is expected to generate peat, allowing it to maintain elevations against future sea-level rise. Alternative B does include habitat conversion. Despite the overall net loss of shallow water habitat, this alternative is expected to have a large beneficial impact on the remaining shallow water areas. At present, shallow water, albeit degraded, is gaining in acreage.

Reestablishing ecosystem functions is one of the primary goals of alternative B as conducted through salt marsh restoration efforts. Marsh grass planting, elevation reclamation, and ditch plugging will restore normal tidal flow, reduce mosquito breeding areas, enhance water quality by providing surface sediment stability, and reestablish filtration and wave absorbent abilities of the marsh.

Individually, frequent low-intensity controlled fires can have relatively benign effects; but collectively they can shape species composition, structure and function of the forest. Such changes in forest composition can have both beneficial and adverse impacts on wildlife populations. Prescribed burns at the Refuge Complex are directed at the reduction of fuel load to create a “fire safe” environment as well as creating conditions to support Delmarva fox squirrels and other species of management concern.

Biological Impacts

The fragmentation of landscapes, exotic species invasions, development sprawl, reduction of fish and shellfish stocks, toxic pollution, and nutrient runoff are decreasing diversity in the Chesapeake Bay ecological systems. The result of these actions over time can reduce the carrying capacity of a natural ecosystem. The continued fragmentation of habitat by highways and development threatens the long-term survival of most wildlife species. Only the most adaptable of species can survive. Our ability to protect and connect land areas to allow safe passage for feeding, breeding, and shelter is crucial for the future maintenance of wildlife populations and biodiversity. The loss of biological diversity known as simplification results in the reduction of a system’s ability to carry out essential functions by limiting the number of ways in which those functions can occur. Wildlife act as a barometer of the overall health of an environment and our own health. From a human perspective, the decline in biodiversity—the diversity of living things—can mean the loss of products and services provided by the land, coastal, or marine systems: food, water filtration, flood protection, and protection against erosion, as well as aesthetic, cultural, and spiritual or emotional benefits. Since a primary goal of the Service ecosystem approach to fish and wildlife conservation is “conserving natural biological diversity

and ecosystem integrity, while supporting a sustainable level of human use," the above adverse actions work to negatively counter the goals and objectives of the Refuge Complex.

The number of invasive species and their cumulative impacts are accelerating throughout the Country and the Chesapeake Bay region. These species are detrimental to native plants and animals. Deer, geese, mute swan, and nutria populations, if left unmanaged, can cause dramatic changes in the structure and composition of vegetated habitat by overbrowsing. Marshlands can virtually be destroyed by geese eat-outs and nutria foraging. This is the case at Blackwater NWR. Nutria and mute swans, also exotic species, wreak havoc on marsh habitat and migratory waterfowl species. The former destroys critical habitat for feeding, nesting, and brood cover; the latter, because of its strong territorial behavior, drives trust species of waterbirds from the area which it occupies or otherwise interrupts their life cycle. Over time, these impacts have a cumulative effect on the welfare of a species population and use of an area. The eradication of mute swans and nutria would, of course, reduce or eliminate the opportunities for public wildlife observation and photography of these species. The changes or destruction of vegetative cover will cause impacts on the feeding, breeding, and protection of other aquatic and terrestrial fish and wildlife species. Johnson grass (*Sorghum halepense*) found on the refuge reduces crop yield and competes with native grasses for ground cover. The European purple loosestrife (*Lythrum salicaria*) changes emergent marsh composition, and has reduced the biomass of numerous species of native plants and endangered wildlife including several duck species that depend on these plants. The three alternatives seek to control or otherwise reduce such exotic species. However, alternative B would contribute the greatest cumulative impact through more aggressive, direct control and public outreach and education.

Land Protection Impacts

Nationwide there is a decreasing land base resulting from an increasing human population. Our landscapes are undergoing incredible fragmentation. As a people we are socially and culturally connected to our landscapes. This not only impacts wildlife populations but a person's health and physical well being as well. With a loss of landscape comes a loss of identity of place. The land protection proposals brought forth in this Draft EA are directed at not only preserving our wildlife heritage but will directly or indirectly serve to preserve the social-cultural heritage of the Eastern Shore as well. A landscape plan that visually depicts the habitat vision for the Refuge Complex is described in alternatives B and C. The spatial and biological relationships of each of the three refuge units with surrounding private and public lands is addressed. The ecological connectivity of public lands is a priority if wildlife migratory corridors are to be preserved and natural resources of the Bay protected. The continuation of land protection will ensure an adequate land base to effectively maintain and sustain wildlife populations.

