U.S. Fish & Wildlife Service

Prime Hook National Wildlife Refuge

Draft Comprehensive Conservation Plan and Environmental Impact Statement

May 2012

Volume 2—Appendixes

Front cover:
Pintails taking flight
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This blue goose, designed by J.N. "Ding" Darling, has become the symbol of the National Wildlife Refuge System.

The U.S. Fish and Wildlife Service (Service) is the principal Federal agency responsible for conserving, protecting, and enhancing fish, wildlife, plants, and their habitats for the continuing benefit of the American people. The Service manages the National Wildlife Refuge System comprised of over 150 million acres including 555 national wildlife refuges and thousands of waterfowl production areas. The Service also operates 70 national fish hatcheries and 81 ecological services field stations. The agency enforces Federal wildlife laws, manages migratory bird populations, restores nationally significant fisheries, conserves and restores wildlife habitat such as wetlands, administers the Endangered Species Act, and helps foreign governments with their conservation efforts. It also oversees the Federal Assistance Program which distributes hundreds of millions of dollars in excise taxes on fishing and hunting equipment to state wildlife agencies.

Comprehensive Conservation Plans (CCPs) provide long-term guidance for management decisions on a refuge and set forth goals, objectives, and strategies needed to accomplish refuge purposes. CCPs also identify the Service's best estimate of future needs. These plans detail program levels that are sometimes substantially above current budget allocations and, as such, are primarily for Service strategic planning and program prioritization purposes. CCPs do not constitute a commitment for staffing increases, operational and maintenance increases, or funding for future land acquisition.

Appendix A

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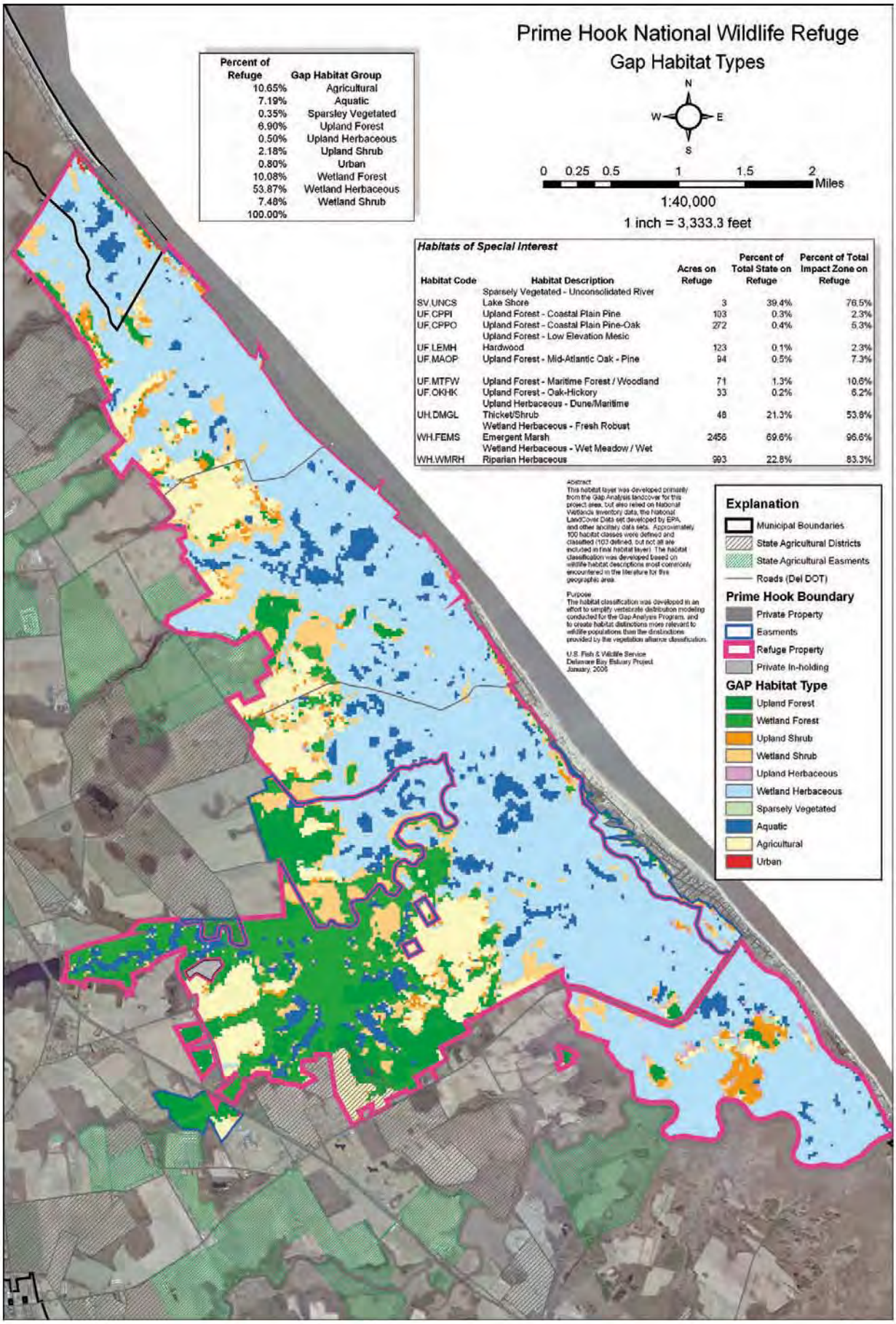
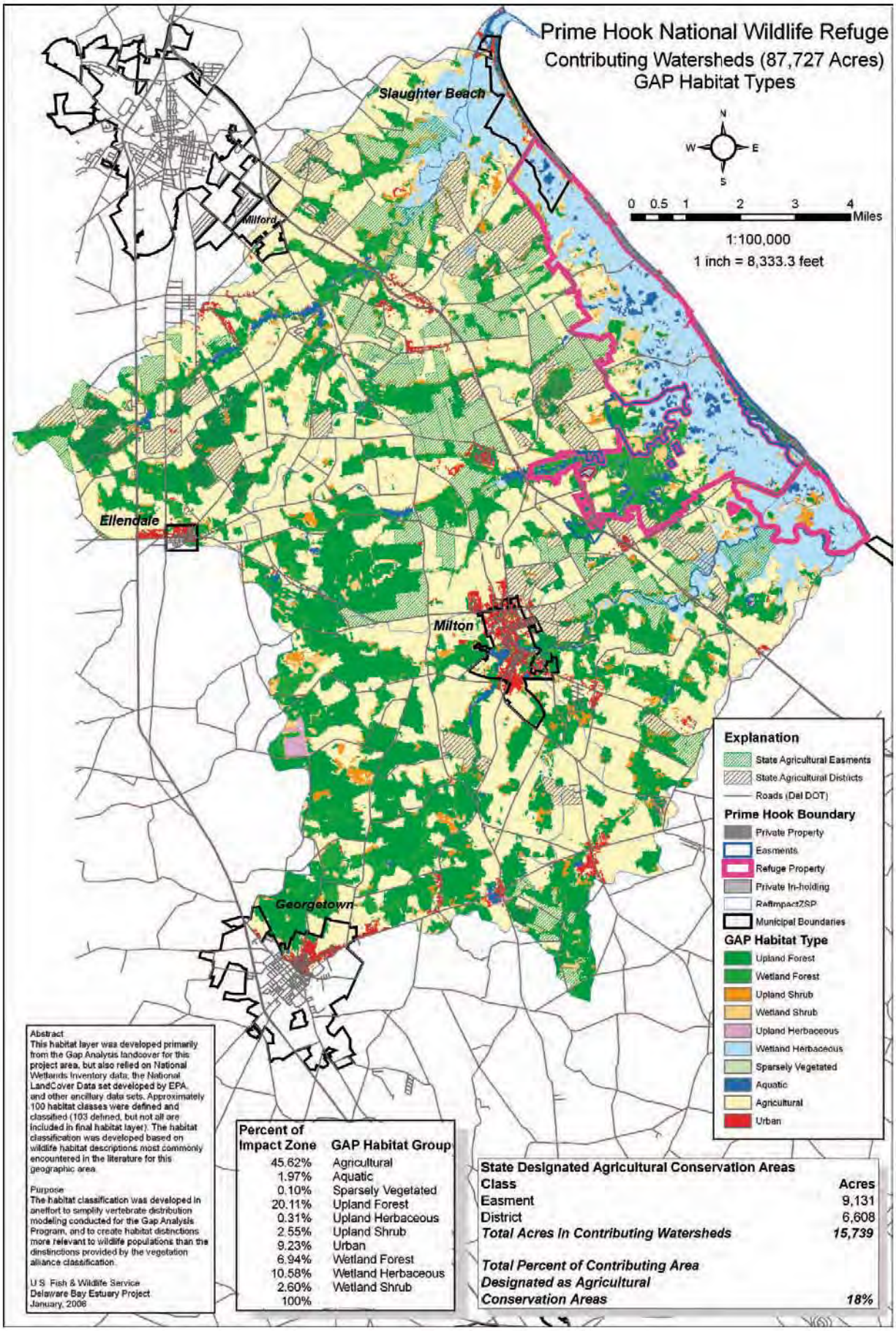
Greater yellowlegs on the refuge

Gap Habitat Maps


Prime Hook National Wildlife Refuge
Gap Habitat Types
N
W
E
S
0 0.25 0.5 1 1.5 2 Miles
1:40,000
1 inch = 3,333.3 feet
Percent of Refuge
Gap Habitat Group
10.65% Agricultural
7.19% Aquatic
0.35% Sparsley Vegetated
6.90% Upland Forest
0.50% Upland Herbaceous
2.18% Upland Shrub
0.80% Urban
10.08% Wetland Forest
53.87% Wetland Herbaceous
7.48% Wetland Shrub
100.00%
Habitats of Special Interest
Habitat Code | Habitat Description | Acres on Refuge | Percent of Total State on Refuge | Percent of Total Impact Zone on Refuge
SV.UNCS | Sparsely Vegetated - Unconsolidated River Lake Shore | 3 | 39.4% | 76.5%
UF.CPPI | Upland Forest - Coastal Plain Pine | 103 | 0.3% | 2.3%
UF.CPPO | Upland Forest - Coastal Plain Pine-Oak | 272 | 0.4% | 5.3%
UF.LEMH | Upland Forest - Low Elevation Mesic Hardwood | 123 | 0.1% | 2.3%
UF.MAOP | Upland Forest - Mid-Atlantic Oak - Pine | 94 | 0.5% | 7.3%
UF.MTFW | Upland Forest - Maritime Forest / Woodland | 71 | 1.3% | 10.6%
UF.OKHK | Upland Forest - Oak-Hickory | 33 | 0.2% | 6.2%
UH.DMGL | Upland Herbaceous - Dune/Maritime Thicket/Shrub | 48 | 21.3% | 53.8%
WH.FEMS | Wetland Herbaceous - Fresh Robust Emergent Marsh | 2456 | 69.6% | 96.6%
WH.WMRH | Wetland Herbaceous - Wet Meadow / Wet Riparian Herbaceous | 993 | 22.8% | 83.3%
Abstract
This habitat layer was developed primarily from the Gap Analysis landcover for this project area, but also relied on National Wetlands Inventory data, the National LandCover Data set developed by EPA, and other ancillary data sets. Approximately 100 habitat classes were defined and classified (103 defined, but not all are included in final habitat layer). The habitat classification was developed based on wildlife habitat descriptions most commonly encountered in the literature for this geographic area.
Purpose
The habitat classification was developed in an effort to simplify vertebrate distribution modeling conducted for the Gap Analysis Program, and to create habitat distinctions more relevant to wildlife populations than the distinctions provided by the vegetation alliance classification.
U.S. Fish & Wildlife Service
Delaware Bay Estuary Project
January, 2006
Explanation
Municipal Boundaries
State Agricultural Districts
State Agricultural Easments
Roads (Del DOT)
Prime Hook Boundary
Private Property
Easments
Refuge Property
Private In-holding
GAP Habitat Type
Upland Forest
Wetland Forest
Upland Shrub
Wetland Shrub
Upland Herbaceous
Wetland Herbaceous
Sparsely Vegetated
Aquatic
Agricultural
Urban


Prime Hook National Wildlife Refuge
Contributing Watersheds (87,727 Acres)
GAP Habitat Types
N
W
E
S
0 0.5 1 2 3 4 Miles
1:100,000
1 inch = 8,333.3 feet
Slaughter Beach
Milford
Ellendale
Milton
Georgetown
Explanation
State Agricultural Easments
State Agricultural Districts
Roads (Del DOT)
Prime Hook Boundary
Private Property
Easments
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Private In-holding
RefImpactZSP
Municipal Boundaries
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Upland Forest
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Abstract
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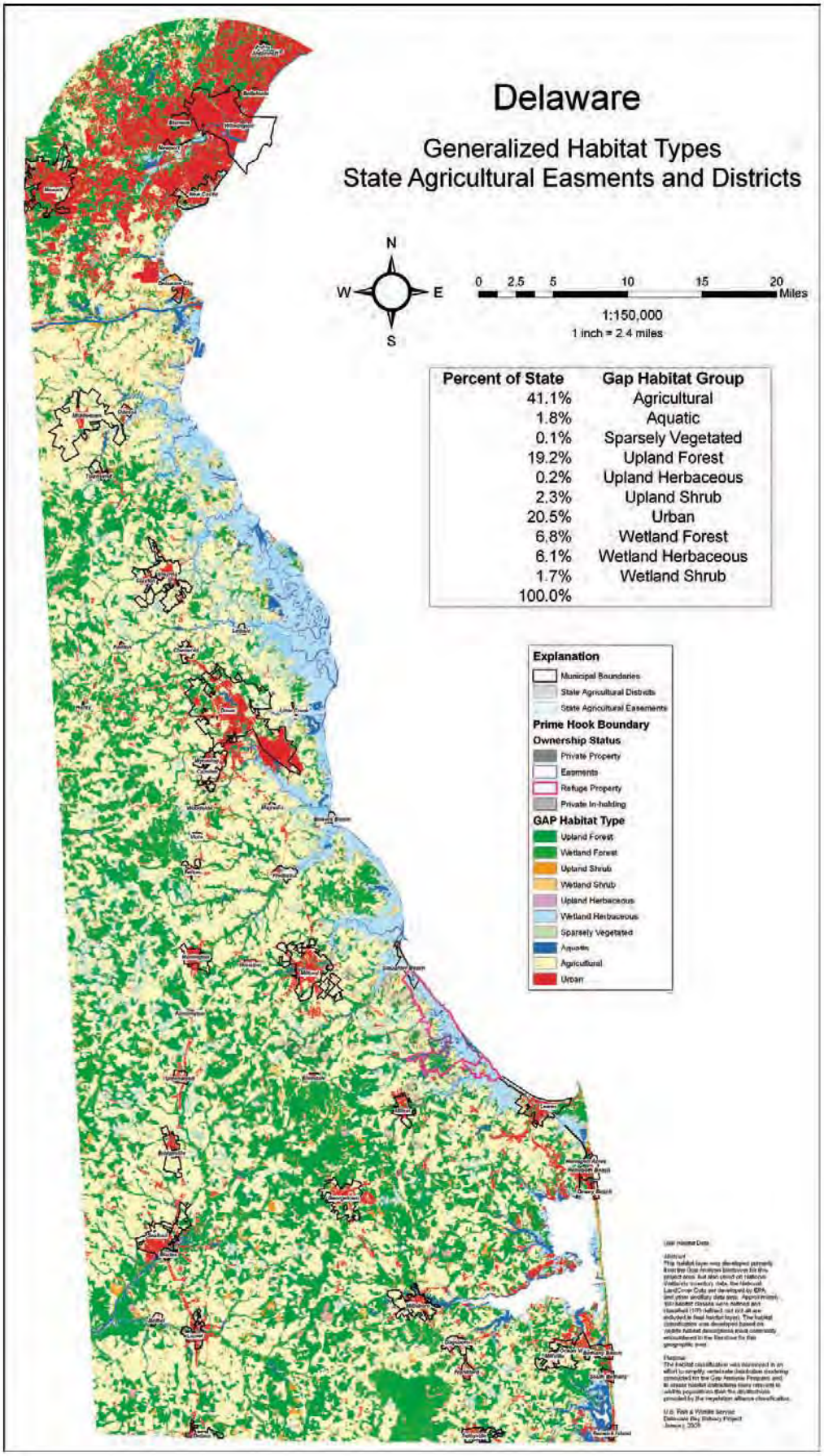
U.S. Fish & Wildlife Service
Delaware Bay Estuary Project
January, 2008
Percent of Impact Zone | GAP Habitat Group
45.62% Agricultural
1.97% Aquatic
0.10% Sparsely Vegetated
20.11% Upland Forest
0.31% Upland Herbaceous
2.55% Upland Shrub
9.23% Urban
6.94% Wetland Forest
10.58% Wetland Herbaceous
2.60% Wetland Shrub
100%
State Designated Agricultural Conservation Areas
Class | Acres
Easment | 9,131
District | 6,608
Total Acres In Contributing Watersheds | 15,739
Total Percent of Contributing Area Designated as Agricultural Conservation Areas | 18%


Delaware
Generalized Habitat Types
State Agricultural Easments and Districts
N
W
E
S
0 2.5 5 10 15 20 Miles
1:150,000
1 inch = 2.4 miles
Percent of State
Gap Habitat Group
41.1% Agricultural
1.8% Aquatic
0.1% Sparsely Vegetated
19.2% Upland Forest
0.2% Upland Herbaceous
2.3% Upland Shrub
20.5% Urban
6.8% Wetland Forest
6.1% Wetland Herbaceous
1.7% Wetland Shrub
100.0%
Explanation
Municipal Boundaries
State Agricultural Districts
State Agricultural Easements
Prime Hook Boundary
Ownership Status
Private Property
Easments
Refuge Property
Private In-holding
GAP Habitat Type
Upland Forest
Wetland Forest
Upland Shrub
Wetland Shrub
Upland Herbaceous
Wetland Herbaceous
Sparsely Vegetated
Aquatic
Agricultural
Urban

Appendix B

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Rough green snake

Draft Habitat Management Plan

Prime Hook National Wildlife Refuge
Habitat Management Plan

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Chapter 1. Introduction

1.1 Scope and Rationale

In 1963, Prime Hook National Wildlife Refuge (NWR) was established to protect migratory birds and preserve coastal wetlands along the Delaware Bay. Lands were later acquired in the early 1970s for the purpose of conserving endangered and threatened species, the protection of natural resources and incidental fish and wildlife-oriented development. In the past, the primary focus of the Refuge has been the restoration of wetland habitats and the management of waterfowl. Although waterfowl management will always be a priority, future habitat management efforts will also ensure the protection, management, and enhancement of native plant communities which will conserve shorebirds, secretive marsh birds, wading birds, landbirds, raptors, the endangered Delmarva fox squirrel, and benefit resident wildlife. Through several CCP scoping and other public meetings our conservation partners and members of the public helped Service and refuge staff develop a future management vision statement. This Refuge Vision Statement serves as a starting point and provides future direction for habitat management planning and implementation.

> *Prime Hook National Wildlife Refuge will comprise a variety of Delmarva coastal plain habitats, such as barrier island beach, freshwater and tidal wetlands, grassland, shrubland and forest. The refuge will manage, maintain, enhance, and where appropriate, restore habitats for native plants and animals, with an emphasis on migratory birds and rare species. A balanced approach will be used to ensure all wildlife-dependent recreational users experience quality opportunities. The refuge will be a leader in conservation, research and community partnerships, adapting to physical and community changes as necessary to maintain the ecological integrity of the refuge and build a stewardship ethic for current and future generations.*

PHNWR is managed by the U. S. Fish and Wildlife Service as part of the National Wildlife Refuge System (NWRS). The mission of the NWRS is to *administer a national network of lands and waters for the conservation, management, and where appropriate, restoration of the fish, wildlife, and plant resources and their habitats within the United States for the benefit of present and future generations of Americans.*

The Refuge's Comprehensive Conservation Plan (CCP) and this Habitat Management Plan (HMP) are the primary tools used to guide refuge staff in achieving refuge objectives and the mission of the System. We have used the most recent refuge biological information and data, scientific literature, and ecological principles in developing this HMP to conserve and protect functional communities of native fish, wildlife, and plants. We view the highest measure of BIDEH as those natural habitats and associated wildlife populations that existed under historic conditions before humans altered the landscape. We have considered a range of habitat management strategies to meet our specific habitat goals and objectives and conducted survey of current refuge habitat conditions using the National Vegetation Classification System (NVCS) community mapping data, scientific reports, conservation partners' professional opinions and Service wildlife management expertise. We will provide for or maintain all appropriate native habitats and species.

This Habitat Management Plan is a dynamic working document with a long-term vision that provides guidance for the management of refuge habitats on an annual basis. The plan will provide direction for the next fifteen years (2010 – 2025), with subsequent reviews every five years, and use of adaptive management principles to assess and modify management activities as required. In the HMP we have considered and incorporated the role that refuge habitats play in international, national, regional, state, and local ecosystem plans. To the extent practicable, we craft our goals and objectives to be consistent with these plans, to assist in attaining the goals and objectives of conservation partners and the larger conservation community, in addition to achieving refuge objectives.

1.2 Legal Mandates

In the early 1960s the southeastern coastal marshes of Delaware were under threat of industrial development from oil refining and manufacturing industries. To help preserve these coastal wetland ecosystems from industrial developmental threats, PHNWR was established under the Migratory Bird Conservation Act (16 U.S.C. 715-715r, as amended on August 8, 1963, "*…for use as an inviolate sanctuary, or for any other management purpose, for migratory birds.*" Approximately 8,356 acres were acquired from sales of Migratory Bird Hunting and Conservation stamps for the purpose of migratory bird management.

Refuge boundaries were later expanded to include lands purchased under the Land and Water Conservation Fund (934 acres) under the authority of the Refuge Recreation Act (16 U.S.C. 460 k --- 460 k-4), as amended for the following purposes "*…suitable for (1) incidental fish and wildlife-oriented recreation development, (2) the protection of natural resources, and (3) for the conservation of endangered species.*"

The National Environmental Policy Act (NEPA) mandates our consideration of the impacts of our habitat management on environmental and cultural resources in planning federal actions. The Comprehensive Conservation Planning (CCP) process ensures compliance with NEPA, and serves as the basis for development of the HMP. In conjunction with the preparation of an Environmental Impact Statement (EIS) under the requirements of NEPA, the CCP process includes intra-Service consultation to fulfill the requirements of the Endangered Species Act (ESA). The Endangered Species Act (ESA) provides a program for the conservation of threatened and endangered plants and animals and the habitats in which they are found.

The Refuge Improvement Act provides the United States Fish and Wildlife Service (Service) the authority to establish policies, regulations and guidelines governing habitat management planning within the System. The Act states that *"... each refuge shall be managed to fulfill the mission of the System, as well as the specific purposes for which that refuge was established…"* {Section 4(a)(3)} and that *"In administering the System, the Secretary shall monitor the status and trends of fish, wildlife and plants in each refuge"* {Section 4(a)(4)}. The Service has established Habitat Management Planning Policy derived from the statutory authority of the RIA and in June of 2002 published Chapter 620: Habitat Management Practices within the NWR System (620 FW 1) in the Service Manual.

The HMP policy delineates strategies and implementation schedules for meeting CCP goals and objectives related to wildlife and habitat management. If a habitat management strategy or activity is required to meet a specific habitat objective in the HMP, and it produces an economic output (like timber harvest or cooperative farming as examples), the requirements for administering refuge management economic activities in the Service's Compatibility policy (603 FW 2) apply, i.e., written compatibility determinations and special use permits. However, compatibility determinations for habitat management activities that do not result in the generation of a commodity are not required. All habitat management activities described in this HMP have been addressed in the CCP.

1.3 Links to Other Plans

Refuge Plans

Habitat goals and objectives developed in the CCP/HMP will provide the groundwork for how the Refuge will conserve, protect, enhance and/or restore functional communities of native plants, fish and wildlife through specific management strategies and prescriptions. These habitat management strategies and prescriptions are linked with national and regional wildlife conservation plans including the Delaware Wildlife Action Plan. These links are explained in this section of the HMP.

Comprehensive Conservation Plan (CCP)
The 1997 RIA requires all Refuges to complete CCPs by 2012. A CCP is an all-encompassing document that guides all biological and public use actions on the Refuge for a 15 year period. Habitat goals and objectives developed in this HMP have been stepped-down from the Refuge's CCP.

Fire Management Plan (FMP)
A FMP is mandated by the Service policy for all Refuges that have *"...vegetation capable of sustaining fire."* The FMP addresses wildland and prescribed fire conditions and events with specific guidelines on the level of protection needed to ensure public safety, protect facilities, refuge resources and property, and restore and perpetuate natural biological processes. Prescribed fire is recognized as an important tool used to mimic ecological processes as an agent of disturbance that releases energy and renews habitats. Other fuels management strategies include mechanical thinning of vegetation and herbicide use. A FMP was completed for PHNWR on 2009. Habitat management goals and objectives developed in the FMP will also be incorprated into this HMP.

Habitat and Species Inventory and Monitoring Plan (HSIMP)
The HSIMP is another step-down plan from the CCP and will be completed 1-2 years after the CCP and HMP have been approved. At that time, habitat condition inventory and monitoring protocols essential to the HMP will be developed in accordance with the Service Manual: Habitat And Wildlife Inventory Monitoring Chapter (701 FW 2).

Monitoring wildlife populations as a sole indicator of wildlife habitat condition is usually not appropriate. However, habitat monitoring in association with wildlife response to habitat manipulations, provide the best measure of achieving HMP objectives (620 FW 1.14). Monitoring will be the primary basis for evaluating the effectiveness of management strategies, prescriptions, and actions to achieve habitat objectives set forth in the CCP/HMP.