The Refuge Complex is but one of a dozen refuge units surrounding the Bay. Large georegional linkages of public lands and open space around the Bay will help to maximize management potential of the natural resources, enhance water quality, and ensure future wildlife dependent recreation. Landscape-level linkages also provide critical migratory corridors important for dispersal of all wildlife forms even migratory pollinators. Approximately 70 percent of our

Nation's land base is still in private ownership. There is never assurance of continued public access to privately owned lands. However, lands placed into public refuge ownership will satisfy in part, future outdoor wildlife-dependent recreational demands, while preserving a portion of the Eastern Shore's regional landscape and associated sense of place.

Cumulative impacts that would result from Service refuge expansion and land protection include the:

- Long-term protection of important wetlands both brackish and freshwater.
- Protection and enhancement of biological diversity on both a community and ecosystem level
- Protection of rare, endangered, and threatened species
- Contribution to the long-term protection of waterfowl species and species of special concern
- Contribution to the protection of water quality, fish spawning habitat and shellfish resources
- Contribution to the protection of the Chesapeake Bay Ecosystem and the goals and objectives of the Chesapeake Bay Ecosystem Team Strategic Plan
- Contribution to the local economy from expenditures relating to the operation and management of the refuge and from refuge visitor expenditures for goods and services obtained in the local area.
- Maintenance of wetland functional values, such as flood protection and groundwater recharge.

Cultural and Historical Resource Impacts

Alternatives B and C are not expected to have any significant adverse cumulative impact on cultural resources within the refuge planning study area. Beneficial impacts would occur from additional land protection which would give protection to any archeological sites or cultural resources found on parcels protected and through environmental education and interpretation programs that incorporate this topic as part of the presentation. Because alternative A would see less lands protected thus the potential for more cultural and historic resources to be damaged or destroyed is greater. Under the Historic Preservation Act, the Service is required to identify, preserve, and manage archeological, historic, and scientific resources. The Service is also required by the Federal Act to coordinate this activity closely with the State preservation officer. Archaeological resources on federal lands are further protected from looting or vandalism through provisions of the Archaeological Resource Protection Act. Surveys will be performed before any public use facility or Refuge operating or administrative improvements are initiated. Professional mitigation or salvage will be provided for all significant cultural resource properties when avoidance of adverse impacts is not possible. A detailed archaeological and

geomorphological reconnaissance study was conducted by TRC Garrow Associates, Inc. in October 1997 for the Service, and the results of the study reported in May 2000. Two new archeological sites were identified during the field study and also a known historic site was investigated. It is the policy of Region 5 to strictly enforce regulations to stop the loss of cultural historic resources caused by vandalism or illegal collection and excavation on Service lands. Additional cultural or archaeological management plans will be prepared as needed.

Socioeconomic Impacts

The economic costs associated with environmental damage can be considerable, and often offset any gains attained through agricultural and industrial development. Soil erosion alone can significantly decrease the value of agriculture by 17 percent, or even more. The continued protection of lands and promotion of best management practices on land use should help increase the economic benefits. The protection of new refuge lands or the expansion of existing refuge boundaries will not result in additional regulatory controls on the use of private property within or adjacent to the boundary.

Local property tax impacts can be a major concern whenever and wherever government land protections are proposed. These tax concerns generally come in two forms: direct losses through non-payment (or minimal payments in lieu of taxes) and loss of assessment. Loss of assessment primarily occurs when highly taxed improved lands, such as good farm land, are allowed to revert to “waste” lands such as wetlands or scrub forests.