Regional and State Plans

USFWS Migratory Bird Program (MBP) Strategic Plan
The MBP completed a 10-year strategic migratory management plan in 2004: A Blue- print for the Future of Migratory Birds - A Strategic Plan for 2004-2014 (USFWS 2004). National Wildlife Refuges provide high quality habitat for many migratory birds. The MBP is seeking to conserve and manage migratory bird populations and their habitats through strategic collaboration with partners committed to the same conservation goals.

Two key strategies of the MBP Plan are bird population monitoring and habitat management. Refuges are currently conducting biological surveys and managing habitat. Prime Hook's HMP will incorporate information from standardized monitoring protocols established while participating in several regional bird studies and from habitat assessments using the NVCS mapping inventories. There is an opportunity for the refuge to contribute to State- and region – wide assessments of bird population trends, and the effects of habitat management activities on migratory birds, by conducting strategies prescribed in this HMP.

North American Bird Conservation Initiative (NABCI)
The NABCI brings together the landbird (Partners in Flight), shorebird, water bird, and waterfowl national plans and consolidates them into a coordinated effort to protect and restore all native bird populations and their habitats of North America. These conservation partnerships reduce redundancy in the structure, planning and implementation of continental conservation goals and objectives. It also utilizes Bird Conservation Regions (BCRs) to guide landscape scale, science-based approaches to conserving birds and their habitats.

PHNWR lies within the New England/Mid-Atlantic Coastal Bird Conservation Region (BCR 30). This area has the densest human population in any region in the country. The highest priority birds of BCR 30 inhabit coastal wetland and beach habitats, especially Saltmarsh Sharp-tailed Sparrow, Nelson's Sharp-tailed Sparrow, Seaside Sparrow, Piping Plover, American Oystercatcher, American Black Duck, and Black Rail. The region also includes critical migration sites for Red Knot, Ruddy Turnstone, Sanderling, Semipalmated Sandpiper, and Dunlin. Other terns and gulls nest in large numbers along with mixed colonies of herons, egrets, and ibis on islands along the Delaware Bay and Chesapeake regions. These birds use Prime Hook NWR for a portion of their life cycle.

Estuarine complexes and salt marsh wetlands created behind barrier beaches in BCR 30 are extremely important to wintering and migratory waterfowl, including 65% of the total wintering American Black Duck population along with large numbers of Greater Scaup, Tundra Swan, Gadwall, Atlantic Brant, and Canvasback.

The Refuge plays an important role in the conservation of habitats for migrating and breeding birds identified in the BCR 30 plan. A comprehensive summary report prepared by Regional Biologist J. Casey (June 2007) collected the most current core information from BCR plans in Region 5 in relation to the bird species found on PHNWR, and this information was used to identify and prioritize specific resources of concern for refuge habitat management.

One hundred thirty-four species have been identified as priority species in the BCR 30 plan (Steinkamp 2008). The majority of these priority species use habitats associated with coastal ecosystems, including beach, sand, mud flats, estuaries, bays and estuarine emergent wetlands. Further review identified priority landbird species of other BCR plans that lie to the north and northwest of BCR 30, which included BCRs 12, 13, 14, and 28. Of the listed ninety-eight priority BCR species in these plans, 83% or 81 priority BCR species use PHNWR during the spring and/or fall migration period (Casey 2007).

The BCR 30 plan has linked bird species of greatest conservation need with their associated habitats that are necessary to sustain their populations. Eleven habitat suites have been identified as critical to conserve highest ranked migratory bird species with associated priority habitat management actions. This information has been incorporated in the Refuge's HMP for identifying Refuge top resources of concern and to establish habitat management priorities for the next 15 years.

North American Waterfowl Management Plan (NAWMP) & Atlantic Coast Joint Venture (ACJV)
The NAWMP outlines strategies in the U.S., Canada and Mexico to protect North America's remaining wetlands and to restore waterfowl populations through habitat protection, restoration, and enhancement actions. Implementation of this plan is accomplished at various regional levels within designated regional habitat "Joint Venture" areas.

The Refuge is part of the Atlantic Coast Joint Venture (ACJV) whose comprehensive conservation approach emphasizes all-bird habitat management. The goal of the ACJV is to *"protect and manage priority wetland habitats for migration, wintering and production of waterfowl, with special consideration to black ducks, and to benefit other wildlife in the joint venture area."*

In order to capture the conservation needs of a diversity of landscapes the ACJV has delineated planning areas into special focus and sub-focus areas. The state of Delaware contains four focus and three sub-focus areas together encompassing over 900,000 acres for waterfowl conservation. PHNWR lies within the Bayshore Focus Area.

The best waterfowl breeding and wintering habitats in the State are found in the Bayshore Focus Area. During the fall and winter hundreds of thousands of waterfowl utilize the areas for feeding and roosting with significant numbers of Canada goose, Snow Goose, Pintail, Black Duck, and Mallard. Over 60% of the Atlantic Flyway's Snow Goose population winters within this focus area. This area also contains concentrations of Northern Shoveler, American widgeon, and Gadwall in the State as well as being notable for the production of American Black Duck and Wood Duck.

The Bayshore Focus Area is also very important for other migratory birds. Located along the eastern coast of the Delaware Bay, it provides some of the most critical habitat (beach, dune, adjacent marshes and impoundments) for migratory shorebirds. This focus area is a major stopover site for over a million shorebirds including 80% of the Western Hemisphere's Red Knot population, along with substantial numbers of Dunlin, Ruddy Turnstone, Semipalmated Sandpiper, Least Sandpiper, Short-billed Dowitcher and others.

Major threats impacting waterfowl and other bird species in the Bayshore Area include sustained resort development, decreasing water quality in natural rivers, streams and bays, and invasive species. Forest and wetland habitats continue to be lost to facilitate agriculture and residential development. AJCV conservation management actions focus on protecting, restoring, and enhancing wetlands and associated upland habitats to form larger contiguous blocks of natural habitats along with connections to undisturbed beach habitats within the Bayshore coastal focus areas. Management recommendations and research priorities are incorporated into refuge habitat management planning and identification of monitoring elements. For example, this HMP places an emphasis on wetland restoration, which is the primary conservation recommendation put forward for the Bayshore Focus Area.

North American Waterbird Conservation Plan and Mid-Atlantic/New England/Maritimes Waterbird Conservation Plan (MANEM)

This plan is a partnership among individuals and institutions with interest and responsibility for conserving waterbirds and their habitats. The primary goal of the plan is to ensure that the distribution, diversity, and abundance of populations of breeding, migratory, and non-breeding waterbirds are sustained or restored.

The regional plan stepped down from the national plan pertinent to PHNWR is the Mid-Atlantic/ New England/Maritimes Waterbird Conservation Plan (MANEM) which has compiled and interpreted scientific and technical information on the region's waterbird populations and habitats, assessed conservation status, developed strategies to ensure the persistence of sustainable waterbird populations in the region and identified waterbird priority species and habitat profiles for each state (MANEM Waterbird Plan 2006). This data will be incorporated in the Refuge's HMP.

U.S. Shorebird Conservation Plan and Northern Atlantic Regional Shorebird Plan

These plans are national and regional partnership efforts undertaken to make certain that stable and self-sustaining populations of all shorebird species are restored and protected. The North Atlantic Shorebird Plan listed priority shorebird species by habitat and scoring habitat use in the region with key "focal species" tabulated for each habitat type (Clark and Niles 2000). Shorebird conservation objectives are incorporated in this HMP, primarily through identification of priority resources of concern (ROCs).

Partners in Flight (PIF) Landbird Conservation Plan

The goal of each regional PIF plan is to ensure long-term maintenance of healthy populations of native birds, primarily passerines. Within each physiographic area, the plans rank bird species according to their greatest conservation needs, describe desired habitat conditions, develop biological objectives, and recommend habitat actions for priority birds. PHNWR lies with Physiographic Area 44, the Mid-

Atlantic Coastal Plain. Priority landbird habitats facing the highest threats include salt marshes, forested wetlands, mixed upland forests, and early successional upland plant communities.

Dealing with human population growth and urbanization while maintaining functional natural ecosystems is the greatest conservation challenge recognized in the Partners in Flight Plan for Area 44. The future of wildlife depends on protecting significant habitat patches for priority species. Identification and maintenance of those blocks large enough to support a full array of breeding birds are PIF's Area 44 highest conservation priority.

As coastal maritime, inland freshwater, and upland habitats are often adjacent, integrating the conservation objectives of priority land birds with those of waterfowl, shorebirds, and nesting waterbirds is the comprehensive conservation goal of the Area 44 plan. Specific habitat management recommendations pertinent to PHNWR, which are reflected in the objectives and strategies within this HMP, include:

- Continue strict protection of barrier beach and dune habitats to minimize productivity losses of priority species
- Protect salt marsh habitats for black rail, salt-marsh sharp-tailed sparrow, seaside sparrow, and American black duck
- Identify, prioritize, and protect all sites of high salt marsh
- Identify, manage and/or restore open lands > 50 ha with potential to support Henslow's sparrow
- Identify and protect forest blocks that support significant populations of prothonotary warbler, wood thrush, and Acadian flycatcher;

Recovery Plans

The Delmarva fox squirrel (DFS) was extirpated from Delaware by the early 1890s. In 1967 this squirrel was federally listed because it inhabited less than 10 % of its historic range. In accordance with the ESA, a recovery plan has been developed. The DFS recovery plan focused around two action objectives:

- Identify critical DFS habitat requirements
- Translocate DFS into suitable habitat outside areas within their historical range.

Range recovery expansion has occurred through eleven successful translocations conducted in the 1980s, of which one site was on PHNWR. To implement recovery actions in Delaware, Recovery Team Members in the late 1990s made the following Refuge management recommendations: 1) Reforest fallow open areas to add to the Refuge's base acres of forested upland habitats; 2) Augment current DFS Refuge population with additional translocations; and 3) Conduct a Population Viable Analysis (PVA) to estimate the Minimum Viable Population (MVP) needed to mitigate inbreeding and Founder's Effect, prevent problems of genetic drift and loss of heterozygosity, and then manage accordingly (Moncrief 1995). Forest management strategies identified in this HMP are guided by requirements identified in these DFS recovery and research efforts.

State Comprehensive Wildlife Conservation Strategy and Delaware Wildlife Action Plan

The Delaware Division of Fish and Wildlife, Delaware Department of Natural Resources and Environmental Control, has recently completed its Delaware Wildlife Action Plan with funding from the State Wildlife Grants program. The state plan acknowledges development pressure and loss of wildlife habitats as threatening the existence of most of Delaware's species of greatest conservation need (SGCN) such as the American oystercatcher, least tern, hooded warbler, carpenter frog, Delmarva fox squirrel, Coastal Plain swamp sparrow, Bethany firefly and many other species (DNREC 2005).

Fifty different vegetative community types have been delineated; several have been singled out as communities of conservation concern due to their rarity across Delaware's landscape, and featured as 'Key Wildlife Habitats' in Delaware's Wildlife Action Plan (DWAP; DNREC 2005). These communities are rare and underrepresented within the state landscape, have special significance in Delaware, are particularly vulnerable to disturbance, and/or have a high diversity of rare plants. As a result of any of these factors, DWAP's 'Key Wildlife Habitats also harbor SGCN.

For example, large blocks of unfragmented forests and wetlands have been designated as Key Wildlife Habitats because of their importance to area sensitive faunal species. Due to habitat fragmentation in Delaware's wildland landscape, a minimum patch size of 250 acres has been used as the criteria defining a "large block." Key Wildlife Habitats have been assigned to wildland habitats with 1) any SGCN occurrences; 2) rare plants or plant communities on the landscape defined as Habitats of Conservations Concern, 3) forest blocks greater than 250 acres, and 4) wetland blocks greater than 250 acres. Refuge staff has consulted with the Division of Fish and Wildlife and Delaware's Natural Heritage and Endangered Species Program to consider opportunities for the Refuge to conserve, protect, and manage species and critical habitats identified in the state's comprehensive wildlife action plan. State wildlife and habitat goals and objectives have been incorporated into the Refuge's habitat management planning efforts and identification of priority resources of concern (ROCs), as appropriate.

1.4 Guiding Principles of Habitat Management

Within the next 15-year horizon, the management of Refuge habitats will be driven by four factors:

- Conserving biological integrity, diversity and environmental health;
- As climate change alters vegetative communities, species occurrence, and migration chronologies of wildlife, we will allow these changes to occur and avoid maintaining static refuge conditions.
- Basing habitat management goals, objectives, strategies, and prescriptions on focal species management;
- Fulfilling the Refuge's purposes and National Wildlife Refuge System mission and goals.

The central theme guiding Refuge habitat management is the restoration and maintenance of natural habitats to meet refuge objectives, but also allow changes to occur in order to maintain, enhance, and restore biological integrity, diversity, and environmental health (BIDEH). Natural conditions and processes represent the highest measure of biological diversity, ecological integrity, and healthy ecosystems.

Guidance to accomplish this comes from specific Service BIDEH policy (See Section 3.2 of this plan for more details). This policy states that *"we use historical conditions as the frame of reference to identify composition, structure and functional processes that naturally shape ecosystems. We especially seek to identify keystone species, indicator species, and types of communities that occurred during a frame of reference."[601 FW 3.12 (B)].*

Maintaining or restoring existing elements of BIDEH on the Refuge depends on allowing natural processes and communities to develop in response to climate changes and other dynamic conditions. We identify umbrella species, indicator species, and types of natural communities that occurred during historic conditions to represent lost elements of biological integrity and environmental health. Where appropriate and feasible, we also manage for BIDEH by eliminating unnatural biotic and abiotic features and management strategies not necessary to accomplish Refuge purpose(s). We use historic conditions as an initial frame of reference to develop habitat goals and objectives (601 FW 3.15), but with consideration for likely future conditions in response to a changing climate.

Conservation Biology Principles

We have used the concepts of umbrella and indicator species as representatives of biological integrity and/or environmental health conditions (Table 1). These concepts also contributed to our identification of priority resources of concern, as outlined further in Chapter 3. Similar use of focal species has been made by other conservation biologists for site-specific biological planning projects (Chase and Geupel 2005). We have used the concept of umbrella species as appropriate targets for management and the concept of indicator species as representatives of historic biological integrity and/or environmental health conditions. In conservation biology, the protection of an umbrella species with concentrated management of its habitat requirements can extend protection for other priority resources of concern. For example, our decision to manage for larger Delmarva fox squirrel habitat patches makes the squirrel a good candidate umbrella species that benefits many breeding forest interior bird species, migratory landbirds, and a host of other forest-dependent resident wildlife. Similarly, American oystercatchers have been used as an umbrella species representative of overwash and sandy beach habitats.

An indicator species can be used to represent a measure of biological integrity and environmental health. A reliable indicator species can operate as a habitat assessment tool that can save time and money. We have chosen indicator species to be either an individual species or guild whose presence, absence, abundance, or relative well-being in a given habitat type is a sign of the overall health of its environmental condition and ecosystem functioning. For example, presence of the beach dune tiger beetle is indicative of quality, healthy beach and functional panic grass dune grassland habitats. In some cases, a species may serve as both an umbrella species and an indicator species simultaneously. We have chosen certain species or a particular guild as umbrella and/or indicator representatives of a habitat type and used them in developing habitat management objectives and strategies. As such, both groups of identified species are useful as monitoring targets.

Monitoring will be an integral component of biological planning using focal species, such as presence/absence as an inexpensive measure to gauge environmental health, relative abundance, and density of focal species as measures of biological integrity and diversity. Our habitat objectives incorporating specific focal species are based on numerous hypotheses and assumptions using the most recent and best available plant and wildlife survey information. These assumptions will be tested in on-going Refuge monitoring studies where focal species serve as key targets for monitoring endeavors to test the effectiveness of habitat management strategies and conservation actions or to adjust strategies and actions when outcomes do not meet expectations.

Table 1. Prime Hook NWR Indicator and Umbrella Species

Prime Hook NWR: Keystone and Umbrella species or guilds representative of biological integrity, diversity, and environmental health under historic conditions and rare or declining in today's landscape.			
Species or Guild	**Indicator**	**Umbrella**	**Habitat Type**
American Oystercatcher	Yes	Yes	Overwash Dunes
Beach Dune Tiger Beetle	Yes		Sandy Beach & Dune Grassland
Little Wife Underwing	Yes		Red Cedar Woods, Maritime Shrubland
Delmarva Fox Squirrel		Yes	Mixed Hardwood Forest

Prime Hook NWR: Keystone and Umbrella species or guilds representative of biological integrity, diversity, and environmental health under historic conditions and rare or declining in today's landscape.			
Long-Horned Beetle	Yes		Mature, diverse Southern Red Oak Heath Forest
Salt Marsh Passerines	Yes		Spartina High & Low Salt Marsh
Coastal Plain Swamp Sparrow	Yes		Spartina High Marsh, Maritime Shrub, Tidal Creek Shrubland
Henslow Sparrow		Yes	Early Successional (ES) Grasslands
River Herring	Yes		Aquatic Food Webs
Maritime Sunflower Borer Moth	Yes		Early Successional Grasslands
Wetland Lepidopterans	Yes		Peat Bog Communities
Obligate Rare Herptiles	Yes		Impoundments = ES Freshwater Marsh
Obligate ES Lepidoterans and other insect pollinators	Yes		ES Upland Communities

Metrics for indicator species remain to be determined. The best biological parameters to assess healthy habitat types and management actions of indicator species will incorporate biological measures at various levels to include a single metric and/or combination of:

- Presence/absence
- Index of Abundance
- Numbers per unit time
- Absolute density (Numbers per unit area)
- Nest densities, nest success, etc.
- Metrics to assess habitat diversity and heterogeneity
- Other population parameters

These habitat quality measures will be developed and refined over time and incorporated into a refuge Inventory & Monitoring plan. They will be used to monitor progress in achieving Refuge habitat restoration and management objectives.

Historic Range of Variability

Historic range of variability (HRV) is a method of restoration ecology describing natural ecosystems as having a range of historic conditions where they were self-sustaining and beyond which they move to a state of disequilibrium or unsustainability, due to degraded ecological integrity caused by anthropogenic stressors (Egan & Howell 2001).

Consideration of HRV can be used as a management tool to understand the dynamic nature of ecosystems, the processes that sustain and change them, the current state of the ecosystem in relationship to the past, and the possible range of conditions that are feasible to maintain and manage for in the future. It is a useful tool for determining a range of desired future habitat conditions (Landres et al 1999). This variability represents the variance of ecological and biological parameters over a specified temporal frame of reference. Our frame of reference has been set for approximately 400 years ago (European Settlement), when their disturbances started having significant influence on biological

condition of natural habitats. Using a HRV management approach considers a range of past habitat conditions when BIDEH elements were maximized and human stressors were minimal. Managing for HRV means restoring historic habitat conditions and maintaining an appropriate representation of those conditions that will ensure both short and long-term maintenance of BIDEH.

Historic conditions of Refuge habitats at this established frame of reference includes native Delmarva Coastal Plain plant communities dominated by mixed upland forests, swamps and emergent wetlands interspersed with transitional (grassland & shrubland) upland habitats. These transitional habitats were represented by small openings of grasslands and thickets influenced by a combination of fires set by aboriginal people, storms and beavers.

The current state of the Delmarva Coastal Plain ecosystem sustained a loss of 75% or more of mature forests, 50% or more loss of wetland habitats, and contains few to no acres of transitional or early successional upland habitats. Remaining fragments of natural areas on Refuge are considerably degraded (Sections 2.2, 2.3, and 2.4).

Managing for HRV for an ecosystem requires the selection of habitat and biological parameters necessary to sustain habitat goals and management objectives for target conservation species, called resources of concern (ROCS). See Chapter 3 for more information on ROCS. Through HRV, the refuge will select variables at all levels of biological organization and habitat classifications such as community type, patch size, tree size, tree density, canopy cover, population size, species composition, water depth and temperature, gene flow, etc., and use them in habitat objectives.

Chapter 2. Background

2.1 Refuge Location, Description and Geographic Setting

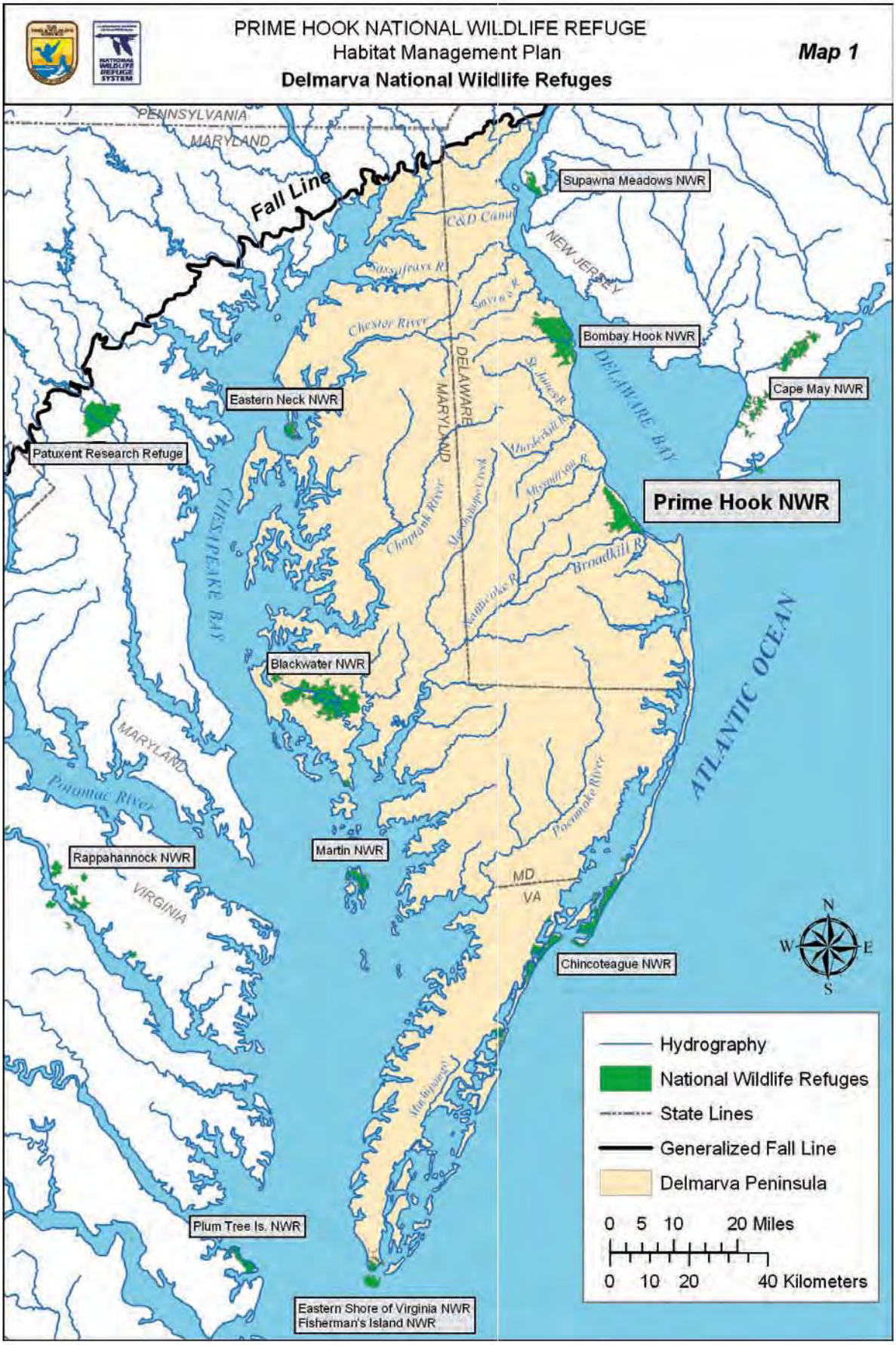
Prime Hook National Wildlife Refuge is located within the Atlantic Coastal Plain (BCR 30 and PIF Physiographic Region 44) along the southwestern shore of the Delaware Bay in Sussex County, Delaware. It is a Refuge within the Coastal Delaware NWR Complex (HMP Map 1). The Refuge, established in 1963, historically consisted of tidal marshes and agricultural lands with both habitats heavily grazed by cattle. The landscape surrounding the Refuge was dominated by small farms producing vegetables and small grains. From the 1990s to present day, resort and residential development and intensive agricultural operations (corn, soybean and chicken production) are the dominant land uses bordering the Refuge.

Natural habitats are dominated by emergent wetlands interspersed with swamp and upland forests representative of the Delmarva Coastal Plain ecosystem. Eighty percent of PHNWR's vegetation cover types are influenced by tidal and freshwater creek drainages that discharge into the Delaware Bay with associated coastal marsh habitats. The remaining twenty percent are composed of upland habitats. NVCS cover typing of the Refuge has resulted in the delineation of 37 land cover types including vegetation and anthropogenic communities and water surface coverages (HMP Maps 2–7).