Almost invariably, these impacts are overestimated by the communities involved. It is assumed that all the land within a project boundary will be purchased in fee title and within a short time frame. Neither is correct. No adjustments are made for the fact that the Service operates on a “willing seller” policy and that Congress must allocate funding on an annual basis. Significant portions of land may never come up for sale, or will be purchased in less than fee title (such as the purchase of development rights), or will simply be placed under a negotiated management agreement. Also, structures are rarely purchased, and are avoided when drawing proposed project boundaries. Therefore, most of a community’s real property value remains on the tax roles even after protection is completed. Lands protected by the Service in fee ownership would be removed from the tax rolls.

To offset the fiscal impact associated with the removal of these lands from the public tax rolls, the Refuge Revenue Sharing Act of 1935, as amended in 1978, provides for payments to offset tax revenue losses. Only those lands purchased in fee title qualify for revenue sharing. Land purchased for refuge purposes is generally assessed at three-quarters of 1 percent of the property’s fair market value. That results in the highest rate of return to the local taxing entities. The assessment based on that formula is based on the land use classification and purchase price. Payments on those lands classified as agricultural or timber could be 40 to 60 percent higher than actual taxes currently assessed. Alternative B would contribute the greatest land increase to the Refuge Complex, with cumulative revenue sharing payments estimated at approximately $8 million or $9 million, depending on per-acre value for Blackwater NWR, and an estimated

$16 million for the proposed Nanticoke protection area, if established. Those figures also assume that the acreage involved would be purchased in full fee title.

Lands subject to refuge revenue sharing payments are reappraised every 5 years. The appraisals set the fair market value of the land, based on its highest and best legal use. If the appraiser determines that the land's highest and best use in the absence of a refuge were residential or some other type of developed use, the appraised market value is based on the value of similar parcels in that use. The appraised market value of the fee lands within the refuge, and thus, the revenue sharing payments, would change over time in relation to the changing value of non-refuge lands. Refuge revenue sharing payments will be in proportion to the amount and value of the lands purchased.

Property values tend to be a reflection of current open market trends. In most cases, protection by the Service on other projects throughout the Northeast has indicated that Service protection has not diminished property values. In many instances, property values have actually been enhanced by their location near a national wildlife refuge. This results in an intangible benefit to the home owner and the community. This is especially true in instances where open space or conservation lands are involved, and Realtors take advantage of the situation to advertise such properties as affording the privacy and aesthetics that natural lands provide. Conversely, scientific and statistical studies conducted in towns and cities nationwide reveal that proximity to hazardous waste sites, landfills, and surface water pollution decreases the values of adjacent properties. Public perception of potential health risks depresses property values independent of scientific assessment.

The economic benefits of a national wildlife refuge can be far reaching and not limited to just the local or regional business areas. Wildlife refuges are fast becoming travel destinations, and are leading to more travel and tourism. Passive recreational benefits, such as nature photography, wildlife observation, and bicycling, are being provided to urban populations, which have a long-term cumulative economic benefit to the local community businesses and to the recreation needs of the region. The benefits begin at the local level and expand outward Associated benefits can also become cumulative over time. For example, tourists spend more money at local businesses, which in turn expand and purchase new equipment from manufacturers and retailers, whose employees benefit and spend their own money, and so forth. This results in a cumulative national economic benefit.

As far as public access is concerned, the Service recognizes the increasing demand for recreational use of refuge lands and open space. "Wildlife first" doesn't mean "people last"; rather, the question is one of compatibility. When determined as compatible with refuge objectives, reasonable access will be permitted and managed so that visitors can receive a quality wildlife experience. We expect recreational opportunities to increase significantly under alternative B, since local landowners do not often provide access for public recreation. As more lands are protected, more wildlife-dependent recreational opportunities can be provided. Protection of these lands by the Service will cumulatively and in the long term maintain the quality of life for Eastern Shore residents by preserving the rural atmosphere of the Eastern Shore and the natural aesthetic and recreational qualities that these lands offer.

Costs associated with the control and eradication of invasive and exotic species are substantial and occur annually. Loosestrife, for example, now occurs in 48 states and costs $45 million per year in control costs and forage loss. The Refuge Complex (Blackwater NWR, especially) spends approximately $80,000 to $250,000 annually, depending on earmarked funding, in an attempt to control and restore habitat impacted by various invasive species. Refuges and other natural reserves are or may become of great value as reservoirs of natural pest control agents.