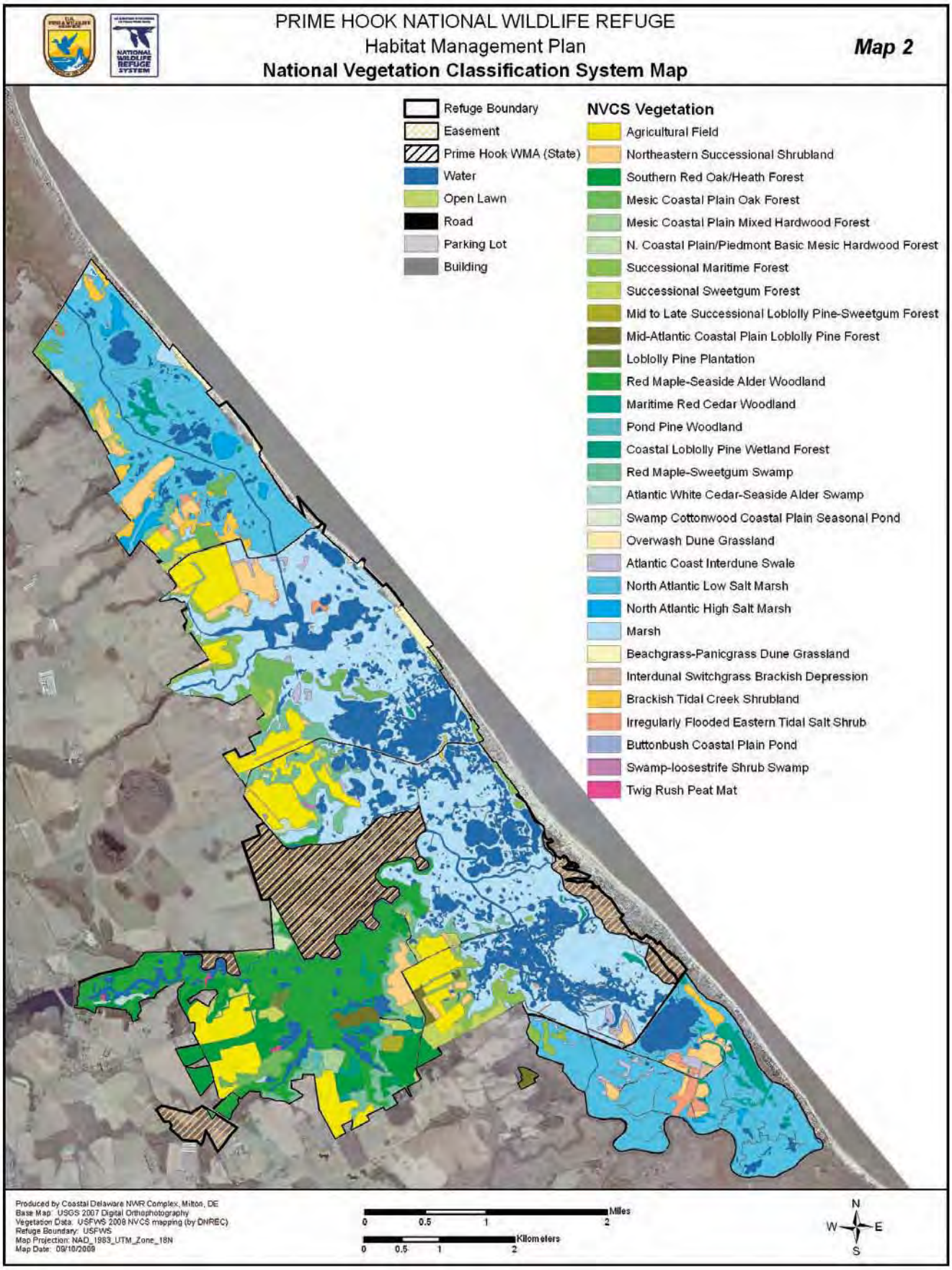
Other natural wildland habitats and managed wetlands immediately adjacent and/or near PRIME HOOK NWR include:

1) The Great Marsh (1,000 acres of salt marsh, owned by the town of Lewes) located just south of the Refuge,
2) Milford Neck WMA (5,459 acres), 3 miles north of the refuge above Mispillion Inlet;
3) Ted Harvey Conservation Area (2,661 acres), 9 miles north of the refuge above Bower's Beach;
4) Little Creek WMA (4,721 acres), 15 north of Prime Hook NWR above Port Mahon;
5) Prime Hook WMA (698.2 acres), adjacent to Prime Hook NWR
6) Bombay Hook NWR (16,000 acres), 25 miles north of the refuge.

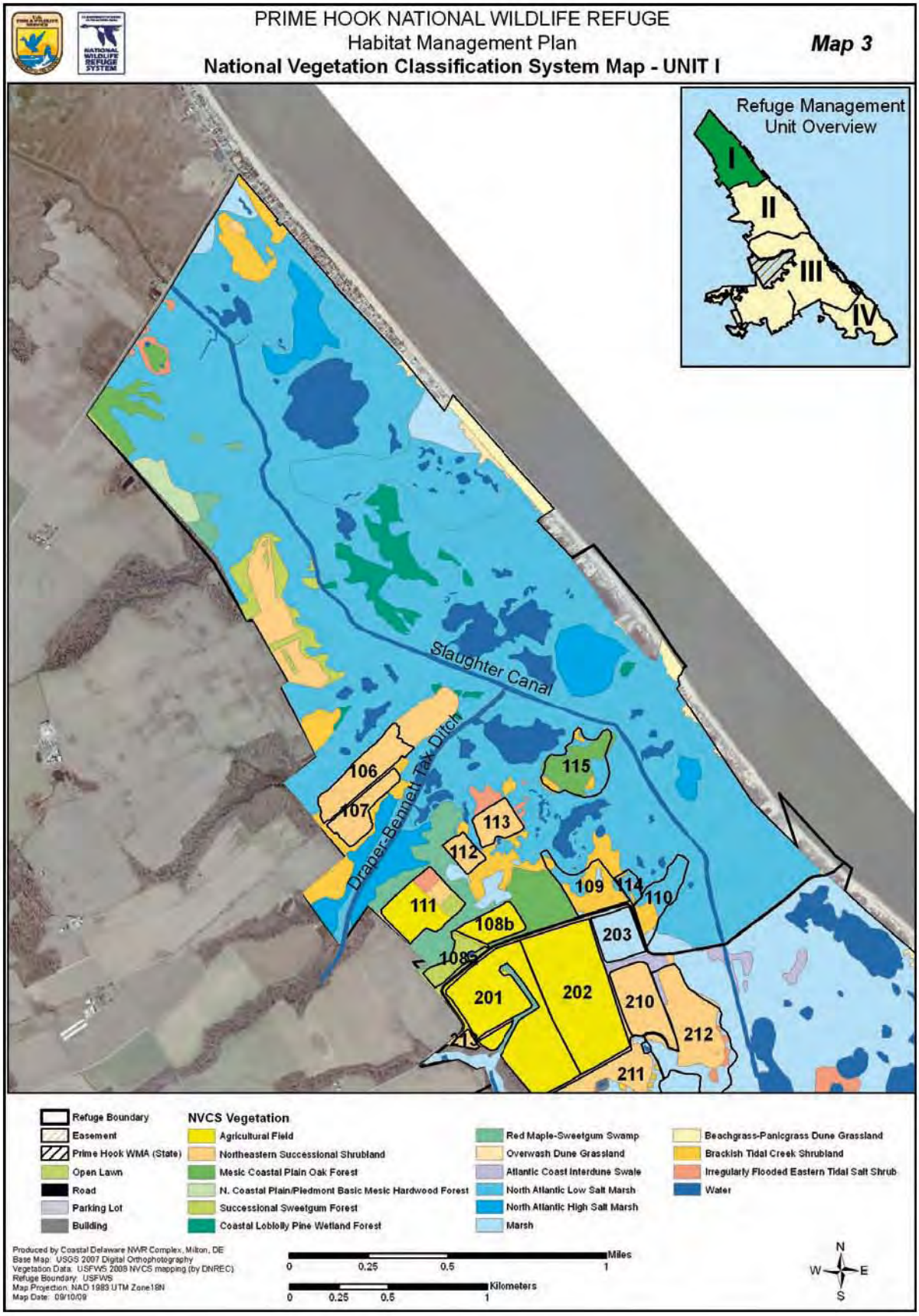
Map 1. Delmarva area National Wildlife Refuges



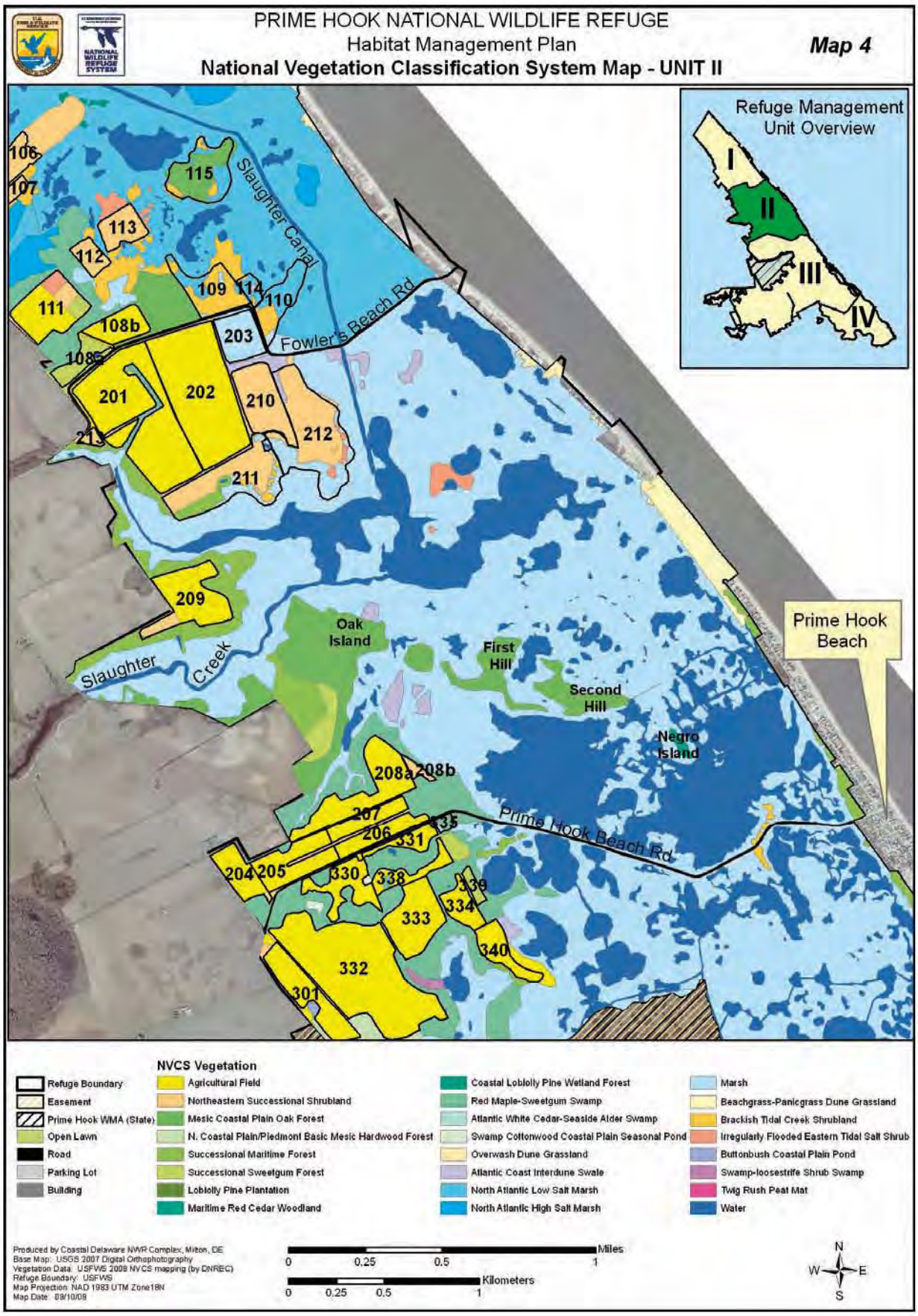
Map 2. National Vegetation Classification System Map - Overview (2006)



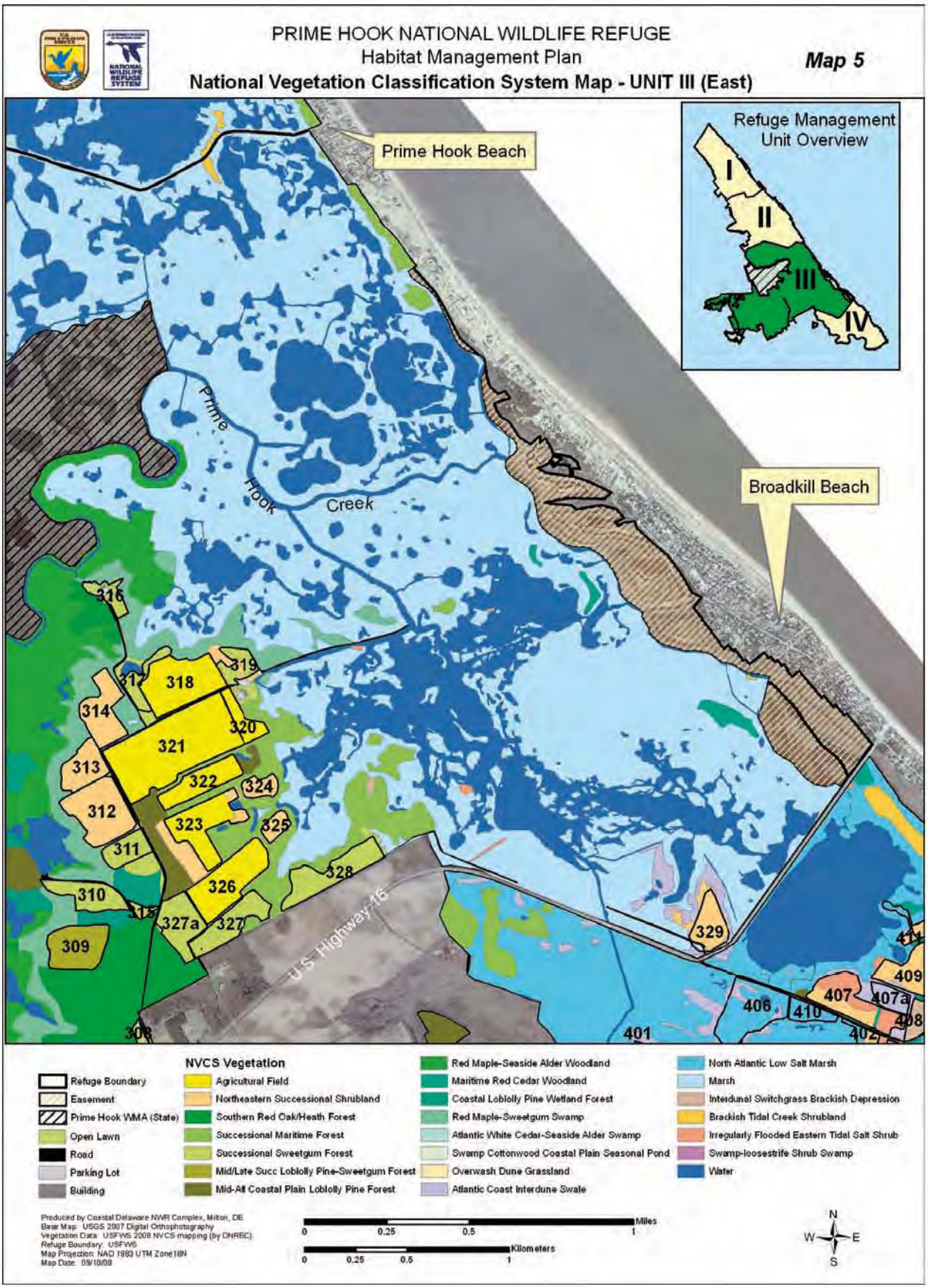
Map 3. National Vegetation Classification System Map - Unit I



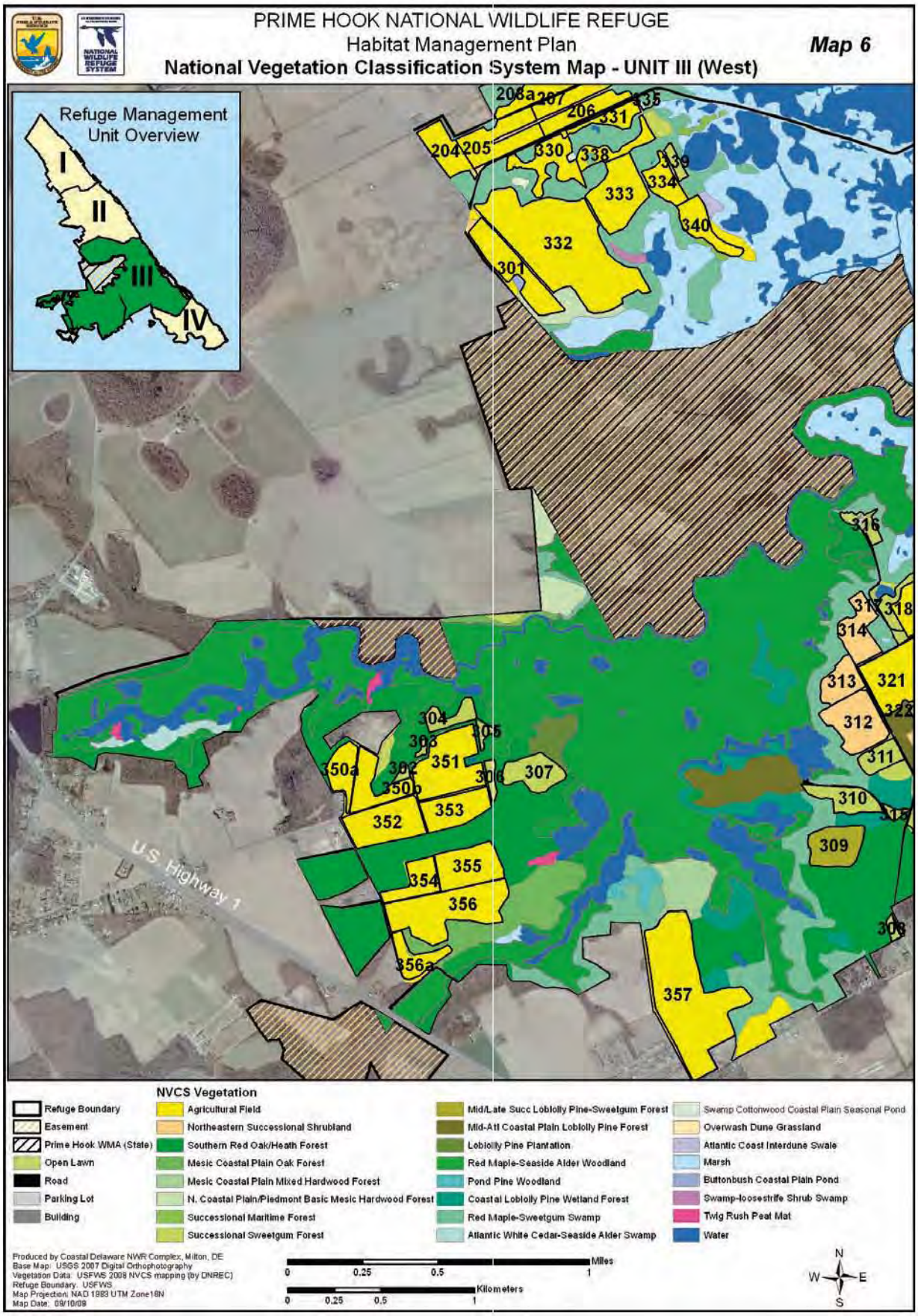
Map 4. National Vegetation Classification System Map - Unit II



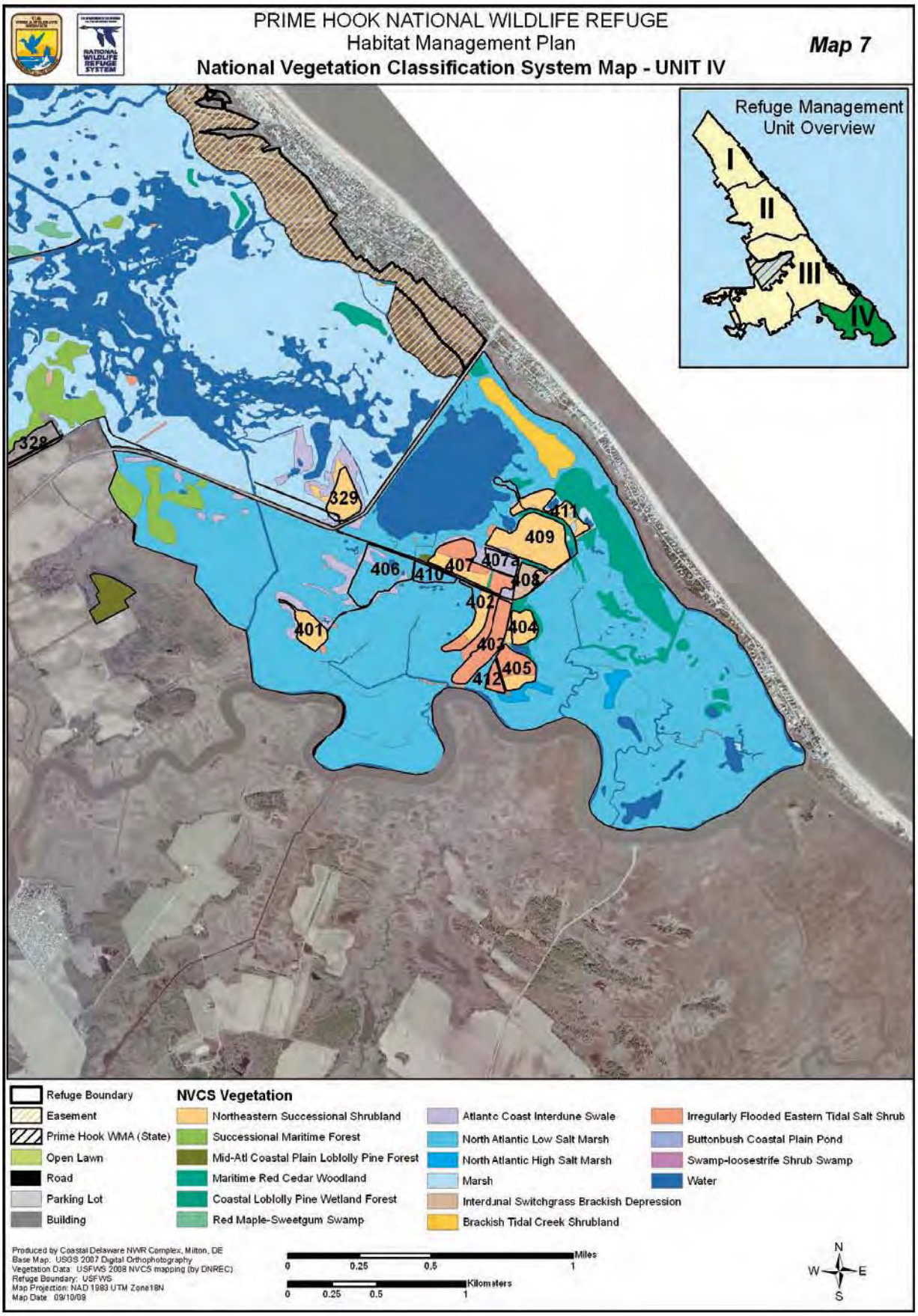
Map 5. National Vegetation Classification System Map - Unit III (East)



Map 6. National Vegetation Classification System Map - Unit III (West)



Map 7. National Vegetation Classification System Map - Unit IV



2.2 Management Units: Geographic Description, Topography, Soils and Historical Perspective

Prime Hook NWR can be described as an elongated coastal strand of ten thousand acres that lies parallel to the Delaware Bay. For management purposes, the Refuge has been divided into four management units transected by four state roads which run perpendicular to the Bay. All managed fields on the refuge and other place names referenced in the HMP are labeled in HMP Maps 3–7. Fields with numerical names in the one-hundreds are located in Unit I, two-hundreds in Unit II, etc.

UNIT 1 (HMP Map 3)

This area comprises the northern most end of the refuge and is delineated by Slaughter Beach Road as its northern boundary, overwashed barrier dunes and a portion of the Slaughter Beach community houses on the east, Fowler's Beach Road on the south, and an upland fringe of scrub-shrub areas on the western boundary.

Hydrology

There is currently no water level management capability in Unit I, which contains about 1,400 acres of salt marsh. Tidal salt water is the primary source of water for the unit, which flows approximately two miles from the DE Bay through the Misspillion Inlet and into Slaughter Canal entering through Slaughter Canal.

Attenuated tidal flow provided by Slaughter Canal bisects Unit I and receives its afflux from the ditches and creeks within the salt marshes in Unit I. The Draper-Bennett Tax Ditch drains the southwestern portion of this unit, which ultimately feeds into the Slaughter Canal. Daily tidal action has a 4.4 foot range and salinities range from 5 to 25 ppt in the Canal. During drought periods, the salinity can get as high as 30 ppt. Rainfall, new and full moon tides, and spring and neap tides maintain the salt marsh community within Unit I. Natural formations of inlets from overwash events along the Bay shoreline rejuvenate tidal marsh habitats in Unit I through maintenance of salinity levels and deposition of nutrients and sediments carried by tidal flow. During the past 30 years several of these mini-inlets have opened and closed along this shoreline. Currently, a breach in the southern portion of Unit I has restored tidal flow into the unit east of the Slaughter Canal.

Soils and Topography

Unit I is dominated by Transquaking and Mispillion soils (TP) which, along with a smaller proportion of Sunken mucky silt loam (SuA), constitute most of the salt marsh habitats. Other soil types found in upland areas include Hammonton sandy loam (HnA) and loam sand (HmA), Carmichael loam (CaA), Hurlock sandy loam (HvA) and loamy sand (HuA), Ingleside loamy sand (IeA and IeB), Marshyhope sandy loam (MdA), Pineyneck loam (PyA), and Unicorn loam (UlA).