Fishing and hunter education are annually supported in part by Federal grant money administered by the Service under the Federal Aid in Wildlife Restoration Act (Pittman-Robertson act) and the Federal Aid in Sport Fish Restoration Act (Dingell–Johnson *or* Wallop–Breaux act). Maryland would continue to receive annual funding for these activities.

The Chesapeake Bay watershed has numerous state, local and private organizations dedicated to the protection of wildlife habitat and water quality. Service actions as part of alternative B would add significantly to the positive impacts on biological resources by others, complement State initiatives, and help offset the continuing large-scale land losses.

The operation, administration and maintenance of Refuge Complex facilities represent a long-term cumulative funding cost. Likewise, fish and wildlife management activities also could result in continued incremental costs, depending on the number and scale of the activities involved. In order to maximize public access and use within the limits of compatibility, it will be necessary to provide appropriate facilities and staffing to accommodate various levels of visitation.

Island Management Impacts

Alternative A would be expected to have long-term, negative impacts on the islands and the Chesapeake Bay ecosystem. Erosion losses of emergent marsh, SAV, dune, beach, and upland forested hammock habitats would negatively affect the aquatic, avian, terrestrial, and benthic species associated with these habitats. Because island habitat values cannot be regained on the mainland, many species would be displaced or forced to relocate to other estuaries. Human communities on Smith Island and Upper and Middle Hoopers Island also would be forced to relocate.

Alternative B would be expected to have long-term positive impacts on the islands and the Chesapeake Bay ecosystems, by providing direct and indirect benefits to all island habitat types and the species that depend upon them. Direct ecosystem improvements would be realized by reducing habitat erosion and encouraging SAV regeneration. By reducing turbidity and anchoring shorelines, the water surrounding the islands would be more conducive to SAV growth, which would further reduce nutrients and slow wave energy, providing long-term benefits to the tidal portion of the Chesapeake Bay watershed. In addition, if the catastrophic marsh and island erosion is reduced, the marsh would be expected to generate peat, allowing it to maintain elevations against future sea-level rise. Alternative B does include habitat conversion. Despite the overall net loss of shallow water habitat, this alternative would be expected to have a large

beneficial impact on the remaining shallow water areas. At present, shallow water, albeit degraded, is gaining in area.

The environmental consequences of alternative C would be the same as alternative A.

Short-term Uses and Long-term Productivity

Short- and long-term effects describe the relationship between short-term uses of the human environment and maintenance of long-term productivity of the natural environment. By long-term we mean that the impact would extend beyond the 15-year planning horizon of this draft CCP/EA. Short-term means less than 15 years.

Although varying in degree, all the alternatives are aimed at enhancing the long-term productivity and sustainability of natural resources on the Refuge Complex. Alternative A, however, is operating with limited funding and staff so its capabilities to achieve long-term productivity and sustainability goals are less than those of alternative B. Alternative C is narrower in scope, but still strives to protect and sustain trust resources on a long-term basis.

Short-term economic effects, both beneficial and adverse, would occur as a result of future land purchases. There would be short-term impacts on tax revenues for the year in which a property is purchased. In the long term, however, land protection would reduce annual municipal service costs, while providing increased quality of life, essential habitat for wildlife, and outdoor recreation. Any loss in taxes would be at least partially offset by the annual refuge revenue sharing payments.

Alternative B, in the long run, would positively impact the local economy by increased spending on environmental programs and related facilities, refuge operational and maintenance service costs, and the expenditures of refuge staff families. Public use programs and activities will attract visitors and positively increase tourism and recreation in the Easton and Cambridge areas. In the long term, any adverse impacts will be mitigated or offset by the positive impacts from increased open space, maintenance of sense of place, and quality of habitat for plants and animals as well as humans.

The enhancement of the existing visitor facilities at Blackwater NWR and Martin NWR, trails, observation platforms or towers, and moist soil and forest management practices will result in both short- and long-term physical impacts on the soil and vegetation. These impacts would be very localized and confined to the areas of the construction sites. Those are located outside of the prime wildlife habitat areas. The increased educational and recreational programs will result in more people being involved in environmental education and interpretation, which will hopefully provide for a greater appreciation of the land in general and the refuge specifically. The refuge environmental education and interpretative programs will directly benefit local and regional schools and provide teacher training opportunities.