Management History – Upland Fields 1978 – 2008 (HMP Map 3).

- **Fields 101-105:** not tilled during this period and have reverted to brush (*Morella, Iva, & Baccharis*). This area was hydro-axed in late 1980s to set back succession. No management has taken place since the late 1980's. These fields are not depicted on the map.
- **Field 106/107:** farmed in early 1970s but Refuge lacks access to this area.
- **Field 108a**: tilled in early 1970s, but farming was ceased in 1972 because field was too wet.
- **Field 108b**: planted until 2006 alternating between corn and soybeans.
- **Field 109** planted in wildlife mixture 5 times in past 30 years.
- **Field 110** reverted to Brush mostly bayberry (*Morella)*; too wet to cultivate.
- **Field 111:** farmed until 2006; 10 acres removed in 1990s, too wet to cultivate.
- **Field 112:** managed as grasslands.

- **Field 113:** managed as grasslands.
- **Field 114:** reverted to brush.
- **Field 115:** reverted to brush and saplings.

Current Vegetation

We have listed the National Vegetation Classification System community associations and habitat descriptions that apply to each of the four management units. Acreages presented in habitat objectives reflect approximations from NVCS mapping.

Management Unit I is the northernmost unit at Prime Hook and totals 1,624.9 acres [657.5 ha (Table 2 and HMP Map 3). Of the total acres, 1,504.7 acres (608.9 ha) are natural communities and 120.2 acres (48.6 ha) are anthropogenic communities. This management unit receives tidal, brackish water inputs from Slaughter Creek which results in the development of *Spartina* Low Salt Marsh, the largest vegetation community in Unit I. A small Wax-Myrtle Shrub Swamp located at the south end of the Unit is the smallest vegetation community mapped. Part of this unit experienced an arson-set marsh fire under high wind conditions (45 + mph) on March 10, 2002 that burned approximately 1,300 acres.

Table 2. Acreage of Natural and Anthropogenic Communities in Management Unit I

Natural Community	UNIT I acreage (ha)
Atlantic Coast Interdune Swale	0.3 (0.1)
Beachgrass-Panicgrass Dune Grassland	12.5 (5.1)
Brackish Tidal Creek Shrubland	73.9 (29.9)
Coastal Loblolly Pine Wetland Forest	34.2 (13.8)
Coastal Plain Depression Swamp	39.9 (16.1)
Marsh	33.2 (13.4)
Mesic Coastal Plain Oak Forest	49.6 (20.1)
Mesic Rich Forest	10.6 (4.3)
Mid-Atlantic Maritime Salt Shrub	10.8 (4.4)
Overwash Dune	5.1 (2.0)
Successional Sweetgum Forest	31.2 (12.6)
Spartina High Salt Marsh	75.2 (30.4)
Spartina Low Salt Marsh	982.0 (397.4)
Open Water	146.2 (59.2)
Natural Community Total	**1,504.7 (608.9)**
Anthropogenic Community	
Agricultural Field	25.6 (10.4)
Northeastern Successional Shrubland	90.1 (36.4)
Road	4.5 (1.8)
Anthropogenic Community Total	**120.2 (48.6)**
UNIT 1 Total	**1,624.9 (657.5)**

UNIT II (HMP Map 4)

This management unit is just south of Unit I and is an impounded wetland system. It is bounded on the north by Fowler's Beach Road, barrier dunes and sand dike plus the Prime Hook beach community on the east, Prime Hook Road on the south, and an upland interface on the west. Prior to 2009, when large breaches formed along the eastern barrier dunes, this unit was managed solely as a freshwater impoundment through the manipulation of water levels at water control structures and the exclusion of tidal flow. Presently, the unit is subjected to daily tidal influence through the breaches and consists of a larger expanse of open water than is reflected in the 2005 vegetation mapping acreage.

Hydrology

During storm tides this sand dune system has been breached several times and washouts have deposited sand and salt water into the Unit II impoundment. Freshwater input is from Prime Hook Creek, which flows from the west. Delaware Bay's normal tidal ranges are from 3 to 3.5 feet except for storm surges and spring tides (± 6.5 ft). Tidal flow enters Slaughter Canal from the Delaware Bay through Unit I salt marshes into the northern portion of Unit II and fresh water flow enters Unit II on the west from Slaughter creek.

Soils and Topography

The area is relatively flat with the exception of four upland islands surrounded by wetland habitats. The dominant soil type of 1,500 acres in Unit II Transquaking and Mispillion soils (TP) which, along with Sunken mucky silt loam (SuA), which together constitute most of the wetland habitats. Negro Island consists of Hurlock loamy sand (HuA). Second Hill soils are Glassboro sandy loam (GoA). First Hill consists of Ingleside sandy loam (IgA) and Glassboro sandy loam (GoA). *Oak Island is made up of (SaB) Sassafras sandy loam with 2 to 5 percent slopes.* The remaining 600 acres of upland forest, croplands and grasslands consist of Pineyneck loam (PyA), and Unicorn loam (UlA), Carmichael loam (CaA), and Glassboro sandy loam (GoA).

Management History – Wetlands

Until 1900, Unit II marshes remained unchanged, consisting of a freshwater system dominated with cattails and sedges. Landowners had the marsh drained and dug Slaughter Canal in the early 1900s to improve drainage of their upland areas by channelizing water north to Cedar Creek. In 1906 the Slaughter Canal dredging reached into Unit II and ended at Oak Island. Portions of Unit II were also heavily grid ditched during the 1930's for mosquito control. To maintain water on the marsh during the fall and winter for muskrat trapping and waterfowl hunting, private owners built water control structures at Fowler's Beach Road, Oak Island and near the bridge at Slaughter Creek to hold water.

The construction of Slaughter Canal in the 1930's vastly increased drainage in Unit II marshes and lowered water tables in upland areas. It significantly altered tidal exchange, leaving only a narrow band of tidal marsh along the edge of the canal and around Oak Island. The dredging of the canal also contributed to Phragmites colonization. By the 1980s, Unit II had completely reverted to a Phragmites jungle, with dense stands covering 1,000 acres (See Prime Hook's Environmental Assessment for Chemical Control of Phragmites and Proposed Marsh Rehabilitation-March 21, 1983).

In 1934, a dike was dug by dragline, along the eastern edge of the marsh from Slaughter Beach to Prime Hook Beach to prevent the bay from washing into the marshes. The deep borrow ditch is still evident today but several sections have been filled by washouts. Until the early 1950s, access to Prime Hook Beach was possible only by boat or during the dry summer by horse or vehicle. In 1953, a gravel roadway was constructed across the marsh and today this roadway is paved (Prime Hook Beach Road). It has effectively acted as a dike between Units II and III with small culverts under the roadway resulting

in some limited flow of water between the units. All of these activities have significantly altered the hydrology of Unit II wetlands (USFWS 1986).

In 1963, the Service proposed a water management plan to the public, which outlined marsh management needs for the entire refuge including Unit II. The plan was designed to impound refuge marshes without backing water against upland areas. Local residents expressed strong opposition to the proposal and the state Drainage Engineer felt that it had the potential to flood or waterlog contiguous agricultural lands as occurred at Bombay Hook NWR. A revised plan with inland canals to provide drainage of uplands was also strongly opposed. Subsequently, a "No Management" policy was adopted which resulted in a severe decline in the quality, quantity, and productivity of the Unit II marshes over the ensuing years (USFWS 1986).

From the establishment of the refuge in 1963 to 1986, Unit II had no water level management capabilities. In 1987 a large concrete water control structure was put into place and partially funded by the first DU Donor Project in the country (J. Howard Isaacs). The project cost about $350,000 to install a concrete multi-bay water control structure with 11 separate bays, spanning 46 feet across the Slaughter Canal serving to impound 1,500 acres. Saltwater intrusion into Unit II is held in check by this structure located on the northern boundary at Fowler's Beach Road. After water level management capability was restored, salinities within this impoundment range from 0 to 8 ppt year round.

The Environmental Assessment documentation (August 1986) for the reestablishment of water control in Unit II provide important information in linking the past with the present. The title of the EA itself is historically interesting "Reestablishment of Water Control in Unit II." Prior to the refuge acquiring this area, both private land owners and the state mosquito control agency used timber sheeting to construct small water control structures throughout Unit II to manage water levels (USFWS 1986).

Historically, the majority of Unit II wetlands were formerly freshwater marsh. Slaughter Creek was the most significant watercourse in the unit, flowing southeasterly across the entire Unit II to Prime Hook Creek south to Prime Hook Road. The hydrology of Unit II was changed with the installment of water control infrastructure as water flows northward to Unit I from First and Second Hills to Fowler's Beach Road but from Oak Island south, water flows in a southerly direction to Prime Hook Road.

Unit II restoration of water level management in 1987 significantly increased the water table of these marshes. Water sources which affect the hydrology of this unit today come from tidal action, runoff from Slaughter Creek, excess water from the Unit III, rainfall and local runoff. Tidal and freshwater exchange would also at the site of the water control structure when abnormal tides and storm surges cause water to flow over the top of stoplogs. Today, large breaches along the barrier dune permit daily tidal flow of brackish water from the Delaware Bay into Unit II, preventing water level management through the water control structures as was conducted for over two decades and resulting in an increased amount of open water relative to the acreage estimated during 2005 vegetation mapping.

Management History – Upland Fields 1978 – 2008 (HMP Map 4)

- **Field 201:** Tilled until early 1990s. Removed from farming, too wet to till. Returned to corn/soybean cultivation in 2006.
- **Field 202:** Tilled until 1991, then field was split into 2 section 202a managed as 64 acre areas in grassland; and 202b planted in corn and soybeans. 202b was put out of production and used in R5 Grassland Study 2001 – 2004. Put back to soybeans in 2006.
- **Field 203:** Switchgrass area currently reverting to brush.

- **Fields 204-208:** all fields cultivated in corn and soybeans until 2006.
- **Fields 210-212:** was grassland now reverting to brush/saplings with Phrag encroachment. Sprayed with herbicide and burned in 2007, partially mowed in 2008.
- **Field 213:** "Old corral" mowed in 1970s and 1980s and reverted to brush.

Current Vegetation

Total acreage of Unit II is 1,997.5 acres (808.3 ha) in size, of which 1,681.8 acres (680.6 ha) are natural communities and 315.7 acres (127.7 ha) are anthropogenic communities (Table 3 and HMP Map 4). The Generic Marsh cover type was identified as the largest vegetation community and the smallest is the Maritime Red Cedar Woodland. As of 2006, this Unit had been invaded (~100 acres) by the river seedbox (*Ludwigia leptocarpa*), a native plant of the south, but considered non-native in Delaware and apparently has invasive characteristics here at Prime Hook NWR. The presence of wetland vegetation identified in the 2005 vegetation mapping has been altered as a result of the introduction of tidal waters through breaches in the barrier dunes. Table 2-2 reflects the baseline vegetation community present prior to the formation of the breaches.

Table 3. Acreage of Natural and Anthropogenic Communities in Management Unit II

NVCS - Natural Community	UNIT II acreage (ha)
Atlantic Coast Interdune Swale	20.1 (8.1)
Beachgrass-Panicgrass Dune Grassland	22.6 (9.1)
Brackish Tidal Creek Shrubland	3.3 (1.3)
Coastal Plain Depression Swamp	47.2 (19.1)
Maritime Red Cedar Woodland	1.9 (0.8)
Generic Marsh	918.9 (371.8)
Mesic Coastal Plain Oak Forest	99.0 (40.0)
Mid-Atlantic Maritime Salt Shrub	7.2 (2.9)
Overwash Dune	4.2 (1.7)
Successional Maritime Forest	71.3 (28.8)
Successional Sweetgum Forest	9.4 (3.8)
Open Water	476.7 (192.9)
Natural Community Total	**1,681.8 (680.6)**
Anthropogenic Community	
Agricultural Field	221.8 (89.8)
Northeastern Successional Shrubland	82.2 (33.2)
Open Lawn	0.2 (0.1)
Road	11.5 (4.6)
Anthropogenic Community Total	**315.7 (127.7)**
UNIT II Total	**1,997.5 (808.3)**

UNIT III (HMP Maps 5 and 6)

Management Unit III is bounded by Prime Hook Beach Road on the north, Route 16 (Broadkill Beach Road) on the south, upland edge on the western boundary, and the Prime Hook and Broadkill Beach developments immediately adjacent to the refuge's eastern boundary.

Hydrology

Unit III consists of roughly 4,400 acres which includes upland forest, impounded emergent marsh, Red Maple-Seaside Alder Swamp, low lying farmed areas, brush, barrier beach on the east, and 140 acres of flowage easement (Tract Nos. 84R, 99F & 99i) on the southeastern boundary of Unit III. This flowage easement drains directly into Prime Hook Creek and flows south to the water control structure of this watercourse. A large portion of Unit III is managed as a freshwater impoundment, however culverts under Prime Hook Rd. bring brackish and saline water in from Unit II, where breaches have restored full tidal flow.

Over the last 2,000 years, sedimentation filled a lagoonal area producing the refuge's marsh (Hoyte 1980). Hoyte extracted nine stratigraphic cores on PHNWR along the Slaughter and Prime Hook Creeks (Units II and III) and has suggested that lagoons behind barrier beaches changed from fresh water over the past 500 years to more saline influences. About 150 years ago, Unit III was a tidal marsh system with several small creeks and abundant potholes where Prime Hook Creek and Deep Hole Creek drained directly into the Delaware Bay (1.5 miles north of current Prime Hook Creek water control structure) (USFWS 1982).

Soils and Topography

Most of the wetlands in Unit III are relatively flat and lie below the 4 foot contour with a few islands rising above 4 foot (between 5 and 9 foot contour). These islands include Tea Cup Island, east of the headquarters ditch, Hay Hummock, south of Prime Hook Road and Bleacher's Island just west of the Prime Hook Creek water control structure. Prime Hook Creek and Petersfield Ditch are the principal water courses in Unit III. The majority of Unit III falls above 2.2 feet {mean sea level (msl)}which is the normal tidal range for the area and is flooded only when the tide is above normal (Spring tides plus storm surges).

The predominant soil types in Unit III are Transquaking and Mispillion soils (TP) and Broadkill mucky peat (Br), both characterized by having large quantities of organic matter on 2,500 acres of impounded wetlands. Soft sediments reach to about 30 feet below the marsh surface. Adjacent upland soils are non-plastic to slightly plastic sandy soil derived from fluvial deposits of the Pleistocene (Matthews and Ireland 1974). The other major soil types found in the Unit III Prime Hook Creek drainage basin include Rosedale loamy sand, Lenape mucky peat, Pineyneck loam (PyA), Carmichael loam (CaA), Hurlock loamy sand (HuA), and Henlopen-Rosedale complex. Minor soil types found in Unit III include Askecksy loamy sand, Broadkiln-Appoquinimink complex, Downer loamy sand, Evesboro loamy sand, and Klej loamy sand.

Management History – Wetlands

A major storm in 1911 plugged and sealed the Deep Hole Creek and Prime Hook Creek outlets to the Delaware Bay. The closing of these 2 outlets drastically changed the daily tidal influence and hydrology of Unit III. Prime Hook Creek now flows through the Petersfield Ditch to ultimately empty into the Broadkill River, which drains into the Delaware Bay about 2 miles south of the present-day refuge. In the 1920s several attempts were made by landowners to create or block drainage within the Unit III area to provide water control. In the 1930s Unit III marshes were heavily grid ditched for mosquito control (USFWS 1982).

Historically, during the 1940s and 1950s, marsh management (e.g., hydrologic manipulation to maintain and/or alter vegetation) on Prime Hook's wetland habitats had been a controversial issue between those who wanted marshes for hunting and trapping and farmers who wanted to drain the upland edges surrounding these wetlands. In 1951, landowners and the UD Cooperative Extension Service

unsuccessfully attempted to develop a plan for the management of Prime Hook marshes. Public Law 766 was enacted by Delaware in 1953 and prohibited the draining of Prime Hook Creek into the Delaware Bay between October 1 and March 10 of the succeeding year. This law was enacted for the benefit of the muskrat industry and permitted the blocking of any marsh draining. Several attempts were made afterwards to eliminate blockages including the use of dynamite by opposing landowners (USFWS 1982).

In the 1950s vegetation coverages in the area east of Petersfield Ditch at the lower end of Unit III consisted of salt hay (*Spartina patens)* and cordgrass *(S. alterniflora). Spartina* grasses were cut for hay and grazed by cattle through the late 1950s. The remainder of Unit III marsh, including much of the marsh west of the ditch was open water with cattail and pickerelweed as co-dominants. Brush was managed in drier areas by grazing and fire. Trees were mostly absent (USFWS 1982).

Phragmites was first observed along Prime Hook Road in Unit III also in the early 1950s and by 1965 it had spread south throughout the unit. Encouraged by drier conditions from mosquito ditching, draining, and excessive soil deposition, red maples began growing along Prime Hook creek, which was once a tidal emergent marsh. Just prior to Service acquisition, portions of the Unit III Prime Hook marshes were also managed by a system of water control structures and a pumping station in Unit III owned by Island Farm Corporation and King Cole, designed by the Soil Conservation Service to provide water for cattle (USFWS – 1982).

Between 1962 and 1968, all the outlets of Prime Hook Creek were permanently blocked either from severe storms or private landowner actions. These blockages severely hampered tidal flow, enhanced sediment deposition in Unit III marshes, and increased the elevation of these wetland habitats.

In 1963, the Service proposed a water management plan which outlined marsh management restoration needs for the entire refuge. It was designed to provide water for the Unit III marsh without backing up water against upland areas. As mentioned under Unit II, it was rejected, and a "No Management" policy was adopted by the Service. This management policy generated severe degradation of Unit III's marshes, as environmental conditions proved detrimental to the quantity, quality, and productivity of Prime Hook's wetland complex from the early 1960s to 1980 (USFWS 1982).

In 1968, a developer of Broadkill Beach had the Broadkill Sound excavated and ditched to drain 10.25 miles of marsh, one mile south of the current Prime Hook Creek water control structure. This action coupled with the retrogression of the blockages of Prime Hook Creek and Petersfield Ditch had continued to exacerbate cumulative negative impacts that contributed to a steady degradation of the Unit III marshes, hastening its drying out and causing considerable deterioration of wetland values. Severe droughts in 1977 and 1980 resulted in the complete desiccation of most potholes and water areas in the Unit III marsh. By 1984 much of Unit III became a *Phragmites* jungle. In addition to the loss of high quality marsh habitats, extreme fire hazards created by dense stands of *Phragmites,* threatened private property values adjacent to the refuge (USFWS 1982).

An Environmental Assessment for the Rehabilitation Management and maintenance of wetlands in Unit III was written in 1982 and by 1984 the water level management infrastructure to restore water level manipulation capability was in place. This infrastructure included a one mile dike east and west of the Petersfield water control structure, tying in the uplands areas to the structure and the construction of 2 large concrete structures, one spanning Petersfield Ditch (35 feet with 8 bays) and the second spanning Prime Hook Creek (20 feet long with 5 bays).

Although water level manipulation is still conducted, the vegetation, water levels, and salinity in Unit III have been influenced by the increased flow of brackish or saline water from Unit II through culverts under Prime Hook Rd., and over the road during storms and high tides.

Management History – Upland Fields 1978 – 2008 (HMP Maps 5 and 6):

- **Fields 301, 330, and 333:** tilled in corn/soybeans until 2006.
- **Field 334:** tilled until 1990; Maintained as early successional grassland w/some brush; mowed 2008.
- **Field 302: Pb-shot site:** cultivated for "goose browse" until 1987. Mowed until mid-1990s; Reverted to trees; Adjacent to private gun-club and current lead shot remediation area.
- **Fields 303-307:** cropped until 1986; Planted in 1987 to pasture mix and mowed annually until late 1990s, and currently reverting to shrubs/trees.
- **Fields 309-314:** cropped until 1987; crop yields poor, farmers gave up fields. Planted in crimson clover/barley mix and mowed annually until 2001, when planted to hardwoods.
- **Field 315:** Reverted to trees in 1970s; designated historic site.
- **Field 317:** Never tilled by USFWS; Used as grassland buffer but stopped mowing in 2000; currently reverting to dense sweetgums.
- **Field 318: c**ropped in corn and soybeans until 2006.
- **Field 319:** pasture only never cropped; a portion is designated historic site.
- **Fields 321 & 332: c**ropped until 2001-2004 part of R5 grassland study; Put back in corn and soybeans until 2006.
- **Fields 322 & 323:** cropped until 2006.
- **Fields 324 & 325:** cropped until 1982, dropped by farmer as too small in size; reverted to grasses and mowed annually until 2001 when it was planted to hardwoods.
- **Field 326:** cropped annually until 1998, too wet to till; planted in hardwoods in 2001.
- **Field 327:** "Cemetary field" tilled until 1983 then let revert to natural succession. Twice planted in trees with poor results.
- **Field 328:** tilled on and off until mid 1990s; planted in hardwoods in 2001.
- **Field 329:** never tilled, mowed as grassland until late 1990s; reverting to shrubs.
- **Fields 350-357:** newly acquired in 2001. Tilled in corn and soybeans until 2006.

Current Vegetation

Management Unit III is the largest of the Units and lies between Unit II and Unit IV. Like Unit II, it is a freshwater system and is non-tidal. It is 4,431.0 acres (1,793.1 ha) in size, of which 3,822.6 acres (1,546.9 ha) are natural communities and 608.4 (246.2 ha) are anthropogenic communities (Table 4 and HMP Maps 5 and 6). The Generic Marsh, which represents the refuge's impounded wetlands, is the largest cover type and an Overwash Dune at the north end of the Unit is the smallest.

Unit III is the most biologically and ecologically diverse of all the Units (Note: Generic marsh and open water roughly correspond to impounded wetland areas). Unit III supports three vegetation communities that are currently known in Delaware only from Prime Hook NWR. These include the Twig Rush Peat Mat, Pond Pine Woodland and Red Maple-Seaside Alder Woodland. Prime Hook Creek flowing east to west roughly divides this unit into a northern half and southern half. This unit contains the largest amount of anthropogenic communities at 608.4 acres (246.2 ha), which is more than the other three units combined.

Table 4. Acreage of Natural and Anthropogenic Communities in Management Unit III

NVCS - Natural Community	UNIT III acreage (ha)
Atlantic Coast Interdune Swale	15.8 (6.4)
Atlantic White Cedar-Seaside Alder Woodland	9.8 (4.0)
Brackish Tidal Creek Shrubland	1.3 (0.5)
Buttonbush Coastal Plain Pond	0.8 (0.3)
Coastal Loblolly Pine Forest	41.5 (16.8)
Coastal Loblolly Pine Wetland Forest	56.3 (22.8)
Coastal Plain Depression Swamp	248.7 (100.6)
Interdunal Switchgrass Brackish Depression	0.7 (0.3)
Loblolly Pine Plantation	10.6 (4.3)
Loblolly Pine-Sweetgum Semi-Natural Forest	39.0 (15.8)
Maritime Red Cedar Woodland	7.8 (3.2)
Marsh	1314.7 (532.0)
Mesic Coastal Plain Mixed Hardwood Forest	19.2 (7.8)
Mesic Coastal Plain Oak Forest	43.8 (17.7)
Mesic Rich Forest	24.5 (9.9)
Mid-Atlantic Maritime Salt Shrub	1.5 (0.6)
Overwash Dune	0.2 (0.1)
Peat Mat	9.0 (3.6)
Pond Pine Woodland	7.2 (2.9)
Red Maple-Seaside Alder Woodland	699.3 (283.0)
Reed Canarygrass Eastern Marsh	1.9 (0.7)
Southern Red Oak/Heath Forest	289.1 (117.0)
Successional Maritime Forest	90.6 (36.6)
Successional Sweetgum Forest	88.0 (35.6)
Swamp Cottonwood Coastal Plain Pond	1.5 (0.6)
Open Water	797.9 (322.7)
Water-willow Shrub Swamp	2.2 (0.9)
Natural Community Total	**3,822.6 (1,546.9)**
Anthropogenic Community	
Agricultural Field	507.1 (205.2)
Building	0.3 (0.1)
Northeastern Successional Shrubland	73.4 (29.7)
Open Lawn	5.0 (2.0)
Parking Lot	1.6 (0.6)
Road	21.0 (8.5)
Anthropogenic Community Total	**608.4 (246.2)**
UNIT III Total	**4,431.0 (1793.1)**

UNIT IV (HMP Map 7)

Management Unit IV is surrounded by Rt. 16 on the north, the Broadkill Beach community on the east, the Broadkill River on the south and west, and the upland edge on the west.

Hydrology

Tidal action occurs along the Broadkill River, whose salinity ranges from 10 to 30 ppt. The majority of the water for Unit IV is provided through the Broadkill River. Some tidal action and leakage of salt water into the Unit IV impoundment also occurs during peak tides from a ditch connected to the Broadkill Sound. Rainfall and excessive runoff from Unit III are other sources that provide fresh water. However, normal runoff and tidal action are not sufficient to recharge the impoundment above its perimeter elevation.

Soils and Topography

Unit IV topography is relatively flat with less than one percent slope. Much of the area lies below the three foot contour. Dominant soils found in this unit are Broadkill-Appoquinimink complex (Ba), Broadkill mucky peat (Br), Transquaking and Mispillion (TP), and Purnell mucky peat (Pu). The largest variation in Tidal marsh soil profiles is the depth to underlying material, which in most places is sandy. The depth ranges from 2 to 3 feet in some hummocks and near the boundaries with upland soils, to an undetermined depth in the interior of broad marsh areas. These areas where tidal fluctuations are great, the horizons are completely liquid. Other minor soil types found in upland habitats include Askecksy loamy sand (AsA), Fallsington sandy loam (FaA), Hammonton loamy sand (HmA) and sandy loam (HnA), Hurlock sandy loam (HvA), and Rosedale loamy sand (RoB).

Management History – Wetlands

Prior to Service ownership, this marsh had been excessively drained by man-made ditches. When the refuge was established, about 1,000 acres of tidal salt marsh surrounded about 150 acres of farm fields. Before 1963, private owners maintained pumping stations for ponds in Units III and IV for cattle and to manage waterfowl and muskrats. Much of the marsh was grid ditched for mosquito control.

The vegetation was predominantly salt marsh cordgrass (*Spartina alterniflora*) and salt hay (*S. patens*) with several patches of high-tide bush (*Iva frutescens*). Unit IV was continually grazed by cattle on the Island Farm which was operated as a large cattle feed-lot operation from the early 1950s up to refuge establishment. Cattle continued to graze in Unit IV until the early 1970s.

In 1980, an Environmental Assessment was written to rehabilitate 200 acres of Unit IV's brackish marsh with the construction of water control structures. Two concrete control structures with logs on the impoundment side and flap gates on the tidal side were installed in 1982 to impound this wetland (Vergie's Pond). By 2003 these structures were seriously deteriorated and were subsequently replaced in 2005 in order to maintain water level management capability in this unit.

Management History – Upland Fields 1978 – 2008 (HMP Map 7):

- **Field 401:** cropped until 1982; maintained as grassland (mowed annually) to 2008.
- **Fields 402-405 & 409:** cropped until 1999; ceased farming due to salt water encroachment; mowed every other year.
- **Field 406:** never cropped, only maintained as grassland.
- **Field 407:** maintained as grasslands until 1985; cropped in corn and soybeans until 1996; currently, has reverted to grassland with some brush encroachment.

- **Field 408:** never cropped only maintained in grassland/brush.
- **Field 410:** never cropped; last area used by Henslow's sparrow in 1970s; maintained as grassland in early 1960s and 1970s; brush encroachment treated with hydroaxe in 1990s to re-establish switchgrass community.
- **Field 411:** never cropped; maintained as grassland.

Current Vegetation

Management Unit IV is the southernmost management unit and is the smallest of all the units with a total area of 1,176.4 acres (476.0 ha), of which 1,111 acres (449.6 ha) are natural communities and 65.3 acres (26.4 ha) are anthropogenic communities (Table 5 and HMP Map 7). Unit IV receives tidal and brackish input from the Broadkill River and as a result, the largest natural community in Unit IV is the *Spartina* low salt marsh. The smallest natural community is an Interdunal Switchgrass Brackish Depression. A Coastal Bay Shore/Succulent Beach is located within the impounded portion of Unit IV and is covered under the general Marsh category. Unit IV is the only known location for this community in Delaware.

Table 5. Acreage of Natural and Anthropogenic Communities in Management Unit IV

NVCS - Natural Community	Unit IV acreage (ha)
Atlantic Coast Interdune Swale	30.5 (12.3)
Brackish Tidal Creek Shrubland	17.7 (7.1)
Coastal Loblolly Pine Forest	9.7 (3.9)
Interdunal Switchgrass Brackish Depression	5.7 (2.3)
Maritime Red Cedar Woodland	66.2 (26.8)
Marsh	4.1 (1.6)
Mid-Atlantic Maritime Salt Shrub	40.4 (16.3)
Spartina High Salt Marsh	7.8 (3.1)
Spartina Low Salt Marsh	774.8 (313.5)
Successional Maritime Forest	22.0 (8.9)
Water	132.2 (53.5)
Natural Community Total	**1,111.1 (449.6)**
Anthropogenic Community	
Building	0.2 (0.1)
Northeastern Successional Shrubland	58.7 (23.7)
Road	6.4 (2.6)
Anthropogenic Community Total	**65.3 (26.4)**
Unit IV Total	**1,176.4 (476.0)**

2.3 Physical and Geographic Setting

Climatic Influences

Delaware's climate is generally mild, continental weather moderated by the effects of the Atlantic Ocean in general, so periods of sustained hot or cold temperatures are typically brief. Extreme temperatures

are moderated by the Delaware Bay, the Atlantic Ocean and the Chesapeake Bay. On refuge, weather conditions are mild year round with temperatures ranging from 32° F for an average low and 80° F for an average high. Normally summer ocean breezes keep the Refuge cooler than inland areas and most winter days are mildly attenuated by the same breezes.

Yearly and seasonal precipitation is highly variable. Average annual refuge rainfall is 41.98 inches. Snowfall is usually light, averaging 10 to 15 inches per year. Prevailing winds from March through October are from the northwest except during summer months when they become more southerly. Prevailing winds from November through February are northeast. Average annual wind speed is about 9 mph, but winds can reach 50 to 60 miles per hour or higher during summer thunderstorms, hurricanes or intense winter northeasters. These climatic conditions correspond to USDA Plant Hardiness Zone (7a). Native plant and ecological restoration biologists refer to the USDA zones for guidance in selecting appropriate species and planting times.

The entire refuge lies within Delaware's Coastal Zone and is subject to periodic flooding by coastal storms. Most of the Refuge lies within the 100 year floodplain. The March storm of 1962 inundated 90% of the current refuge lands. When PHNWR is subjected to intense winter storms with strong sustained winds and high tides, this leads to extreme flooding of impoundments with saline Delaware Bay waters and severe erosion of dunes and impoundment dikes, resulting in heavy salt water intrusion of freshwater wetlands and adjacent upland habitats. This occurred on the winter of 1998 from a severe Nor'easter, and again in 2006 from Hurricane Ernesto, and 2008 from another Nor'easter on May 11th.

Delaware's Landscape Ecology

The state of Delaware occupies approximately 1.3 million acres along the mid-Atlantic coast. Despite its small size, the state possesses a diversity of flora and fauna since it spans 2 physiographic provinces. More than 1,000 species of wildlife are known to presently occur or have occurred in the past with approximately 125 different types of vegetative communities recently mapped in the Delaware Wildlife Action Plan (2005).

The Delaware Natural Heritage Program, tracks rare species distribution and abundance using the methodologies of the international network of Natural Heritage Programs. This methodology allows for comparison of species status across all taxa, and for this reason was chosen by the State of Delaware as the foundation for determining Species of Greatest Conservation Need (SGCN) in Delaware's Wildlife Action Plan. The state plan identifies 457 species of greatest conservation need associated with 50 different habitats required to support rare flora and fauna (DNREC 2005).

Floristically, Delaware lies within the transition zone, in which species of southern and northern affinities intermingle. This creates a unique biological interface of falling on the southern end of the most northern ranges of species and also at the most northern end of the southern ranges of flora and fauna, a situation that serves to heighten its biological diversity. Avian diversity also derives from the state's location on the Delaware Bay, adjacent to the Atlantic Ocean and its strategic placement along a major migration route on the Atlantic Flyway.

Wetlands Past and Present

Coastal wetlands found on the refuge are comprised of three wetland classifications as defined by NWI, these are; estuarine emergent, estuarine scrub-shrub, and intertidal flats. Estuarine wetlands represent about one-third of Delaware's marsh habitats with palustrine wetlands encompassing the remaining marsh habitats. About 75% of Delaware's vegetated wetlands are emergent or forested types. Ninety-eight percent of the state's wetlands occur in the coastal plain (Tiner 2001). More than 45,000 acres of the state's tidal wetlands were grid-ditched for mosquito control by the Civilian Conservation Corps in the 1930s (Whitman & Cole 1986).

During the past 300 years, Delaware has lost about 55% of its original wetland acreage. Channelization and drainage still pose serious problems for palustrine wetlands; large-scale drainage ditches are still constructed, lowering water tables. Restoration efforts are needed to improve water quality and function of these damaged wetlands and to re-establish the functions of lost wetland areas (Tiner 2001).

Open water environments account for approximately 4% of Delaware's cover-types. The state contains about 843 miles of perennial streams and creeks forming several drainage sub-basins that are distinctly different according to geographic location. Piedmont streams are exclusively freshwater with steeper gradients and swifter flow than Coastal Plain waterways. However, in estuarine creeks powerful currents can be generated by tidal flow and salinity varies seasonally with distance from the ocean or Delaware Bay. More than 1,000 acres have been classified as deepwater habitats (water depths > 6.6 feet) in Delaware (Tiner-1985).

Many small coastal plain streams in Sussex County have been channelized for drainage through a state "tax-ditch" system. Delaware Code Title 7, Chapter 41, provides the basis for a uniform system for establishing, financing, administering, maintaining, and dissolving tax ditch organizations in Delaware, under the supervision of DNREC. Currently more than 2,000 miles of channels in Delaware are managed by 228 tax ditches and political state subdivisions that have maintenance taxing authority. Tax ditch channels range in size from 6 to 80 feet wide and 2 to 4 feet deep. The dimensions depend upon the acreage being drained and the local topography (State of Delaware-1998). It has been estimated that 13% of the state's palustrine forested wetlands (mostly in Kent and Sussex Counties), continue to be drained by these tax ditches (Tiner-1985). Two tax ditches occur on the Refuge, Draper-Bennett Tax Ditch in Unit I and Naylor-Wells Tax Ditch in Unit III.

Prior to European settlement virtually all of Delaware's upland areas were forested. Transitional habitats representing small blocks of early successional grassland openings and thickets were more prevalent than today likely due to Native American set fires to maintain open areas for hunting (Tetra Tech 2004).

Agricultural and urban development have eliminated much of the forests of Delaware. By 1950 agricultural lands accounted for 904,000 acres of the state's 1,251,000 total acres. This had dropped to 600,000 acres by 2000, lost to commercial and residential development. Today, forested cover types have dropped significantly with the greatest losses occurring in Sussex County, leaving less than 150,000 acres remaining throughout the state. Continuing forest losses, forest fragmentation and clear cutting throughout Delaware have resulted in a loss of over 85% of forested habitats (ELI-1999 & DE Office of Planning 2005).

Delaware Natural Heritage Program (DNHP) data lists over 2,200 plant species, varieties, and hybrids of native (1,590) and non-native (610) vascular plants known to occur in Delaware. The overall flora is represented by 173 families and 770 genera. A full synopsis of the flora of Delaware is provided in "*The Flora of Delaware: An Annotated Checklist*" (McAvoy & Bennett -2001).

Species rarity on a local, regional, and global level as assessed by the DNHP is primarily a function of habitat loss. Habitat losses within the Delaware landscape have been due to the conversion of natural habitats to agriculture, commercial and residential development, and from draining and filling wetlands. Over 40% of the known native flora (620 taxa) are classified as species of Conservation Concern and are in need of some level of proactive protection (DNREC 2005).

Seventy-seven plant species are known from only a single population in Delaware; 171 species have not been reported in the state for 15 years or more (historical), and 57 species are considered to be extirpated from the state. Fifteen percent of the known native flora of the state is either historical or

extirpated. Seven species in Delaware are listed by USFWS as either threatened or endangered, and 36 species are considered globally threatened by The Nature Conservancy.

Of the 620 plant species of Conservation Concern, 585 native species of plants are restricted to the Coastal Plain physiographic province. Forty-five percent of all rare plants in Delaware are found in freshwater non-tidal wetland habitats (or 266 species). Non-tidal freshwater wetlands in Delaware are not protected by the state. By comparison, 55 native species of Conservation Concern are found in tidal (fresh and saline) wetlands or 8% of all rare plants in the state. Tidal wetlands are state protected. There are 297 species of plants that occur in upland habitats (forests, forest canopy gaps, early successional habitats and coastal dunes) that are of Conservation Concern in Delaware. Natural upland habitats have been identified as rare key wildlife habitats in Delaware's 2005 Wildlife Action Plan. These habitats in Delaware have no regulatory protection (DNREC 2005).

2.4 Current Refuge Condition

In this section we have identified individual plant and community types, vegetative composition, invasive species, contaminant problems and other current conditions that affect habitat management. We have also identified existing rare floral and faunal species, declining, or unique natural communities, and species within the Refuge's boundaries. These species along with the focal species identified in Chapter 2 of the CCP are important to the management of biological integrity, diversity, and environmental health of the Refuge habitats.

Plant Communities at Prime Hook NWR

Thirty four natural vegetation communities have been mapped on PHNWR by the DNHP in 2005 and 2006. The *Spartina* low marsh (1,685 acres) was the largest association and the Button Bush Coastal Plain Pond was the smallest (1 acres). Four associations (*) were identified on the Refuge that are unique in Delaware and found nowhere else in the state. These include the Red Maple/Seaside Alder (799 acres), Pond Pine Woodland (8 acres), Coastal Bay Shore/Succulent Beach (150 acres) and Twig Rush Peat Mat (10 acres) associations (See Table 6 and HMP Map 2). It should be noted that, as a result of the recent shoreline changes in Unit II (overwashes, inlets), these vegetation communities may be changing in composition and in size. With many of these areas in transition, the exact nature and extent of these changes are not known. Thus, we recognize that the vegetation map information is already outdated for portions of our managed wetland impoundments that have been affected by recent coastline changes.

Table 6. Habitat Types by Acres and NVCS Common Names on PHNWR

HABITAT TYPE	ACRES	NVCS Association Common Names
Overwash Dune	17	Salt Meadow Cordgrass, Common Threesquare, Seaside Goldenrod (G2G3) (Habitat of State Conservation Concern)
Beachgrass/Panicgrass Dune Grassland	35	American Beachgrass, Bitter Panicgrass (G2) (Habitat of State Conservation Concern)
Atlantic Coast Interdunal Swale & Depression	74	Wax-Myrtle, Salt Meadow Cordgrass, Panicgrass Shrubland (G3) (Habitat of State Conservation Concern)
Mid-Atlantic Maritime Salt Shrub	60	Groundsel, Maritime Marsh Elder, Salt Meadow Cordgrass (Habitat of State Conservation Concern)
Maritime Red Cedar Woodland	76	Eastern Red Cedar, Northern Bayberry Woodland (G2) (Habitat of State Conservation Concern)
Southern Red Oak/Heath Forest	289	White Oak, Southern Red Oak, Dangleberry
Mesic Coastal Plain Oak Forest	193	Southern Red Oak, Willow Oak, American Holly
Successional Sweetgum Forest	180	Sweetgum, Loblolly Pine, Red Maple
Coastal Loblolly Pine Forest	51	Loblolly Pine, Wax-myrtle, Royal Fern

HABITAT TYPE	ACRES	NVCS Association Common Names
Mesic Coastal Plain Rich Forest	19	Tuliptree, Red Oak, Green Ash, Bellwort (Habitat of State Conservation Concern)
Mesic Coastal Plain Mixed Hardwood Forest	19	American Beech, Red & White Oak, Tuliptree, Christmas Fern
Pond Pine Woodland*	8	Pond Pine, Sweetbay, Highbush Blueberry, Atlantic Sedge (Habitat of State Conservation Concern)
Red Maple-Seaside Alder Swamp*	799	Red Maple, Seaside Alder Saturated Woodland (S1) (Habitat of State Conservation Concern)
Waterwillow Shrub Swamp	2	
Coastal Plain Depression Swamp	335	Sweetgum, Red Maple, Willow Oak, Fetterbush Flooded Forest (Habitat of State Conservation Concern)
Buttonbush Coastal Plain Pond	1	Buttonbush/Swamp Smartweed/Warty Panicgrass Shrubland (Habitat of State Conservation Concern)
Coastal Loblolly Pine Wetland Forest	91	Loblolly pine, Southern Bayberry, Royal Fern Saturated Forest
Atlantic White Cedar swamp	10	Atlantic White Cedar, Seaside Alder Seasonally Flooded Woodland
Cottonwood Coastal Plain Pond	2	Swamp Cottonwood, Red Maple, Pin Oak, Sweetgum (Habitat of State Conservation Concern)
Coastal Bay Shore/Succulent Beach*	150	
Impounded Freshwater/Brackish Wetlands ➔ Generic Marsh = 2946 Water = 1554	4,500	(1/3 Perennial Vegetation) Wild Rice Marsh, Narrow-Leaf Cattail, Rosemallow Marsh, Fall Panicum, Olney Three-Square Marsh, Pond Lily Marsh, Cattail, Bulrush Marsh (2/3 Annual Moist Soil Veg) Sea Purslane, Spearscale Marsh (Habitat of State Conservation Concern)
Peat Bog Community*	10	Twig Rush, Ten-Angle Pipewort, Tawny Cotton Grass (S1) (Habitat of State Conservation Concern)
Salt Marsh	2,200	*Spartina* Low Salt Marsh, Salt Panne, *Spartina* High Salt Marsh, Bayberry-Salt Meadow Cordgrass (Habitat of State Conservation Concern)

Refuge plant surveys conducted in 2004 and 2005 by Delaware Natural Heritage Botanists provided data on current habitat conditions and species composition. The flora of PHNWR is represented by 100 families and 247 genera (See Appendix E of the CCP). The largest families are the sedge family (Cyperaceae) with 60 taxa and 11 genera, followed by the aster family (Asteraceae) with 57 taxa and 34 genera, and the grass family (Poaceae) with 45 taxa and 30 genera. The largest genera include: *Carex* (28 taxa), *Quercus* (9 taxa), *Eleocharis* (8 taxa), *Polygonum* (8 taxa), *Bidens* (7 taxa), *Eupatorium* (7 taxa), *Juncus* (7 taxa), *Asclepias* (6 taxa), *Cyperus* (6 taxa), and *Rhynchospora* (6 taxa).

The majority of Refuge plants are perennial broad-leaf herbs with 131 taxa, followed by annual broad-leaf herbs with 58 taxa. Graminoids (grasses, sedges, and rushes) are a large component of the Refuge's flora, equaling 112 taxa, (45 taxa of grasses, 60 taxa of sedges, and 7 taxa of rushes). Trees and shrubs are also very prominent in the flora, with 29 taxa of deciduous trees, 6 taxa of evergreen trees, 32 taxa of deciduous shrubs, and 5 taxa of evergreen shrubs.

True ferns [e.g., cinnamon fern (*Osmunda)*] and their relatives [e.g., tree club-moss (*Lycopodium*)] form a unique assemblage of the flora with 16 taxa. Most of the Refuge's flora is wetland plants (wetland indicator status of facultative-wet and obligate) represented by 236 taxa, compared to 189 that occur either occasionally in wetlands, or never occur in wetlands. The majority of the flora on the refuge has southern affinities with 104 taxa having a more southern natural geographic distribution. By comparison 47 taxa have a more northern natural geographic distribution. Documented rare plants included 42 species (7-S1, 20-S2, and 17-S3).

Rare Plants and Exemplary Communities

Exemplary natural communities are those that have been minimally impacted by humans and contain an exceptional diversity or unique rare plant species. The most significant community found on the Refuge was the Twig Rush Peat Mat. These sites (6 were mapped by McAvoy and Coxe 2007) support many state rare plant species and occur in open water within a shrub-dominated swamp matrix. This unique habitat develops on deep, mucky, peat that appears to float (true "quaking bog"). Of the six quaking bogs inventoried and mapped, the most exemplary was the "Prime Hook Bog," described below.

The "Prime Hook Bog" is about 1.5 acres in size and is floristically diverse with 66 species and varieties documented. Twig rush sedge (*Cladium mariscoides)* is the dominant herb with many rare plants (See Table 7) including several insectivorous plants like purple pitcher-plants, round-leaf sundew, fibrous bladderwort, and southern bladderwort. In addition, a subspecies new to the flora of the State of Delaware and the Delmarva Peninsula was discovered here: the bushy bluestem (*Andropogon glomeratus* var. *hirsutior.*

Table 7. State-rare plants associated with the NVCS - Twig Rush Peat Mat Community on Prime Hook National Wildlife Refuge

SCIENTIFIC NAME	COMMON NAME	STATE RANK
Alnus maritima	Delmarva alder	S3
Andropogon glomeratus var. *hirsutior*	bushy bluestem	S1
Bartonia paniculata	twining bartonia	S2
Bidens coronata	tickseed sunflower	S3
Bidens mitis	small-fruit beggar-ticks	S2
Cyperus diandrus	Umbrella flatsedge	S1
Drosera rotundifolia	round-leaf sundew	S2
Eleocharis robbinsii	Robbins spike-rush	S3
Eriocaulon decangulare	ten-angle pipewort	S1
Eriophorum virginicum	tawny cotton-grass sedge	S1
Eriocaulon parkeri	Parker's pipewort	S2
Fuirena squarrosa	hairy umbrella-sedge	S2
Fuirena pumila	Dwarf umbrella sedge	S3
Juncus pelocarpus	brown-fruited rush	S2
Lycopus amplectens	sessile-leaved bugleweed	S2
Pogonia ophioglossoides	rose pogonia	S2
Rhynchospora alba	white beakrush	S2
Rhynchospora scirpoides	Long-beaked beakrush	S2
Sagittaria engelmanniana	Engelmann's arrowhead	S2
Sagittaria graminea	Grass-leaf arrowhead	S2
Sarracenia purpurea	purple pitcher-plant	S2
Spiranthes cernua	nodding ladies'-tresses	S3
Utricularia fibrosa	fibrous bladderwort	S2
Utricularia juncea	southern bladderwort	S2

In addition to rare vascular plant data, exceptionally large individual tree species (relative to PHNWR and the state of Delaware) were measured and recorded. One willow oak measured 53" diameter at breast height (dbh) with several other willow oaks in the 40" dbh range.

Nonvascular plants are the simplest of all land dwelling plants. Like their closest ancestors, the green algae, they lack an internal means of water transportation. They do not produce seeds or flowers. They generally only reach a height of one to two centimeters, because they lack the woody tissue (xylem and phloem) necessary for support on land. Because of their sensitivity to the environment around them, they can be useful indicators of environmental conditions as they are particularly susceptible to air and water pollution. They also serve as food for small animals and insects. Non-vascular plants grow from spores. Non-vascular plants include two distintly related groups Bryophytes and Algae Bryophytes include the Bryophyta (mosses), the Marchantiophyta (liverworts), and the Anthocerotophyta (hornworts). A number of mosses and liverworts were documented in various habitats on the refuge by DNHP (Table 8).

Table 8. Nonvascular plants documented on Prime Hook National Wildlife Refuge

HABITAT (Refuge Unit)	SCIENTIFIC NAME (substrate)	TYPE
Southern Red Oak Heath Forest (Unit III)	*Amblystegium serpens* (bark)	moss
	Capylium hispidulum (base of tree)	moss
	Coloejeunea biddlecomiae (bark)	liverwort
	Dicranum condensatum (soil)	moss
	Orthotrichum stellatum (bark)	moss
	Pylaisella selwynii (bark)	moss
	Tortella humilis (base of tree)	moss
Coastal Loblolly Pine Wetland Forest (Units I and II)	*Aulacomnium palustre*	moss
	Climacium americanum	moss
	Dicranum flagellare	moss
	Hypnum imponens	moss
	Isopterygium tenerum	moss
	Leucobryum albidum	moss
	Plagiothecium denticulatum	moss
	Thuidium delicatulum	moss
	Cephalozia connivens	liverwort
	C. lunilifolia	liverwort
	Cephaloziella rubella	liverwort
	Leucolejeunea clypeata	liverwort
	Lophocolea heterophylla	liverwort
	Nowellia curvifolia	liverwort
	Odontoschisma prostratum	liverwort
	Pallavacinia lyellii	liverwort
	Sphagnum cuspidatum	peat moss
	S. palustre	peat moss
Twig Rush Peat Mat (Unit III)	*Sphagnum fimbriatum*	peat moss
	S. recurvum	peat moss
	S. perichaetile	peat moss

HABITAT (Refuge Unit)	SCIENTIFIC NAME (substrate)	TYPE
Early Successional / Open Field Habitats	*Riccia hueberneriana* subsp. *Sullivanti*	liverwort
	R. hirta	liverwort
	Notothylus orbicularis	hornwort

Rare Fauna

Zoological surveys were undertaken for reptiles, amphibians, and state-rare insects in 2004-2005 as part of the Refuge's CCP pre-planning baseline data inventory efforts. For insects, inventories focused on species of conservation concern (DNHP ranks: S1, S2, & SH) for which information regarding status (local, regional, global) were available. This included dragonflies and damselflies (Odonata), fireflies (Coleoptera: Lampyridae), tiger beetles (Coleoptera: Carabidae), moths and butterflies (Lepidoptera), and wasp species (Hymenoptera). Other species reported included undescribed species, new county and state records. Rare fauna documented on the refuge are summarized in Table 9.