All impacts on biological resources resulting from the implementation of alternative B are expected to be long-term and beneficial. Long-term beneficial effects include the increased productivity of threatened and endangered species, Neotropical songbirds, waterfowl, wading birds, deer, small game and myriad other species (e.g., butterflies, reptiles and amphibians) dependent on refuge habitat. The public would gain long-term opportunities for recreation and education on some refuge tracts.

Short-term uses of refuge lands include wetlands and island restoration and enhancement, hunting, fishing, trapping, exotic plant and animal control, management for endangered and other selected species, wildlife inventories and monitoring, forest regeneration, prescribed burns, crop and water management, and the construction of administration and public use facilities. These will be implemented with the primary goal of ensuring the sustained productivity of refuge resources.

The Service is required to "plan and direct the continued growth" of the Refuge System as a cohesive national system by giving increased protection priority to lands that will provide long-term protection and alleviate the greatest threats to biodiversity. To accomplish that objective, the Refuge Complex management staff must constantly evaluate surrounding land uses for impacts on refuge habitat and its dependent water sources. Protection strategies can involve working with local landowners and municipalities to reduce or eliminate competing uses or degrading land use practices, and may also involve future land purchases. Benefits to the local tax base are not often considered, but generally, property values rise when a government agency is buying land, since that introduces a new buyer and a new source of money into the local real estate market. A long-term land protection program has the potential to benefit a good percentage of the property owners and the real estate market over time. Federal conservation lands demand few services, and make an attractive neighbor. Larger holdings, such as Blackwater NWR, also provide local employment and purchases from local businesses. National wildlife refuges also attract ecotourism, which is advantageous to the local community.

The Blackwater NWR and other mainland refuge lands, in addition to their wildlife habitat significance, play a crucial role in the long-term protection and filtering of pollutants and runoff into the Chesapeake Bay. Refuge lands represent a natural buffer to Bay waters and associated aquatic resources. The Bay's ability to cleanse itself and support indigenous populations has been and is being compromised. The ability of the remaining areas to carry out these functions must be permanently protected if we are to benefit economically and sustain ecological carrying capacity. Regulatory protection for environmentally significant areas alone will not ensure long-term preservation of these sites.

Therefore, land protection helps to maintain the remaining natural areas and their important water quality and habitat values. Preserving environmentally sensitive habitats, such as coastal plain forest, marshland and islands, and maintaining open space minimizes runoff pollution, provides long-term wildlife habitat, storm protection and recreational and economic benefits. Seasonally saturated coastal plain forested wetlands (flatwoods) are an protection priority. Flatwoods, characterized by loblolly pine (*Pinus taeda*) and sweet gum (*Liquidambar styraciflua*) in the Eastern Shore region, are among the most threatened wetlands in the coterminous United States. The proposed alternative B will support not only Refuge Complex

long-term management objectives, but also The Chesapeake Bay Program water quality and land protection objectives. Land conservation is also a method of mitigating impacts caused by sea-level rise. To eliminate or substantially reduce saltwater intrusion, land protection has to happen. The restoration of the hydrology in the Upper Blackwater River also depends on the protection of certain land parcels.

The monitoring, surveys, and research studies proposed in alternative B will provide a basis for future informed decision making. Although monitoring is no substitute for understanding, it does alert us to possible problems and trends.

Long-term refuge effects include increasing productivity of threatened and endangered species, waterfowl, songbirds, and myriad species dependent upon refuge habitat. In addition, the public will gain long-term opportunities for wildlife-dependent recreation and education on some refuge tracts.

The development of any trails, visitor or education facilities, and wetland restoration will lead to both short-term and long-term impacts on soils and vegetation. The impacts from these actions will be very defined and localized.