Table 9. Rare fauna documented on Prime Hook National Wildlife Refuge

SPECIES GROUP	COMMON NAME	SCIENTIFIC NAME	STATE RANK	ASSOCIATED HABITAT(S)
Amphibians	Carpenter Frog	*Rana virgatipes*	S1	Coastal Plain Depression Swamp; Coastal Loblolly Pine Wetland Forest; Red Maple-Seaside Alder Woodland; Atlantic White Cedar-Seaside Alder Woodland
	Cope's Gray Treefrog	*Hyla chrysoscelis*	S1	
Reptiles	Ribbon Snake	*Thamnophis sauritus*	S2	
	Rough Green Snake	*Opheodrys aestivus*	S2	
Odonata	Elfin Skimmer	*Nannothemis bella*	S1	Twig rush peat mat; Impounded Freshwater Marsh
	Sphagnum Sprite	*Nehalennia gracilis*	S1	
	Lilypad Forktail	*Ischnura kellicotti*	S1	
Hemiptera: Delphacidae (Planthoppers)	Unnamed –Species is new to science	*Megamelus sp*		Twig rush peat mat
Coleoptera: Carabidae	Beach Dune Tiger Beetle	*Cicindela hirticollis*	S1	Beachgrass-panicgrass dune grassland; Overwash dune grassland
Lampyridae (Fireflies)		*Photuris pensylvanica*	S2	Twig rush peat mat; Red maple-seaside alder woodland; Impounded marsh
		P. tremulans	S2	
		P. pyralomimus		
		P. frontalis	S1	
Cerambycidae: (Long-horned Beetles)		*Prionus laticollis*	County Record	Southern red oak heath forest

SPECIES GROUP	COMMON NAME	SCIENTIFIC NAME	STATE RANK	ASSOCIATED HABITAT(S)
Lepidoptera (Butterflies and Skippers)	Great Purple Hairstreak	*Altides halesus*	S1	Red Maple Seaside Alder Swamp
	Southern Broken Dash	*Wallengrenai otho*	S1	Maritime Red Cedar Woodland
	Little Glassy Wing	*Pompeius verna*	SU	
	Delaware Skipper	*Anatrytone logan*	SU	Coastal Plain Depressions; Coastal Loblolly Pine Wetland Forest; Maritime Red Cedar Woodland
Moths	Hydrangia sphinx	*Darapsa versicolor*	S1	Red maple-seaside alder woodland
	Graphic Moth	*Drasteria graphica*	S1	Maritime Red Cedar Woodland (host plant = *Hudsonia tomentosa)*
	Blueberry Dart	*Xestia youngii*	S1	Twig rush peat mat
	Pitcher Plant Borer Moth	*Exyra fax*	S1	
	Maritime Sunflower Borer Moth	*Papaipema maritima*	S1	Early successional grassland; Successional maritime forest
	Little Wife Underwing	*Catocala muliercula*	State Record	All communities with significant component of southern bayberry (*Morella cerifera)*
	Marbled Underwing	*Catocala amrmorata*	S1	Southern red oak-heath forest
	Tearful Underwing	*Catocala lacrymosa*	S1	
	Praeclara underwing	*Catocala praeclara*	S1	Coastal Plain depression swamp; Coastal loblolly pine wetland forest; Red maple/seaside alder woodland
	Noctuid Moths	*Zale metatoides & Z. metata*	S2	Coastal loblolly pine forest; Pond pine woodland

Invasive Plants

Of the 429 plant taxa listed in Appendix E of the CCP, 46 are non-native of which eleven are considered to be invasive. Some of these invasive include spotted knapweed (*Centaurea bieberstei)*, Canada thistle (*Cirsium arvense*), Japanese honeysuckle (*Lonicera japonica),* water-willow (*Ludwigia leptocarpa)*, Japanese stilt-grass *(Microstegium vimineum),* reed canary grass (*Phalaris arundinacea)*, alien common reed (*Phragmites australis* subsp. *Australis*), multi-flora rose (*Rosa multiflora*), porcelainberry (*Ampelopsis brevipeduncaulata)*, autumn olive (*Elaeagnus umbellate)*, and kudzu (*Pueraria Montana)*.

Spotted knapweed and Canada thistle are restricted to roadside areas, fallow agricultural fields, edges of hedgerows, and early successional fields throughout the Refuge. Japanese honeysuckle is ubiquitous throughout the Refuge mostly in wooded habitats. Water-willow, which is adventive in Delaware (native further south), may dominate about 100 to 150 acres of impounded marsh in Unit III, depending upon annual water regimes that may promote germination of this annual species. Japanese stilt grass (about

50 acres) is mostly found on Oak Island, where it dominates the herbaceous layer. All invasive plants are scattered throughout the refuge.

Reed canary grass, another invasive species in Delaware dominates an old field habitat in Unit III (corners of Field # 328). This is the same location where the state-rare plant lance-leaf orange milkweed (*Asclepis lanceolata)* grows. The lance-leaf orange milkweed is abundant here and is the largest known population in the state (100+ individuals), where current annual mowing late in the growing season appears to be favoring this milkweed species by suppressing woody vegetation. Multi-flora rose is widespread throughout the Refuge, growing in scattered areas within hedgerows, thickets, early successional fields, and woodland edges.

Pollutants and Contaminants

The Clean Water Act (CWA-33USC 251) is the cornerstone of surface water quality protection of aquatic habitats and has established WQS (Water Quality Standards) for individual states in the US. If water bodies are designated as "impaired" by not meeting WQS, the most common state strategy is the development of a Total Maximum Daily Load (TMDLs) for a non-compliant watershed. TMDLs determine what level of pollutant load would be consistent with meeting WQS by allocating acceptable loads among sources of relevant pollutants.

State-wide water quality assessments performed by DNREC has shown that more than 90% of Delaware's waterways are "impaired." Impaired waters are deemed polluted waters suffering from excess nutrients, low dissolved oxygen, toxins, bacteria, or any combination of these problems. Delaware has 41 designated watershed boundaries and most of Prime Hook NWR is located within the Broadkill River Watershed which is approximately 69,000 acres in size.

The Broadkill River and its tributaries and ponds adjacent to the Refuge are impaired by high levels of bacteria and elevated levels of nitrogen and phosphorus as determined by state monitoring efforts (Broadkill Watershed Assessment-DNREC 2000). There has been a significant decrease in wetlands and forests over time as these natural filters have been converted to other uses and the area develops into a more urban/suburban watershed. A pollution control plan (Jan 2008) has established TMDLs for the Broadkill River Watershed requiring a 40% reduction in non-point source nitrogen load, 40% reduction in non-point source phosphorus load, and 75% reduction in non-point source enterococcus bacteria, relative to 2002-2003 DNREC baseline data. The Refuge partnered in developing strategies to abate Broadkill River Watershed pollution and on-going watershed water quality sampling includes sampling points both on and near the Refuge.

Sussex County's extensive poultry industry produces over 600 million chickens and 1.6 billion pounds of manure annually (USDA 1997). In addition to nitrate and phosphate overloads that create hyper-eutrophication of adjacent waterways, poultry litter contains feed additives such as trace metals, antibiotics, and hormones. Excessive land application of poultry litter has resulted in severe water quality problems in surface and groundwater contamination in the Delmarva area (McGee et al 2003). Greater quantities of animal feed additives used in the poultry industry include metals such as arsenic, selenium, zinc copper and antibiotics. The majority of these additives are excreted and found at elevated concentrations in manure. Studies have indicated that these environmental contaminants are migrating to nearby surface waters (Miller et al 2000).

Due to the high density and intensity of agricultural operations and documented water quality problems throughout the peninsula, it seemed highly likely that contaminants associated with AFOs would represent a threat to Refuge ecological resources. This was the incentive to conduct a two-year investigation on Prime Hook NWR in Delaware and Blackwater NWR in Maryland, conducted by

contaminant biologists of the Chesapeake Bay Field Office (CBFO), "*Evaluating the Potential Water Quality Impacts of Animal Feeding Operations on National Wildlife Refuges on the Delmarva Peninsula.*" The purpose of the study was to assess water quality impacts on these two Refuges associated with AFOs by evaluating chemical and biological conditions impacted by animal feed additives and other "nontraditional" contaminants. Based on sampling results, PHNWR was the refuge with greater water quality problems associated with AFOs (McGee et al 2003).

Study results provided direct evidence of transport of tetracycline family of antibiotics and hormones from poultry litter applied to fields adjacent to refuge waterbodies on Prime Hook. Fish tissue data suggest that Refuge fish are being exposed to significant concentrations of estrogenic compounds from AFOs. Tissue data demonstrated that pesticides, hormones and high levels of antibiotics are significantly contaminating Refuge and Delmarva Peninsula waterbodies and that the negative impacts on fish and wildlife resources merits further investigation.

An unexpected result of the study was the finding that mercury contamination of piscivorous fish species from Refuge waterbodies of Slaughter Canal and Prime Hook Creek were at levels of human health concern. Refuge largemouth bass (LMB) exceeded EPA fish tissue residue criterion for mercury [Hg] in two waterways: Prime Hook Creek (0.54 ug/g) and Slaughter Creek (0.53-0.68 ug/g) {EPA Standard = 0.3ug/g}. Other contaminants of concern in Slaughter Creek included PCBs and Furan.

In 2006 the Refuge was included in the State of Delaware's "Toxics in Biota Monitoring Plan for FY 2006 and 2007. Further studies conducted by the state concluded that mercury is the primary risk driver for LMB in Prime Hook Creek and Waples Pond, and PCBs, Dioxin and Furans are the primary risk drivers in Slaughter Creek. In 2007 and 2008 these two waterbodies have been added to Delaware's Fish Consumption Advisories posted by DNREC annually in its State Fishing Guide.

For 37 years, The Broadkill Sportman's Club adjacent to the Refuge operated a trap-shooting range, located on the southwestern corner of the headwaters of Prime Hook Creek. Clay-target launchers were oriented so that expended lead shot dropped into a forested wetland and upland grassland area on Refuge lands. After many years of lead shot deposition, it was discovered that lead shot concentrations were as high as 57,868 pellets per square foot in some areas on Prime Hook National Wildlife Refuge.

The trap club was founded in 1962 on Pikes Neck, Sussex County. Service property boundaries surrounding the club were established in 1964. The club used five trap houses, each containing five shooting stations. Shotgun rounds were projected across a grassy field toward a wooded wetland intending to hit airborne clay targets above the field. Numerous lead shot pellets from misses and overshot trajectories often hit trees inside the Refuge boundary and falling to the ground, accumulating through the years.

The club was located in an upland area about 0.1 miles from the Refuge's Prime Hook Creek. The highest elevation of club lands is about 10 feet above sea level and most of the adjacent Refuge forested wetlands is 5 feet or less in elevation (Soeder & Miller 2003). The trap-shooting range was operated from 1962 to 1998, at which time a proposed land swap with the USFWS was initiated by the club.

Upon this request the Service initiated a Level One Contaminant Survey of Refuge lands. During August and October of 1998, CBFO Service personnel collected soil samples to determine the extent of lead concentrations in Refuge soils. Results showed significant lead contamination. The EPA and Service then ordered the club to discontinue depositing lead shot onto Refuge lands and in 2000 initiated a five-year clean-up project.

A preliminary assessment in 2000 determined that an affected area of 22 acres down-range of the club had accumulated most of the lead shotgun pellets with the highest densities concentrated in a designated "drop-zone" sized at 26,200 square feet. (Crowley & Richardson 2001). As part of an environmental risk assessment prepared by CBFO contaminant biologists, USGS investigated the potential for lead soaked soils to leach into the groundwater and minor tributaries feeding into Prime Hook Creek.

Study results verified that low pH ground water values probably from acid rain deposition helped to create exceedingly acidic environmental conditions responsible for dissolving lead carbonate off the pellets. Due to a lack of buffering capacity and adsorption sites in the silica-rich sediments of the area, the dissolved lead was then easily mobilized and moved into the groundwater on the Refuge.

The Service has physically excavated and removed part of the pellet-contaminated soils on Refuge property, which has since revegetated with native plants. The major source of groundwater contamination has been remediated on Refuge lands but not on club lands. The mitigation of high lead concentrations in Refuge ground water resources will require long-term monitoring to confirm the potential of natural attenuation of the system.

A Central Hazmat Fund Proposal submitted by CBFO contaminant biologists will provide long-term monitoring of the Refuge lead shot area, which included 5 wells sampled every three months for a two year period followed by every six months for an additional eight years. Using EPA and USGS methods for groundwater sampling, USFWS will obtain samples for analysis of total and dissolved arsenic, antimony and lead. Samples will be analyzed by Severn-Trent Laboratories (Edison, N.J.) and the results will be provided to Delaware Department of Natural Resources and Environmental Control (DNREC). This lab is certified by the State and data is provided with detection limits required by DNREC (8.68 ppb for SB, 4.70 ppb for As and 2.70 ppb for Pb).

The results will be reviewed by DNREC and statistical analyses will follow DNREC guidance for groundwater monitoring of the 5 wells each year. Depending on lead levels, groundwater monitoring could continue for up to 30 years. Groundwater monitoring is required under CERCLA (Comprehensive Environmental Response Compensation and Liability Act).

Additional threats to refuge communities, especially salt marshes and other wetlands, include oil spills and other petro-chemical contamination, as the Delaware Bay is the third largest shipping channel in the US, Refuge communities are also impacted by atmospheric mercury deposition.

2.5 Changing Climate and Sea Level Rise

Climate Change

Climate change is an immense and serious challenge that will affect fish and wildlife profoundly. A growing body of evidence indicates that accelerating climate change, associated with increasing global temperatures, is affecting water, land, and wildlife resources (Titus et al. 2009). While climate change has occurred throughout the history of our planet, current changes are occurring at a greatly accelerated rate, largely as a result of the accumulation of greenhouse gases from human activities. Climate change can affect the migration phenology and body condition of migratory songbirds (Buskirk et al. 2009). Along our coasts, rising sea levels have begun to affect fish and wildlife habitats, including those used by waterfowl, wading birds and shorebirds on our National Wildlife Refuges.

Successful conservation strategies will require an understanding of climate change and the ability to predict how those changes will affect fish and wildlife at multiple scales. We need to develop, test, and implement conservation strategies to cope with to the physical changes in the coastal environment

resulting from climate change. Some of the current and predicted impacts of climate change in the coastal zone include:

- Shoreline erosion and shoreline displacement
- Displacement of wildlife (as critical habitats decline)
- Conversion of upland habitats to wetter habitats, freshwater habitats to saline
- Conversion of forested areas to emergent wetlands
- Conversion of tidal wetlands to mudflat or open water
- Decreased nearshore and/or freshwater recreational opportunities
- Damage to refuge facilities, roads, trails, towers, etc.
- Decreased water quality as a result of increased temperatures, and runoff associated with stronger, more frequent storm events
- Decreased groundwater availability due to changes in precipitation regimes

Refuge staff will need to increase cooperative efforts with science partners, such as DNREC, Ducks Unlimited, USGS, NOAA, and others to research and monitor the current and likely physical and biological impacts of climate change, and to assess species and habitat vulnerabilities. This information will be used to formulate guidelines or thresholds to mitigate habitat losses and/or assist ecosystem adaptation to the refuge's changing environment.

Sea Level Rise

Sea level rise (SLR), a manifestation of a warming climate, has been gradually occurring for thousands of years. Increasing ocean water volumes are caused by thermal expansion of water and the melting of polar ice caps. In addition to the volume of the ocean increasing, land in the Mid-Atlantic is actually sinking as a result of geologic changes near the surface and deep within the earth. This is known as shallow and deep zone subsidence. Thermal expansion, melting of the polar icecaps and subsidence all combine to contribute to relative sea level rise.

Sea level rise has been recognized as a key issue facing coastal communities for decades. The Federal Coastal Zone Management Act of 1972 directed local governments to anticipate and plan for the effects of sea level rise. At the International Level, a committee was formed to assess SLR on a global scale the Intergovernmental Panel for Climate Change (IPCC). In its Fourth Assessment Report (FAR), The IPCC estimated that global sea level could rise between 0.2 and 0.6 meters by the year 2100 based on projected greenhouse gas emissions scenarios. Some climatologists believe that far underestimates the potential rise in sea levels and suggest that SLR may exceed 1.0 meters (Rahmstorf 2007). At the national level, the U.S. Climate Change Science Program was formed to investigate climate change and sea level rise. This committee recently released a multi-year study entitled "Coastal Sensitivity to Sea Level Rise: A Focus on the Mid-Atlantic Region." This study discussed the potential impact from sea level rise using three scenarios for the year 2100: a rise of 1.3 feet (current rate), 1.6 feet; and 3.3 feet.

Potential impacts from SLR can vary significantly depending upon the scenario; therefore, different SLR scenarios should be evaluated to consider an entire range of potential effects. SLR has the potential to significantly impact the refuge, Delaware's coastal resources and communities, and Delaware's overall economy over the next several decades. As a result of higher sea levels, low lying coastal communities are becoming more frequently inundated during storm events. As storm events are predicted to become more frequent and more intense, coastal erosion and flooding events will likely be more severe than previously experienced. These impacts will have profound effects on the refuge. Structured decision making models are being developed to provide a framework that will allow the Service to proactively consider potential effects of SLR when making long-term infrastructure and habitat management decisions.

In 2008 and 2009 the Delaware Coastal Program (DCP) conducted a Sea Level Rise Affecting Marsh Model (SLAMM) exercise, using high resolution elevation data, at PHNWR. The model used estimated maximum and minimum sea-level predictions, assuming that the actual sea-level will probably fall somewhere within that range. However, certain conditions are predicted by both scenarios and we assume they are good predictors of the future environment at the refuge. By the year 2050, the model projects that at least half of the current upland area of the refuge will be lost (either converted to wetlands or open water), decreasing from 20% to, at most, 12% of the current land base. Open water and tidal mud flat areas may increase throughout the next 100 years.

If sea level rises at an accelerated rate to one meter in the next 100 years, the impact will be much greater on the refuge. By the year 2050 open water and mudflats comprise 26% of the refuge under high accretion rates, or possibly up to 58% of the refuge with low accretion rates. Under the worst case scenario, by the year 2100, up to 88% of the today's refuge could instead be open water or tidal mud flats and only 1% for the refuge would be uplands. The full report can be found in Appendix D of the Refuge CCP, or at *http://www.swc.dnrec.delaware.gov/coastal/Pages/SeaLevelRiseAdaptation.aspx*. Additional information regarding climate change and sea level rise can be found at the Service's website, *http://www.fws.gov/home/climatechange*.

Overwash

Overwash is a natural manifestation of rising sea levels, but also critical to maintaining healthy emergent wetlands in barrier island systems of estuaries like the Delaware and Chesapeake Bays. Emergent marshes must, in part, receive periodic influxes of sediment, to help build marsh elevation sufficiently to keep pace with rising sea levels. When humans impede natural overwash and marsh building processes (e.g. by constructing dunes, filling overwash areas) they impede back-bay marsh development.

Notable storm induced overwashes occurred on the refuge in 1982, 1988, and 1999. The dunes were artificially rebuilt in 1999. In 2006, Hurricane Ernesto caused a beach overwash just north of Fowler's Beach Road on Prime Hook NWR. On May 12, 2008, a Nor'easter brought flooding that overtopped or completely removed beach dunes extending from the Slaughter Beach Community to the Prime Hook Beach community. This includes the 2006 overwash area. Overwashes, and the refuge's response to those overwashes, have been controversial, particularly within local beachfront communities. Some feel that overwashes, inlet formation and subsequent flooding of the road and impoundment system are the fault of the Refuge. They are worried that their neighboring beachfront homes are being endangered by these events, and that it is up to the Refuge to make reparations. Please see Rationale for Objective 3.1, in Chapter 2, for further discussion of the Refuge's response to SLR.

The overwash north of Fowler's Beach Road joins the Delaware Bay to a lagunal tidal salt marsh. Overwashes provide nutrients and sedimentation that is vital for tidal salt marshes, and provides critical habitat for priority coastal migratory birds. The area immediately south of Fowler's Beach Road has formed inlets during the past few years, as well. The impacted area covers approximately 4,000 linear feet of beach, with 95% of the breaches on private lands. During high tides this area floods a freshwater impoundment, Unit II, with saline bay water. In response to inlet formation, thousands of shorebirds are using the Unit II overwashes, during migration. In addition to the shorebird response, State endangered least terns and American oystercatchers have been confirmed nesting in the overwash.

There were numerous changes in the refuge freshwater habitats caused by the Mother's Day Storm of 2008. The salt intrusion plus the lack of rains to flush the salt from the system slowed the healing process in the freshwater marsh. The winter and spring rains allowed the staff to slowly flush the system, and it is gradually return to normal freshwater emergent community. The salt water intrusion resulting from the storm greatly reduced invasive plants such as *Phragmites* and hydrilla, at least

temporarily. Unit II has been one of the refuge's historic, premier waterfowl areas, managed as a moist soil unit via water control structures installed by DU. Accordingly, following the 2008 overwash event, the refuge re-established the dunes in this area, to prevent high tides from entering the freshwater impoundment from the Bay. At that time, the refuge reasoned that allowing the overwashes to continue could result in a species and habitat composition shift in Unit II, and change in the quality of the PHNWR's hunt program.

However, storms in 2009 created two large breaches in Unit II, elevating the situation from that of minor dune repair to major management activity. Thus an Environmental Assessment was prepared to conduct dune repair one more time. The repeated overwash events in recent years necessitated a reconsideration of traditional impoundment management objectives and strategies, to be evaluated during the CCP. At this point, reasoning for dune repair shifted from a goal of perpetual maintenance, to a goal of maintaining the status quo while the wetland's response to the hydrological changes and potential for restoration, could be studied, and management alternatives evaluated through the CCP. Legal challenges delayed the dune repair until 2011. By the time the repair was conducted, Hurricane Irene (August 2011) had reduced the amount of on-site material available significantly. The repair was conducted by the Shoreline section of DNREC to the best of their ability, but the breaches reopened merely weeks later. Daily tidal flow of salt water through the breaches and into Unit II continues.

Throughout the planning process, refuge staff carefully examined the numerous factors influencing management of the freshwater impoundments, Unit II in particular. These include not only the natural processes of overwash and beach migration, but also the elevation and accretion of the marsh surface, elevation and subsidence of the management infrastructure (roads and water control structures), and increasing storm frequency and intensity. A detailed account of these factors is provided within the CCP (Under Objective 3.1, in Alternative B of the Draft CCP). The resulting impoundment management objectives are outlined within this Habitat Management Plan. We continue to meet with DELDOT and DNREC to comprehensively assess the roads (which also serve as dikes), sea level rise, transportation safety planning and wildlife resources as we draft a water management and restoration plan for the site.

Chapter 3. Resources of Concern

3.1 Resources of Concern (ROCS)

Resources of Concern are defined in the Habitat Management Planning Policy as *"all plant and or animal species, species groups, or communities specifically identified in Refuge purpose(s), System mission, or international, national, regional, state, or ecosystem conservation plans or acts"* {620 FW 14 (G)}. Each refuge has one or more purposes for which it was established that guide it's management objectives. For example, based on PHNWR's purpose legislation, migratory birds and endangered species are priority resources of concern (ROCs) for the Refuge.

Other Service "trust resources" that are also considered as resources of concern include inter-jurisdictional fishes, wetlands, marine mammals. Further, refuges support other elements of biodiversity, including invertebrates, rare plants, unique natural communities, and ecological processes that contribute to biological integrity and environmental health at refuge, ecosystem, and broader scales (USFWS 1999, 2003).

The Refuge supports other elements of biological diversity that include rare plant, amphibian and invertebrate species, unique natural communities for Delaware, and natural ecological processes that contribute and/or sustain biological integrity and environmental health at the Refuge, state, ecosystem, and broader scales, and many of these elements are also considered resources of concern (See Appendix E of the PHNWR CCP).

Given the multitude of purposes, mandates, policies, regional, national, international, and state plans that apply to PHNWR, there is a need to identify and prioritize all the potential ROCS that the Refuge would be best suited to focus its habitat management objectives and associated strategies. We used the process described in the Service's "*Handbook for identifying refuge resources of concern and establishing management priorities for the NWR System*" (USFWS – March, 2007). The first step in this process yielded a comprehensive list of resrouces of concern (CCP Appendix E – Table A).

From this process, we selected priority habitats (CCP Appendix E – Table 5), and priority resources of concern (CCP Appendix E - Table 6) for PHNWR were identified. These ROCs served as the foundation for developing management goals and objectives. This process is described in more detail in Section 3.3.

3.2 Biological Integrity, Diversity and Environmental Health (BIDEH)

The RIA in section 4(a)(4)(B) states that in administering the System the Service shall *"…ensure that the biological integrity, diversity and environmental health of the System are maintained for the benefit of present and future generations of Americans…"* The Service defines these terms in its policy (601 FW 3) for maintaining and restoring the biological integrity, diversity, and environmental health (BIDEH) of the National Wildlife Refuge System.

Wherever and whenever possible, Refuge habitat management will mimic and/or restore natural ecosystem processes and functions to maintain and enhance biological integrity, diversity, and environmental health. The policy states that *"We will, first and foremost, maintain existing levels of biological diversity, integrity, and environmental health at the refuge scale.* To help achieve this policy goal we have mapped the existing elements of BIDEH on the Refuge (CCP Appendix E - Tables 1-4) as our starting point in determining habitat goals and management objectives, strategies, and prescriptions, to first, maintain existing elements of ecological integrity and second, to restore lost elements of BIDEH when feasible.

Maintaining Biological Integrity and Scoring Biological Condition

Developing and using indicators that assess current habitat condition and measures the consequences of habitat management actions will improve Refuge management of BIDEH. James Karr's Index of Biological Integrity (1997) is useful in understanding biological integrity. Karr believes that biological condition is the primary indicator of ecosystem health.

Using the approach of Karr's multimetric index of biological integrity (IBI) for aquatic sites, the Service is currently developing a multimetric Salt Marsh Integrity Index to assess salt marsh condition and integrity on Refuges. Karr (2000) explains the idea of developing a multi-metric index as assessing the biological condition of a place along a continuum of human influence. He depicts this idea by plotting biological condition along the y-axis (representing a continuum from "pristine" to "nothing alive") versus along the x-axis (representing a continuum of human disturbance from "none" to "severe"). The slope of that graph defines a threshold range intercept on the y-axis where the site degrades from healthy to unhealthy.

Biological integrity is the condition of a place with its evolutionary legacy – parts (species) and processes (nutrient cycles, trophic structure, etc.) – still intact. Biological condition can degrade to a threshold beyond which the system is unsustainable. This threshold represents a biological tipping point beyond which neither the natural biota nor human activity can be sustained in a place (Karr 2000).

These are the principles the USFWS and scientists with the U.S. Geological Survey (USGS) are employing to develop a Salt Marsh Integrity Index, an ongoing project the refuge is participating in. It is envisioned that with the use of a structured decision making process we can apply multi-metric indices for other habitat types. Such indices will improve performance measures to monitor habitat management activities on other habitat types, like freshwater marshes, etc.

In planning habitat management activities we will focus on the establishment of native communities we believe can occur through natural succession and/or maintain native non-climax communities to best achieve Refuge purpose(s). We will favor techniques that set back succession such as water level management, prescribed fire, mowing and other techniques to maintain early successional communities for migratory birds and other priority resources of concern. But in the case of Delmarva fox squirrels, we wish to accelerate succession toward a more climax seral stage. When restoring habitats we attempt to re-establish native plant species and vegetative communities found under natural conditions and use native seed sources or rely on natural succession and native seed banks in ecological restoration projects.

Growing information that wildlife diversity can help buffer human populations from infectious disease point to the increasing evidence for the economically valuable ecological services provided by maintaining and increasing biodiversity. All refuge habitat management actions that increase biological integrity, diversity, and environmental health and avian diversity have the potential of providing a buffer against future disease outbreaks from refuge-produced mosquitoes.

Maintaining and increasing biodiversity has been recently shown to slow the spread of infectious disease to humans and wildlife. Recent infectious disease models illustrate a suite of mechanisms that can result in lower incidence of disease in areas of higher disease host-diversity (defined as the dilution effect). These models are particularly applicable to human zoonoses, i.e., infectious disease of wildlife or domestic animals that spill over into human populations (Keesing et al 2006; Krasnov et al 2007, Ostfeld and Kessing 2000). Examples of zoonoses include avian influenza, anthrax, Lyme's disease, and WNV, to name a few.

Research conducted in the eastern U.S., when the West Nile Virus (WNV) epidemic was in full swing in 2002, found fewer incidences of WNV in humans in areas with a diverse array of bird species (Swaddle

and Calos 2008). This link between higher bird diversity and reduced human WNV infection is attributed to the fact that crows, jays, and other common West Nile viral hosts tend to increase in numbers when avian diversity is low. But when bird diversity is high, viral host populations remain in check, hindering their ability to spread disease. Similar studies showed how increased mammalian diversity decreased Lyme disease risk to humans (LoGiudice et al 2003).

3.3 Process for Determining Resources of Concern and Habitat Priorities

The refuge followed the process outlined in the Service's handbook (USFWS 2007) for prioritizing the key habitats and species upon which to focus habitat management actions in this HMP. First, a comprehensive list of potential resources of concern was developed from Refuge purpose and Service trust species that were found on the Refuge (CCP Appendix E – Table A), using the following list of regional and state wildlife and habitat data sources:

- BCR 30 Bird Species List
- PIF – Area 44 Bird Species List
- National and Regional Bird Conservation Plans for waterfowl, landbirds, shorebirds, and waterbirds
- USFWS Birds of Conservation Concern
- Federally Threatened and Endangered Species Listings
- State Threatened and Endangered Species Listings
- Anadromous Fish Resources Using Refuge Habitats
- Refuge Purpose/Service Trust Resources
- Delaware Natural Heritage Program Data
- Delaware Wildlife Action Plan (DWAP)
- Botanical and Zoological survey data plus NVCS habitat data to map existing elements of biological integrity, diversity and environmental health on PHNWR

Second, we cataloged existing elements of biological integrity, diversity and environmental health for each habitat type on PHNWR in tabular form (CCP-Appendix E, Tables 1 – 4). These tables also identified and listed specific habitat attributes and characteristics, described the natural processes responsible for these habitat conditions, and their respective limiting factors.

Consultation and coordination with state and other conservation professionals played an important role in the prioritization process. In collaboration with Bombay Hook NWR, Service Region 5 Biologists and Managers, cross-programmatic expertise from the Delaware Bay Estuary Program Office, State wildlife biologists, State of Delaware botanical and zoological experts, and a state community ecologist, were all participants in several collaborative meetings to narrow down the potential ROCS list and prioritize Refuge habitats, using all of the researched and compiled information described in ROCS handbook plus information from the DWAP.

To guide us in prioritizing this list, we considered the following concepts:

- Achieving Refuge purposes, and managing for trust resources as well as biological diversity, integrity, and environmental health can be addressed through the habitat requirements of "focal species" or species that may represent guilds that are highly associated with important attributes or conditions within habitat types. The use of focal species is particularly valuable when addressing USFWS trust resources such as migratory birds.
- The Bird Conservation Region (BCR) plans are increasing their effectiveness at ranking and prioritizing those migratory birds most in need of management or conservation focus. Although all species that make it to a ranked BCR priority list are in need of conservation attention, we selected focal species that were ranked High or Moderate in Continental concern with a High to Moderate

BCR Responsibility. If there were too many or too few birds with these rankings for a given habitat type then species with the highest then high then medium final BCR ranking were chosen. (See www.abcbirds.org/nabci for BCR rules used to rank birds.)

- Habitat conditions on or surrounding the Refuge may limit the Refuge's capability to support or manage for a potential species of concern. The following site-specific factors were evaluated:
  - Patch size requirements
  - Habitat connectivity
  - Compatibility of surrounding land uses
  - Environmental conditions: soils, hydrology, disturbance patterns, contaminants, predation, invasive species
  - Specific life history needs
- The likelihood that a potential species of concern would have a positive reaction to management strategies.

The next step required linking selected priority ROCS to habitats and then prioritizing mapped NVCS habitat types for habitat management. We did this by linking priority species to their habitat structural requirement needs. The refuge focused immediate management attention to the most important umbrella species that will also benefit a larger number of priority resources of concern species. Lower priority habitats were designated, which benefit fewer species or require less active management. Simplistically, this led to defining two habitat categories as either Priority I Habitats or Priority II Habitat (See CCP Appendix E – Table 5).

The Refuge's Priority I habitats: 1) can be managed to provide the greatest conservation benefit to priority ROCS; 2) offer the greatest contribution to maintenance and restoration of BIDEH; 3) represents important ecological and ecosystem processes not well represented within state and regional landscapes; and, 4) in their current condition or as a result of other environmental factors suggests an urgent need for active management.

Priority II habitats are still important, providing value to a wide range of migratory birds and resident wildlife and contributing to the overall biodiversity at the Refuge scale. However they require less active management or are too limited in extent to make a meaningful difference on a larger landscape level. A summary of Refuge priority species and associated habitat types is in Table 10 below:

Table 10. Priority Habitats for Prime Hook NWR and Associated Priority Focal Species

Priority I Habitats	Associated Priority Focal Species
Barriers Beach Island Habitats • Overwash Areas • Beach/Panicgrass Dune Grassland • Atlantic Coast Interdune Swale • Maritime Red Cedar Woodland	American Oystercatcher, Sanderling, Whimbrel, Migratory Shorebirds, Beach Dune Tiger Beetle, Little Wife Underwing;
Salt Marsh Habitats • Spartina High Salt Marsh • Spartina Low Salt Marsh • Salt Panne	Black Rail, Clapper Rail, Least Tern, Gull-billed Tern, Black Skimmer, Willet, Saltmarsh Sharp-tailed Sparrow, Seaside Sparrow, Coastal Plain Swamp Sparrow, Henslow Sparrow, American Black Duck.
Impounded Wetland Habitats • Emergent Freshwater & Brackish Marsh • Coastal Plain Depressional Ponds • Twig-Rush Peat Mat Bog • Button-Bush Coastal Plain Pond	American Black Duck, Northern Pintail, migrating Dabbing ducks, Snow goose, Canada goose, Virginia Rail, Forster's Tern, Least Bittern, American Bittern, Short-billed Dowitcher, American Avocet, Greater/ Lesser Yellowlegs, Alewife, Blue-backed Herring, American Eel, Hickory and American Shad, Striped Bass, American Eel, Rare Peat Bog Plants, Rare Obligate Amphibians;

Priority I Habitats	Associated Priority Focal Species
Upland Forested Habitats • Southern Red Oak/Heath Forest • Mesic Coastal Plain Oak Forest • Coastal Plain Loblolly Pine Forest • Mesic Coastal Plain Mixed Hardwood Forest • Pond Pine Woodland • Mesic Coastal Plain Rich Forest	Delmarva Fox Squirrel, Bald Eagle, Black and White Warbler, Wood Thrush, Scarlet Tanager, Yellow-Throated Vireo, Kentucky Warbler, Great-crested Flycatcher, Northern Flicker, Whip-poor-will, Bay-breasted Warbler, and other breeding and migrating landbirds;
Forested Wetland Habitats • Red Maple/Seaside Alder Swamp • Atlantic White Cedar/Seaside Alder Saturated Forest • Swamp Cottonwood Coastal Plain Pond	Acadian Flycatcher, Prothonotary Warbler, Yellow-throated Vireo, Delmarva Fox Squirrel, Migratory landbirds.
Early Successional Upland Habitats • Early Successional Forested areas • Scrub/Shrub Habitats • Herbaceous, Farmed Areas	Prairie Warbler, Brown Thrasher, Whip-poor-will, Willow Flycatcher, Western Towhee, Field Sparrow, Northern Bobwhite, Henslow's Sparrow, Coastal Plain Swamp Sparrow, Maritime Sunflower Borer Moth, Migratory landbirds and waterfowl.

3.4 Habitat Requirements for Priority Resources of Concern

Species-habitat relationships of priority resources of concern were researched, listed, and described in Table 6 of CCP Appendix E. These relationships are central to understanding the precise habitat structure and habitat management strategies that are required to conserve target ROCS. Species-specific structural habitat requirements provided the framework to develop habitat objectives to conserve and support all of the focal priority wildlife species on the refuge for the next 15 years. Improved wildlife population monitoring conducted to implement the refuge's new Inventory and Monitoring Plan (IMP) will provide subsequent evaluation of various planned habitat management strategies and prescriptions to meet focal species life history requirements.

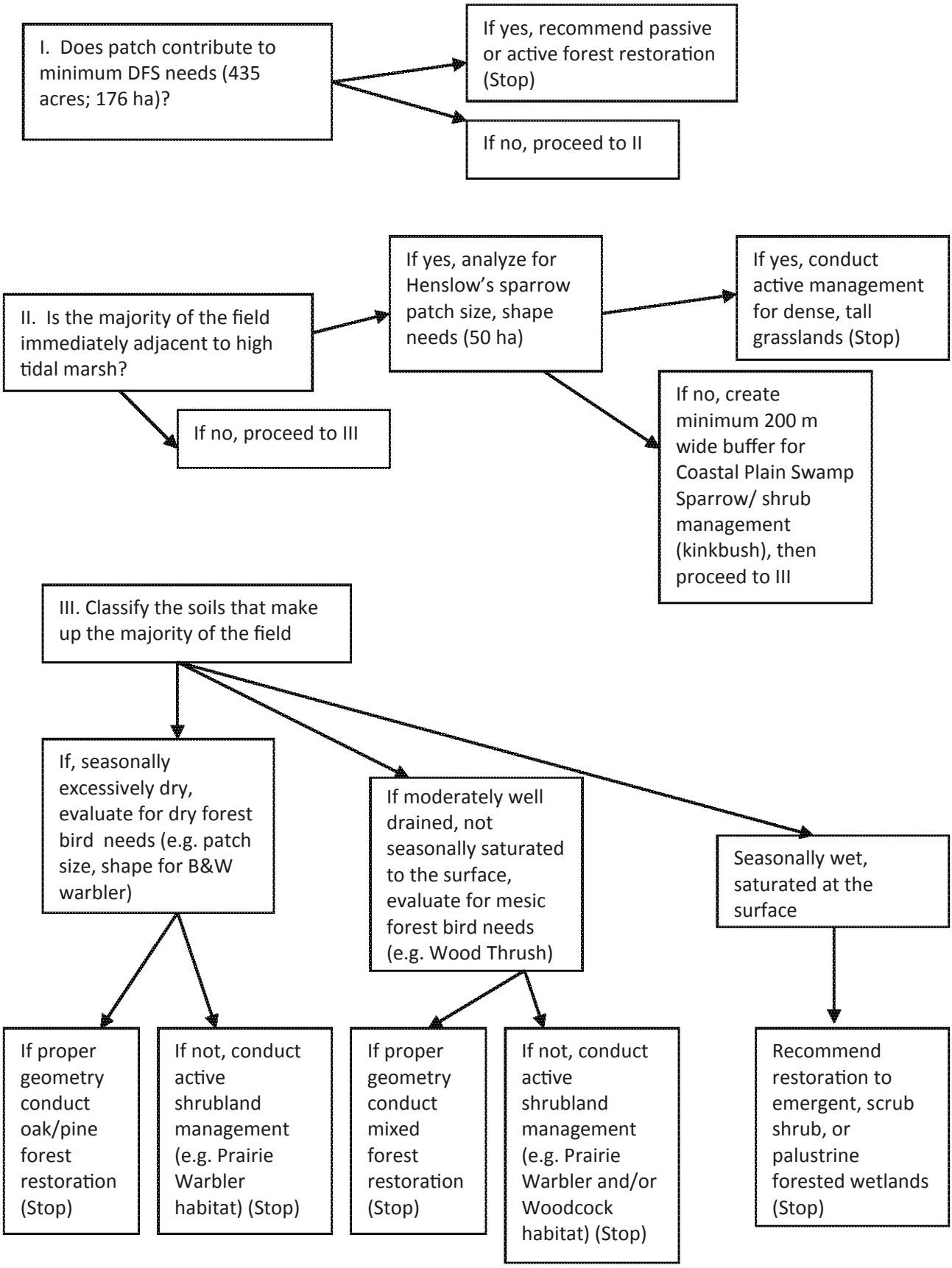
3.5 Conflicting Habitat Needs

Given the diversity of goals, purposes, and mandates for the NWRS, it is not uncommon to have conflicts over management priorities on a Refuge. Balancing the types and proportions of habitat conditions on the Refuge requires a thoughtful and documented process for determining the best course of action. Prime Hook NWR is taking a deliberate, transparent approach to resolving at habitat management conflicts associated with the HMP:

Open Fields versus Upland Forest Restoration

We utilized a habitat management decision process to guide where on the refuge we could best meet certain upland (primarily) objectives outlined in the HMP (Figure 1). This process incorporated the best available landscape and vegetation map data, soil type data, and literature on habitat requirements of identified priority species. Open fields were evaluated on the basis of the site capability (e.g., soil drainage) and potential contribution to the existing landscape context. This process is documented in greater detail in Appendix B [Not Yet Developed] of this HMP. The following flowchart summarizes how habitat management decisions were generally made. Deviations from the flowchart recommendations could occur at the discretion of refuge management.

Figure 1. Open Field Habitat Management Decision Flowchart



Mosquito Management in Salt Marshes
The Delaware Mosquito Control Section, under Service permits, has controlled mosquitoes on the refuge since its establishment in 1963. We have been working with our State partners to reduce the quantity of insecticides used on Refuge lands and ensure activities are consistent with the Service's policies. Mosquito management is a complicated issue for the Refuge. PHNWR is adjacent to residential beach communities where nuisance issues are amplified. A conflict of interests arises between nuisance complaints, managing refuge habitats for migratory birds, and maintaining and enhancing biological integrity, diversity, and environmental health within the refuge.

Although the refuge does not regard mosquito control, in and of itself, to be a salt marsh habitat management objective, the control of mosquitoes is a State priority and a reality of management of salt marshes in the State of Delaware. There have been three techniques employed to control mosquito populations on the Refuge within salt marsh habitats: use of the chemical adulticide, naled, source reduction using the chemical larvicides, Bti and Methoprene, and a biological control facilitated by open marsh water management (OMWM). These control methods are described in more detail in both the CCP, under Objective 1.3, and in HMP Appendix A.

Impoundment Management and Salt Marsh Restoration
As described briefly in Section 2.5 on Climate Change and Sea Level Rise, and in more detail in the Draft CCP (Under Objective 3.1 in Alternative B), the refuge faces considerable challenges and uncertainties regarding impoundment management. A Structured Decision Making (SDM) process is in development, cooperatively with other coastal refuges facing similar challenges. However, in the case of Unit II at Prime Hook NWR, changes are occurring presently and without an easy remedy. In the short-term, the refuge will likely have little choice but to restore Unit II to salt marsh, and this is outlined in Objective 3.1 below. Indeed, such restoration will have many biological benefits. However, there will also be trade-offs, as the freshwater impoundments do serve as valuable concentrated food sources for migrating and wintering waterfowl. The management fate for Unit III, in the long term, will be evaluated through the SDM process. Although both managed freshwater impoundments and salt marsh wetlands are valuable to wildlife, and even many species can and will utilize both habitat types, they cannot exist in the same place. Thus, this presents a conflicting habitat needs challenge that is actively being explored, even as the planning process proceeds.

3.6 Adaptive Management

The priority resources of concern and their respective habitat attributes were used to develop specific achievable habitat objectives. Many factors, such as the lack of resources, existing habitat conditions, species response to habitat manipulations, climatic changes, contaminants or invasive species, may reduce or eliminate the ability of the Refuge to achieve objectives. Although these limiting factors were considered during the development of management objectives, conditions are likely to change over the next 15 years and beyond. The Refuge will use adaptive management to respond to changing conditions that impair our ability to measure and achieve the habitat objectives. That will require the Refuge to establish and maintain a monitoring program to ensure that changing conditions can be detected and responded to adequately and efficiently. The monitoring program will be developed in accordance with 701 FW 2 as a step down plan.

Chapter 4. Habitat Management Vision, Goals, Objectives and Habitat Management Strategies and Prescriptions

This chapter outlines the Habitat Management Vision, as well as Goals and Objectives which are also associated with the refuge CCP. Strategies for each objective are provided as well. A detailed summary of all potential management strategies is provided in Appendix A of this Habitat Management Plan. Management prescriptions for open upland fields are summarized at the end of this chapter, because they span multiple management units and fulfill multiple management objectives.

Habitat Management Vision Statement: *We will conserve, restore, and enhance the biological diversity and ecological integrity of the Refuge's native plants and wildlife in wetland and upland habitats found within the Delmarva Coastal Plain Ecosystem.*

4.1 GOAL 1. (Barrier Beach Island and Coastal Salt Marsh Communities)

Manage, enhance and protect the dynamic barrier beach island ecosystem for migratory birds, breeding shorebirds and other marine fauna and flora. Perpetuate the biological integrity, diversity and environmental health of North Atlantic high and low salt marsh communities.

Objective 1.1 (Barrier Beach Communities: Overwash, Sandy Beach and Mudflat)

Maintain and monitor the dynamic nature and natural functioning of 1.5 miles of sandy beach, overwash dune-grassland and mudflat in Unit I parallel to the salt marsh management unit. Over time, permit the development of an additional approximately 1.5 miles of these features and communities along the shore of Unit II, as salt marsh restoration is pursued. These areas provide spawning habitat for horseshoe crabs, and nesting, foraging, and staging habitats for breeding (e.g., American oystercatcher, piping plover, least and common tern) and migrating shorebirds (e.g., red knot, sanderling, whimbrel) and other species of greatest conservation concern during critical periods (mid-March through mid-November). Barrier beach communities are characterized by the following attributes:

- Plant species typical of overwash grasslands include a mixture of Cakile eduntula, Spartina patens, Schoenoplectus pungens, Cenchrus tribuloides, Triplasis purpurea, and scattered Baccharis halimifolia seedlings.
- Diagnostic dune grassland species consist of a mixture of Ammophila breviligulata, Solidago sempervirens, Panicum amarum, and Opuntia humifusa.

In years when piping plovers, American oystercatchers, and/or least and common terns do nest, maintain suitable nesting habitat through beach closures, predator management, and public education to achieve minimum productivity rates, as defined within current recovery or management plans. Proposed productivity targets are as follows:

- 1.5 piping plover chicks per nesting pair on average over a five year period
- 0.35 American oystercatcher chicks per nesting pair
- 1 least/common tern chick per nesting pair

Rationale

Barrier beach island and coastal salt marsh habitats are priority conservation habitat-types within the Delaware Bay and the mid-Atlantic coastal region. Remaining undeveloped coastal saltwater wetlands in Delaware support the greatest diversity of species of conservation concern, while beach overwash

and dunes provide habitats for some of the state's and region's most critically rare and threatened species. Saltwater marsh and sandy overwash beach habitats also support a shorebird migration that has worldwide ecological significance.

Despite the heavy loss of habitat, Delaware Bay remains one of the country's most important migratory "stopovers" for hundreds of bird species (USFWS-Shore Technical Committee 2003).All remaining beach dune and overwash habitat patches are considered critical habitats regardless of size. These habitats are the most representative of the region, and should receive priority conservation protection on the Refuge, especially during the critical breeding and migration periods for highest priority shorebird species identified in BCR 30, BCC 2008, and bird and insect species identified in the DWAP (DNREC 2005).

On the Refuge, Barrier Beach Island habitats are comprised of five natural community types:

- Overwash Dunes
- Beachgrass/Panicgrass Dune Grassland
- Atlantic Coastal Interdune Swale
- Maritime Red Cedar Woodland
- Successional Maritime Forest

These highly dynamic habitats are closely related to the natural ecological processes of estuarine tidal creek shrubland, Spartina low and high salt marsh communities. Processes creating all of these habitat-types include tidal salt water flows and eolian actions that contribute to active sand deposition and/or erosion. Natural ecological processes responsible for shifting mosaics of sandy beach, mudflats and inland salt marsh habitat migrations have been impeded and/or altered by human activities within the state landscape.

Overwash dune communities of the mid-Atlantic are globally ranked as rare, and restricted to bayshore areas of Delaware, Maryland, Virginia, and some coastal areas of North Carolina. Dune-grassland communities are also rare, extending from Long Island to North Carolina. Less than 3,000 acres are currently undeveloped, and little of this acreage is protected (PHNWR NatureServe Report 2006). Comparing extent of Habitat Gap Class of Sparsely Vegetated and Unconsolidated shoreline on Refuge to State Habitat Gap Analysis Maps, it can be seen that although this coverage accounted for less than 0.4% of Refuge habitat-types, it accounts for 40% of the total coverage that is still left remaining in today's Delaware landscape.

Natural dynamic forces (e.g., tides, wind, and storms) are responsible for structuring overwash communities and creating shifting dune mosaics and contribute to these increasingly rare and threatened communities on the state landscape. These beach, dune grassland, and overwash communities are considered to be ephemeral components of a highly dynamic ecosystem, being buried over time by sand deposition and formed anew as other areas are subjected to overwash.

Importance to Priority Species and Species of Greatest Conservation Concern
Storm-maintained ecosystems are critical for the highest priority shorebird species identified in BCR 30 during breeding and migration periods, USFWS-Birds of Conservation Concern (2008) plus pollinator species, birds and rare insect species of greatest conservation need identified in Delaware's Wildlife Action Plan (2005). Maintaining natural coastal formation processes provides high quality breeding habitats critical for American oystercatchers, least terns, common terns, piping plovers, black skimmers, beach dune tiger beetles, and seabeach amaranth, which are all dependent on habitats maintained by coastal storms.

A dune system with overwash and ephemeral inlets, identified as a Key Wildlife Habitat of special conservation concern in the DEWAP and BCR 30 plan, is found from the northernmost private residence on Prime Hook Beach, north to Slaughter Beach. Beach heather (Hudsonia tomentosa), beach plum (Prunus maritima) and dune panicgrass (Panicum amarum) are interspersed with several overwash habitats along Unit I and Unit II. In 2006, Hurricane Ernesto plus several other Nor'easter storms of 2007 and 2008 expanded the overwash habitats, flattened most dune areas, and increased tidal flows in the salt marsh. This has increased habitat availability for shorebirds by providing greater amounts of invertebrate and fish food resources flowing in daily from the Delaware Bay for easier exploitation by nesting and migrating birds. Refuge sandy beach and overwash dune grassland habitats have recorded greater use by spring and fall migrating shorebirds since 2006. There has been an increase in nesting attempts by American oystercatcher, least terns, and common terns. Furthermore, observations of piping plovers staging on the Refuge, and spilling over from State -protected breeding piping plover beaches, suggest that refuge barrier beach island habitats could potentially host State and Federally endangered nesting shorebird species in the near future.

Immediately parallel to the Delaware Bay, Unit I habitats have increasingly become more important for both migrating and breeding shorebirds in the face of beach development along bay shore areas. The highest quality dunes remaining along the Delaware Bay shore occur from Big Stone Beach south to Beach Plum Island (Clancy et al. 1997) and have been identified as a Key Wildlife Habitat of special conservation concern in the DEWAP and the BCR 30 plan. Strand beach habitats along Unit I are migrating landward as a result of storm surges and sea level rise. Storms and high tides deposit wrack composed of algae, vascular plant fragments, and assorted mollusk shells, abundant casings of whelks and remnants of clams, crab, and fish. This rich, organic debris provides important feeding and breeding sites for a variety of invertebrates. Coupled with spawning sites for horseshoe crabs, wrack lines provide nutritious and plentiful natural food resources for migrating birds all year long and for nesting birds in the spring and summer.