Prescribed fire is used on the Refuge Complex to reduce hazardous forest fuels and to meet habitat management goals. Burning removes the accumulation of underbrush, deadwood, leaves, and needles that pose a fire hazard in the dry summer months. Fire is also used as a management tool. Without fire, natural succession would take place resulting in the replacement of desired habitat with less desirable habitat types. For example, the conversion of the pine and hardwood stands to a predominantly mixed hardwood forest type through successional processes would negatively impact Delmarva fox squirrel populations. Burns associated with forest and grassland management would cause short-term impact on local air quality. In addition, fire, if not properly scheduled could have short- and long-term negative impacts on native and migratory nesting bird species. On the beneficial side, burns create new habitat and successional growth that will favor a variety of bird and mammal populations. If not properly planned, other burns could displace endangered Delmarva fox squirrels and decrease the suitability of a forest core to support that species.

Habitat damage by nutria and mute swans, although not necessarily irreversible, does have long-term consequences for the wetland ecosystem and associated dependent fish and wildlife populations. The management actions proposed to eliminate or severely restrict the numbers of these two invasive species will ensure the long-term viability of feeding and cover habitat for migratory waterfowl and breeding habitat for important fish and shellfish species.

Irreversible and Irretrievable Commitments of Resources

Irreversible commitments of resources are those which cannot be reversed, and result when an area cannot be returned to its natural condition. For example, the depletion of old growth forest is irreversible, as is an action that contributes to a species' extinction. Once extinct, it can never be

replaced. The use of non-renewable resources such as mineral or fossil fuel consumption is also irreversible.

In comparison, irretrievable commitments of resources are those which can be reversed, given sufficient time and resources, such as when a renewable resource is allocated to a given use but cannot be recovered without significant effort. An example of an irretrievable commitment is the conversion of shrub-scrub land to moist soil. If for some reason conversion were terminated, the moist soil unit would revert to shrub-scrub land.

The protection of refuge lands is considered an irreversible commitment because it is extremely rare that refuge lands revert to any other ownership. Management of refuge lands protected will result in an irreversible and irretrievable commitment of funding for administration, operation and maintenance of the refuge, especially public use facilities and programs. Funding and personnel commitments by the Service to purchase and manage refuge lands render those resources unavailable for other Service programs and projects.

Refuge lands are public lands. That status, however, precludes the freedom to use these lands according to individual desires. All public uses of refuge lands must be compatible with the purposes for which the refuge was established. Traditional land uses that are clearly incompatible with resource protection and enhancement will not be allowed. The potential for development of these lands for residential or commercial purposes by the private sector will be lost. However, refuge lands provide long-term public benefits by creating public use areas, protecting open space, watersheds, and views, decreasing the costs of community services, and increasing the value of homes adjacent to refuge lands.

Wetlands restoration could remove some lands from agricultural use. However, this loss is not entirely irreversible, since at some future date these lands could be returned to agricultural use if desired.

Existing multiple environmental threats are working to reduce the Bay Ecosystem's natural biodiversity. The extinction of any species is an irreparable loss, and biodiversity teaches us that with each extinction an entire ecosystem is weakened in both structure and function. Since humans are an integral part of the ecosystem, we must interact properly with the rest of the ecosystem if we are to survive.

Committing land to the construction of new public use facilities, e.g., foot trails, bike trails, observation platforms, towers, the new visitor center for the proposed Nanticoke protection area, and the remodeled or new addition to the existing Blackwater Visitor Center represent irreversible actions. However, even some of those could be reversed if needed or desired.

The rising sea levels due to climatological changes, regional land subsidence, and nutria foraging on marsh vegetation are working in concert to accelerate the erosion of emergent salt marsh, resulting in an irreversible conversion to open water. The loss of marsh habitat negatively effects fish, shellfish, water birds, and other wildlife that are dependent on this habitat type for breeding, spawning, feeding, and shelter. Alternative B seeks to mitigate that trend by restoring natural hydrological features, additional land protection, marsh restoration, and implementing nutria

control measures. The Army Corps of Engineers Baltimore District and the Service are working together to initiate major marsh restoration by filling in eroded areas to raise the surface of the marsh to a level that will again support plant growth.

Refuge management would result in an irreversible and irretrievable commitment of annual funding for operation, administration, and maintenance. Funding and personnel commitments by the Service to construct, purchase, or manage refuge lands or facilities render those resources unavailable for other Service programs and projects. The more public use activities and facilities provided, the greater the operating and maintenance costs involved.

The costs associated with the development and implementation of this refuge comprehensive conservation plan are irreversible and irretrievable. Planning costs and time are part of doing business.

The costs associated with land protection for the refuge would be irreversible. Refuge land protection removes acreage from private ownership, as well as any potential development benefits. However, such land, once placed in public ownership under the Refuge System, provides a new set of uses and benefits a much broader group of people. Structural improvements that are purchased with any land may be declared surplus to government needs, and sold or demolished onsite at a cost. Federal ownership may affect surrounding land use patterns, local economies, and tax revenues. Property located adjacent to conservation and refuge lands generally increases in value; landscapes become protected; revenues to local service businesses increase; and costs to local municipalities for services decrease.

Habitat restoration projects, e.g., wetlands, would be considered irreversible. Following restoration, the Clean Water Act would make it very difficult to reconvert wetlands on a national wildlife refuge to a drained condition. Irreversible loss of habitat, as part of the Service's proposed action, would occur at the construction sites of new facilities, such as the new, paved bike trails.

Exotic plant and animal population control or eradication is considered irreversible and irretrievable. Although animal and plant populations are renewable in different degrees, the loss of those that are harvested either through hunting or trapping is irreversible. Construction sites and some habitat management practices may irretrievably damage natural communities, at least for a period of time.

Unavoidable Adverse Impacts

We are aware that the proposed expansion of the Refuge Complex would affect real property tax rolls and, consequently, could reduce tax revenues. Potential negative economic impacts on counties or towns resulting from Federal land protection generally are offset by payments made under the provisions of the Refuge Revenue Sharing Act, as amended. The act directs the Service to make annual payments to counties or the local taxing entity based on a percentage of the fair market value of refuge lands in their jurisdictions. While those payments are not technically in

lieu of taxes, they often provide the counties with revenue comparable to what they would have received if the land had remained on their tax rolls. Congress determines the annual percentage of payment to be made. Also, continued housing construction elsewhere in those counties and towns should result in no net loss of tax revenue, or mitigate that loss attributed to refuge land protection.

The development of any lands purchased for incorporation into the Refuge Complex would be precluded. Thus, the local economy could be adversely affected by losing the monetary gain from future development. However, that type of impact is viewed as being minor, as the Service is committed to working only with willing sellers. People would not be willing to forego rewards from future development potential if the value of the property, adjusted to account for risk and inflation, is greater than the value they receive by forfeiting their development rights. Therefore, it can be assumed that property owners who give up their development rights do not expect the development potential of their land to increase greatly, or are simply more interested in land conservation or preservation of family heritage than any monetary gains.

Construction operations for new public use facilities or improvements will result in temporary localized impacts on soils, topography and vegetation. Impervious surfaces associated with bike trails, roads, and paved trails will increase water runoff rates and reduce groundwater recharge. Such surfaces will be kept to a minimum in terms of total surface area.

Refuge public use may eventually lead to minor increases in vehicular traffic noise, especially if proposed visitor center facilities construction are implemented. However, this increase would be localized, seasonal, and of short duration. Traffic and visitor numbers will be limited by refuge parking availability, and that will control or restrict noise levels.

The harvest of certain species, e.g., deer, nutria, and mute swans, will reduce the populations of these species in favor of prohibiting irreversible habitat damage. In the case of nutria it is a priority refuge to goal to eliminate the species altogether in order to preserve the natural salt marsh habitat so essential to commercially important fish and shellfish species as well as migratory waterfowl. The reduction in population numbers of these species could mean fewer public viewing opportunities of the species at least temporarily until their numbers recover.

The landscape vision for land protection for the Refuge Complex will result in the purchase of some farmlands which will be taken out of production in order to satisfy Service objectives for wildlife population maintenance, recovery, and enhancement. The majority of lands identified for future purchase however, involve wetlands and not agricultural lands.

Construction projects and increased visitation would affect local air and water quality and natural vegetation, through vehicle emissions, localized damage to vegetation, and soil compaction and erosion. Enhanced visitation would also mean additional disturbances to both resident and migratory wildlife. Increased visitation generally necessitates additional restrictions for public safety and to minimize public use.