The Refuge's natural barrier beach island habitats and associated species are also threatened by a number of human disturbances and activities such as the development of homes and cottages, artificial dune stabilization and replenishment, pedestrian activity, dogs running at large, and other public uses (Harrington and Drilling 1996; Pfister et al. 1992, 2008). According to Harrington (2003), human disturbance at non-breeding areas affect shorebirds by leading to reduced forage time, increased daily energy expenditure from increased numbers of flush flights (take-offs), loss of time for preening and resting, and decreased habitat availability due to chronic human disturbance. In addition, disturbance has been found to significantly lower body weights of shorebirds returning to Arctic breeding grounds (Harrington 2003, Pfister et al. 2008). This reduces the likelihood that birds will successfully complete their long-distance migrations and increases the possibility that they will arrive in poor condition on their breeding grounds. Pfister et al (2008) found reduced survivorship of sandpipers that do not achieve threshold weights at migration stopover sites. Shorebird research data strongly support the assertion that proactive management of public use and control of human-related trespass on critical habitats for both migrating and breeding shorebirds are the most effective management actions to benefit shorebirds, especially along coastal migration routes.

The Importance of Detecting Changes in Shorelines

A major issue for the conservation, management, and vulnerability assessment of all refuge coastal wetland habitats in the face of climate change and sea level rise is the magnitude and rate of shoreline change in coming years. Coastal geomorphological changes and shoreline condition will be a direct consequence of sea-level rise inundation (CCSP-2009). Elements of monitoring coastal shoreline position provide coastal managers more detailed knowledge of the hydrodynamic forcing of sediment mobilization, transport, deposition, and measurements of morphologic change and ecosystem response. Compared to other geomorphological processes and responses, shoreline position is a highly valued

metric with high data value as it can be measured effectively (Psuty et al 2010) and used to address refuge shoreline management issues.

In an effort to address seasonal and long-term changes in shoreline position, the National Park Service (NPS), in collaboration with geomorphologists, coastal and climate scientists, and other partners, has developed a Vital Signs Coastal Monitoring Program - Shoreline Position Monitoring Protocol. Prime Hook NWR, in coordination with NPS and other USFWS Region 5 coastal refuges, will begin recording changes in shoreline position in Spring 2011.

Collecting a record of the changes on the shoreline position in Units I and II over time, will chronicle variation in sediment supply, distribution, and will also function as a surrogate for sediment budget. Seasonal and annual shoreline monitoring will provide knowledge of the spatial and temporal variation in sediment transfers and sediment budget influences and will create a fundamental database for use in refuge sandy beach and marsh habitat management decisions. Decisions will derive from annual shoreline change metrics and marsh surface elevation data to assess wetland habitat vulnerability and resiliency to climate change and sea-level rise on an annual basis. Sediment and marsh surface elevation data will provide critical information to gauge and adjust annual habitat management decisions to changing climatic conditions and accelerating sea-level rise rates in annual habitat work plans.

Climate Change and Sea Level Rise Adaptation

The shoreline on the western side of the Delaware Bay, which include coastal areas within the refuge boundary, are characterized as a lagoon-barrier-marsh shoreline (Kraft 1976c). These shoreline areas occupy a low-lying coastal plain and are part of a larger geological structure known as the Atlantic coastal plain continental geosyncline. Delaware shorelines of both the Atlantic Ocean and Delaware Bay are migrating rapidly in geologic time in a landward direction (Kraft 1976b). This is caused by several geological processes:

- The continental shelf and coastal plain are known to be experiencing deep subsidence
- Local, apparent sea level rise
- Erosion and redistribution of sediments as shorelines shift in a landward and upward direction

Inlet formation acts as a safety valve mechanism by adjusting and shifting in size and location in response to each storm event or higher than normal tide cycles. The dynamic nature of inlets means that a stable, deep channel is rarely maintained naturally and inlets are filled after they are formed. Barrier island shorelines are dependent upon storm overwash formations to build shoreline elevation and width, and both inlet and overwash developments are critical processes, allowing these sandy beach ecosystems to keep pace with sea level rise. Overwash events also provide sediment inputs, helping coastal wetlands accumulate material reserves – or "elevation capital" – which increase the marsh elevation and may buffer these systems from rising sea levels (Cahoon and Guntenspergen 2010, Kraft 1976a; Drew 1981; Riggs and Amers 2007; Defeo et al. 2009).

Even non-storm, tidal surges can produce waves that overtop beach berms on the Delaware Bay shoreline and result in overwash fans on the marsh side of the shoreline. Through time, overwash events bury the marshes and associated peat deposits and/or fill in old inlet channels or create new ones. For example, during the last 47 years, numerous mini-inlets, various depositional overwash fans and shoreline recessions have occurred on the refuge. These natural processes are driven by hurricanes and Nor'easters and are all crucial and integral elements for both short-term and long-term evolution of healthy shoreline habitats (Kraft et al. 1975; Kraft 1976a; Drew 1981; Defeo et al. 2009; Pilkey and Young 2009). Shoreline transgression assists wetlands behind shorelines to accrete sediments and keep up with sea level rise and restores tidal flows that enhance salt marsh habitat and water quality (Cahoon et al.

2010). The ability of salt marshes to build upward and migrate landward with their associated shorelines has been a natural response to sea level rise for thousands of years.

The geological, ecological, and biological significance of overwash and natural sandy beach communities has been described by various scientists and summarized by Maurmeyer (1978) and others (Defeo et al. 2009; McLachland and Brown 2006). There are several benefits of these natural systems. The net effect of overwash processes is the maintenance of a fairly constant shoreline width. Barrier beach island habitats are raised naturally over time, providing resilience to sea level rise. Healthy salt marsh plant communities develop quickly on recently developed overwash fans. Rapid growth of salt marsh grasses act to dissipate wave energy, hold sand in place, and trap more sand to eventually develop a natural sand berm. Natural overwash, intertidal areas, and shorelines support diverse and rich biological resources that are exchanged between open water, the intertidal zone, and the back-barrier marshes, such as unique bacteria, protozoans, microalgae, meiofauna, and macroinvertebrates. These resources, in turn, form food webs that support birds and other wildlife species (McLachlan and Brown 2006, Defeo et al. 2009).

A major issue for the conservation, management, and vulnerability assessment of all refuge coastal wetland habitats in the face of climate change and sea level rise, is the magnitude and rate of shoreline change in coming years. Coastal geomorphological changes and shoreline condition will be a direct consequence of sea-level rise inundation (CCSP-2009). Monitoring coastal shoreline position provides coastal managers with more detailed knowledge of sediment mobilization, transport, deposition, and measurements of morphologic changes and ecosystem response. Compared to other geomorphological processes, shoreline position is highly valued information with high data value as it can be used to address refuge shoreline management issues (Psuty et al. 2010).

From a scientific perspective, shoreline position represents the morphological response of wave, current, tide, and other physical processes acting on sediment supply (Short 1999). Understanding the dynamics of changes in shoreline position over time, in a systematic manner and through standardized data collection, will provide a scientific basis for informed sediment resource management. The assemblage of reliable and consistent data enables robust statistical analysis, and yielding a better grasp of local sediment budget cycles, trends, and storm episode influences (Psuty et al. 2010). Collecting a record of the changes on the shoreline position over time, will monitor variation in sediment supply and distribution, and can also function as a surrogate for sediment budget. The determination of shoreline position twice a year, in the early spring (fully developed winter beach), and in the early fall (fully developed summer beach) will lead to the acquisition of a time series of seasonal shoreline positions that represent the annual maximum and minimum configurations of the beach. Each annual pair of shoreline position data, will document the variation caused by changes in the seasonal wave patterns on the beach sediment supply (Psuty et al. 2010).

Refuge shoreline habitats include areas of wide coastal marshes separated from Delaware Bay by a continuous, relatively narrow, sandy coastal barrier. This zone starts at Bowers Beach and continues southward to the Great Marsh in Lewes, and is one in which the longshore transport (parallel to the shoreline) of sand and mud sediments is fairly continuous. In this zone, a broad wave fetch which results in wave action and longshore drift systems help maintain continuous barrier-beach habitats between broad coastal marshes and the Delaware Bay. Within a tidal regime and frequent storm setting, sand is normally washed across barrier beach island habitats into marsh areas. However, these barrier beach island segments of Delaware Bay have a relatively limited supply of sand, resulting in narrow and shallow shorelines (sand sediment is rarely any deeper than 5 feet and no more than several hundred feet wide), dominated by inlet and overwash processes (Kraft 1976c).

Objective 1.2 Maritime Shrub and Maritime Forested Habitats

Over the next 15 years, maintain and protect unique and uncommon maritime shrub and forested habitats which include 67 acres of Atlantic Coast Interdune Swale, 76 acres of Maritime Red Cedar, and 184 acres of Successional Maritime Forest communities for migrating passerines and other maritime shrub and forest-dependent species.

Manage these habitats especially for short and long distance migrating songbirds, breeding birds, and rare flora and fauna dependent on maritime shrub-forest ecosystems. Conserve insect species (butterflies, skippers, moths, etc.) associated with these habitats include the following state ranked (S-1) species found on the refuge:

- Little Wife Underwing Moth – *Catocala muliercula*
- Southern Broken Dash – *Wallengrenia otho*
- Delaware Skipper – *Anatrytone logan*
- Little Glasswing – *Pompeius verna*
- Graphic Moth – *Drasteria graphica*

Rationale

Atlantic Coast Interdune Swale, mid-Atlantic Maritime Red Cedar and Successional Maritime Forested habitats are underrepresented within Delaware's landscape of natural communities and regionally at the mid-Atlantic coastal plain level. These habitat types found on the Refuge range from unvegetated pools and interdune swales to grass or forb-dominated and/or shrub dominated communities to red cedar woodlands and maritime shrub-forested areas.

Interdune swales are low depressions that form behind primary and secondary dunes where the water table intersects the soil surface for part or all of the growing season. This community may also receive salt spray from the Delaware Bay and is characterized by moderately open to dense stands of southern bayberry *(Morella cerifera)* and interspersed with wild black cherry *(Prunus serotina)* and sweetgum *(Liquidambar styraciflua)* (NatureServe-2006).

The herbaceous layer consists of switch grass *(Panicum virgatum)*, salt grass *(Distichlis spicata)* and smooth rush *(Juncus effusus)*. The community is found scattered on high points around marsh habitats in Units II, III, and IV. Maritime Red Cedar Woodland habitats are found in some Unit III sandy substrate areas, in Unit II on "Negro Island," where a 49 inch diameter willow oak *(Quercus phellos)* was measured, and Unit IV, which has the largest area.

Shrub layers include northern bayberry *(Morella pensylvanica)*, southern bayberry *(M. cerifera)*, salt shrub *(Baccharis halimifolia)*, marsh elder *(Iva frutescens)*, and highbush blue berry *(Vaccinium corymbosum)*. The Unit IV Red Cedar community is found adjacent to the dunes along the Delaware Bay and according to the Delaware Natural Heritage Program (DNHP) is the "best remaining examples in Delaware and maybe the East Coast" (McAvoy et al 2007).

The Little Wife Underwing Moth *(Catocala muliercula)* was not an expected resident at the Refuge and is a State Record species. The individual collected on July 29, 2004 represents the first specimen collected in the state of Delaware. Furthermore, this species has not turned up in other large collections of the *Catocala* of the Delmarva Peninsula. The DNHP considers this species as warranting special conservation attention by the Refuge. This moth's host plant is southern bayberry which is somewhat common on the Refuge but is very uncommon state-wide (McAvoy et al 2007).

The rare graphic moth *(Drasteria graphica)* feeds on beach heather *(Hudsonia tomentosa)*. Several adults were secured in the Maritime Red Cedar Woodland habitats of Unit IV, where beach heather was found. But since beach heather is patchily distributed, the DNHP suggests the graphic moth warrants consideration as a conservation target to protect its core population (McAvoy et al 2007).

Generally, the plant diversity is low due to stressful conditions, where the soils are hot, sandy and nutrient poor but this community does support the Delaware rare plant, golden heather (*H. ericoides)*, ranked S-1, as state botanists claim the Refuge's population represents only one of two known in Delaware (McAvoy et al 2007). Prior to its discovery in 2005, golden-heather was known on the Delmarva Peninsula only from Cape Henlopen State Park. This plant grows at the edge of openings bordered by red cedars, where it prefers sun with just enough shade supplied by the cedars.

Other species found in the Maritime Red Cedar community of Unit IV included several rare (S-1) butterfly species which included the Southern Broken Dash (*Wallengrenia otho)*, whose larval host plants consist of *Panicum* grasses and *Paspalum* species*;* Little Glassy Wing *(Pompeius verna),* whose larval host plants also include various grasses, especially "purpletop" *(Tridens flavus)*; and the Delaware Skipper *(Anatrytone logan).* The Skipper's host plants include big bluestem *(Andropogon sp.)*, wooly beard grass *(Eriantus divaricatus)*, and switchgrass *(Panicum virgatum & P. amarum).* The presence of any of these individual invertebrate species or collectively as a focal group can be used as indicators of environmental health of a mature and unique Maritime Red Cedar ecosystem.

The Refuge Maritime Red Cedar community is recognized status as an exemplary natural community of biological diversity in the state (McAvoy et al 2007). In addition, NatureServe has ranked it as globally rare (G2), in its habitat analysis report of Prime Hook's NVCS alliance and association descriptions. This conservation ranking was based on the following reasons: *"This maritime woodland community is naturally restricted to major coastal dune systems. An estimated maximum of 30 occurrences exist, ranging in size from less than an acre up to a maximum of 100, with an average size of 10 acres. The habitat is threatened by many of the same threats common to coastal dune systems: dune stabilization, commercial and residential development."* (PHNWR NatureServe Report 2006)

Widespread population decline in many migratory songbird species is one of the most critical issues in avian conservation. Studies have shown the critical role that barrier beach island shrub and maritime forested communities play for migratory passerines during the fall migration, which is second in importance only to the spring shorebird migration (McCann-1993; Clancy et al 1997).

The McCann study demonstrated that often these habitats support over twice as many migratory landbirds than adjacent mainland forested habitats. This is attributed to the fact that birds migrating long distances first reach landfall on barrier beach island habitats. These areas are also the last stop-over place where migratory passerines congregate to forage in dense mid-Atlantic shrub and maritime forested habitats. The value of these habitats during migration is attributed to significant populations of invertebrates and the production of fruits and berries, which provide the energy the birds require before moving on to their wintering grounds.

Radar data collected from migrants departing from stopover coastal habitat sites on PHNWR and along the Delaware Bay also support the importance of maintaining and managing Maritime shrub and forested habitats in a healthy condition. High densities of migratory songbirds during fall migration events along the Atlantic Coast and Delmarva Peninsula have been attributed to two factors: 1) a higher proportion of hatching year birds, and 2) maritime shrub and forested habitats containing a significant abundance of energy rich food resources in the form of fruits, berries, and high densities of insects (Mizarhi 2006).

Objective 1.3 (North Atlantic Low and High Salt Marsh Habitats)

By 2020, enhance and restore the quality and natural function of 2,200 acres of salt marsh by 10%, as measured by Region 5's Salt Marsh Index of Ecological Integrity and consistent with local reference sites by maintaining a mix of North Atlantic high and low salt marsh vegetation comprised of less than 5% invasive species cover, and pool, panne, and irregularly flooded tidal salt shrub communities to provide breeding, migrating and wintering habitats for key species (e.g., seaside sparrow, salt marsh sharp-tailed sparrow, clapper rail, shorebirds, and waterfowl), and passage and rearing habitats for diadromous and prey fish species and marine invertebrates.

- Increase cover of native vegetation to greater than 95% by controlling the presence of invasive plant species. Native plant species found high salt marsh communities include: *Spartina patens*, *Distichlis spicata*, and *Juncus gerardii* with lower densities of *Aster tenuifolius*, *A. subulatus*, *Atriplex patula*, *Solidago sempervirens*, and *Panicum virgatum*. In low marsh communities, native plant species include *Spartina alterniflora* with lower densities or *Distichlis spicata*, *Salicornia maritime*, *Juncus gerardii*, and *Juncus roemerianus*.
- Special emphasis will be given to conserving and protecting small patches of remnant high salt marsh areas on the Refuge that are less common than low marsh communities.
- For breeding obligate passerines, maintain extensive stands of salt-meadow hay with scattered shrubs or clumps of black needle rush and salt grass.
- Develop up to 4,000 acres of additional salt marsh within the refuge impounded wetland complex through active wetland restoration efforts; these efforts will be guided by a restoration plan developed with assistance from state and federal coastal scientists and other subject matter experts (see Objective 3.1).

Rationale

Salt marshes in North America are among the most degraded of all habitats (Amezaga et al 2002). Within the mid-Atlantic region, a substantial number of salt marshes have been lost over the past 200 years. From 1950 to 1970 loss rates were extremely high due to urban and industrial development (Tiner 1984). Protective legislation helped to slow down the loss with the passage of the Wetlands Act in 1972, when Delaware was losing nearly 450 acres of salt marsh annually. After protective legislation, losses declined to just 20 acres per year (Hadisky & Klemas 1983). Other states in the region experienced similar trends.

Habitat analysis mapping for Delaware shows less than 7% of herbaceous wetland habitats remain on the landscape (Appendix A of the CCP) while salt marsh communities are listed as habitats of conservation concern in the DWAP (DNREC 2005). Tidal salt marshes are one of the most productive ecosystems and provide significant invertebrate and small fish trophic levels that support many bird communities throughout the year. Patches of low marsh are abundant in the state and Refuge landscapes, but high marsh is very uncommon and spatially restricted on the Refuge (less than 85 acres of high marsh compared to 1,756 acres of low marsh (McAvoy et al 2007).

BCR 30 and PIF 44 plans listed eight species with high conservation concern scores dependent on salt marsh habitats. Priority species using the low marsh include Seaside Sparrow and Clapper Rail, and priority species using the high marsh include salt marsh sharp-tailed Sparrow, Black Rail, Prairie Warbler, Henslow's Sparrow, American Black Duck, Willet and Sedge Wren. Species that require high-marsh habitats are the most threatened marsh-nesting species within the region, state, and locally on the Refuge. Within the mid-Atlantic Coastal Plain, all the high marsh species listed breed within extensive stands of salt-meadow hay with scattered shrubs or clumps of black needle rush and salt grass.

Mosquito Management in Salt Marshes
The Delaware Mosquito Control Section, under Service permits, has controlled mosquitoes on the refuge since its establishment in 1963. We have been working with our State partners to reduce the quantity of insecticides used on Refuge lands and ensure activities are consistent with the Service's policies. Mosquito management is a complicated issue for the Refuge. PHNWR is adjacent to residential beach communities where nuisance issues are amplified. A conflict of interests arises between nuisance complaints, managing refuge habitats for migratory birds, and maintaining and enhancing biological integrity, diversity, and environmental health within the refuge.

Although the refuge does not regard mosquito control, in and of itself, to be a salt marsh habitat management objective, the control of mosquitoes is a State priority and a reality of management of salt marshes in the State of Delaware. There have been three techniques employed to control mosquito populations on the Refuge within salt marsh habitats: use of the chemical adulticide, naled, source reduction using the chemical larvicides, Bti and Methoprene, and a biological control facilitated by open marsh water management (OMWM). These techniques are described in more detail in Appendix A, and discussed under Section 3.5 on Conflicting Habitat Needs.

Climate Change and Sea Level Rise Adaptation
Delaware Bay-wide average salt marsh accretion rates have been estimated to range from 3.0-5.0 mm/yr (Kraft et al. 1989 in Fletcher et al. 1990). The dominant accretionary processes vary according to geomorphic settings. Peat accumulation is important to all wetlands in the Delaware Bay. Vertical accretion driven by peat accumulation is expected to increase in the future in response to sea level rise (Reed et al. 2008). However, salt marshes may only accrete up to a certain threshold rate set by natural processes. The rate of SLR may ultimately exceed and overwhelm the rate of marsh accretion, resulting in stress and potential loss of existing marshes. .

DNREC's Coastal Program is conducting a coastal impoundment accretion rate study. The State has collected baseline data on the sedimentation rates over the last 50 and 100 years in impounded and natural wetlands, by analyzing the presence of radioisotopes (210Pb and 137Cs) in sediment cores. This data can be utilized to evaluate a wetland's ability to achieve optimal habitat benefit under different management strategies and sea level rise scenarios. Correlating long-term wetland sedimentation rates to current wetland elevation will enable a detailed analysis of the potential sedimentation deficits that exist within the impoundments, as compared to the reference wetlands. The elevation and sedimentation gradients between the reference and impounded wetlands can be used to calculate potential future elevation trajectories under different sea-level rise and management scenarios.

For this accretion rate study, monitoring sites were chosen within impounded and reference (natural marsh) sites throughout the State based upon a wetland area change analysis (using a time-series of available imagery), and basins that have been identified as needing detailed study to aid in their management to optimize the future available habitat. Sites studied include: marshes along the Delaware River near New Castle; Ted Harvey Wildlife Area; St. Augustine Wildlife Area; and Prime Hook National Wildlife Refuge.

The early results show that the refuge's salt marshes are keeping pace with sea level rise. Results ranged from 3.1 mm/year to 6.9/mm/year. So, it is imperative that the processes discussed in Objective 1.1 be allowed to proceed naturally.

For further discussion refer to the rationale under objective 1.1.

4.2 GOAL 2. (Forested Habitats)

Manage the biological diversity, integrity and environmental health of Refuge upland and wetland forested cover-types to sustain high quality habitats for migratory birds, increase quality habitat for the endangered Delmarva fox squirrel (DFS), forest interior breeding and wintering landbirds, reptiles, amphibians and other resident wildlife.

Forested Habitats Summary

We envision a composite long term forest management goal, which combines objectives 2.1, 2.2, and 2.3 and their associated strategies that reflect the desired future conditions of a refuge forest matrix complex. This forest matrix complex incorporates the existing upland and wetland forested acreage plus projected restored upland forest acreage, and management actions will be conducted on approximately 1679 acres in the next 15 years. Mechanical silviculture management will generally not occur in hydric soils with the exception of some coastal plain depression swamp areas. A summary of anticipated future forested habitats and management is outlined in Table 11.

Table 11. Future Refuge Forest Habitats

Future Refuge Forest Habitats envisioned in next 100 years and silvicultural management expected over the next 15 years on wetland and upland forest habitats		
Forest Habitat Cover-types	***Forested Acres with Projected Restored Acres***	***Silvicultural Management Expected over the Next 15 Years?***
Southern red oak/heath	295	Yes
Mesic coastal plain oak	193	Yes
Northern coastal plain basic mesic hardwood	35	Yes
Successional sweetgum	181	Yes
Mid-Atlantic mesic mixed hardwood	20	Yes
Red maple/seaside alder swamp	799	No
Atlantic white cedar/seaside alder swamp	10	Yes
Coastal plain depression swamp	355	A Portion (75 acres)
Coastal loblolly pine wetland	91	No
Buttonbush coastal plain swamp cottonwood	3	No
Restored mixed-hardwood-oak dominated areas	870	Yes
TOTAL ACRES	2,903	1,679

These desired future forest conditions include approximately 2,900 acres and minimally taking 100 years to develop, will encompass two core areas of restored mature, upland, mid-Atlantic coastal plain mixed hardwood forest with a high oak component; one core area surrounding red maple-seaside alder and Atlantic white cedar swamp with the second core area restored to upland forest surrounding depressional swamp habitats (See CCP Map 2-10).

Restoring additional upland forested habitats is essential to increase the refuge population size of Delmarva fox squirrels and provide larger forest tracts for breeding, area sensitive FIDS. Conserving forested wetland habitats will provide critical supplemental late winter and early spring feeding habitats for fox squirrels and provide important foraging and stopover habitats for migrating landbirds (Mizrahi et al 2006).

Objective 2.1 (Mixed Hardwood Forest Communities)

During the next 15 years, conserve and enhance existing forest cover-types to conserve forest interior dwelling birds (e.g., bald eagle, black-and-white warbler, wood thrush, scarlet tanager, whip-poor-will, yellow-throated vireo, and Kentucky warbler) and the Delmarva fox squirrel (DFS) using silvicultural prescriptions as needed. These cover types include southern red oak/heath, mesic coastal plain oak, Mid-Atlantic coastal loblolly pine, Northern coastal plain basic mesic hardwood, Mid-Atlantic mesic mixed hardwood, and successional sweetgum forest communities. Mixed Hardwood forest communities are characterized by the following attributes:

- Sustain and enhance mast producing trees (e.g., white and red oaks, hickories, walnuts) greater than 12 inch dbh to comprise at least 40% of the total canopy cover and with shrub canopy closure of less than 30%, providing suitable habitat structure for DFS;
- Mature canopy closure 80% or greater, with a multi-layered tree species profile and with canopy gaps to maximize annual mast production and ensure regeneration of shade tolerant tree species (e.g., oaks); and,
- Oak dominated mixed hardwood patch sizes of greater than 250 acres. Use the presence of long-horned beetle (*Pronius laticollis*) as in indicator species for patch size and environmental health of oak dominated mature forest stands.

Rationale

Ecosystem function of forested habitats in Delaware has steadily declined in the past four decades. The Delaware Nature Society determined that less than 3.5% of the state remained in "anything resembling its natural conditions". During the developmental boom of 1984-1992, most of Delaware's residual upland and wetland forested ecosystems became highly fragmented due to increasing development pressures for agriculture and urbanization (ELI-1999). Between 1984 and 1992, Delaware's human population grew by 14% but the percentage of developed land for urban and agricultural uses increased by 50%, incurring significant forested habitat fragmentation and/or losses (OSP-1998). Today, developmental pressures, especially urbanization, continue to accelerate and outpace state and local comprehensive planning efforts to protect natural areas in Sussex County (Broadkill River Watershed Assessment Report-2007).

A common consequence of the pattern and intensity of urban and agricultural development in Delaware has been the severe fragmentation of an originally connected forested landscape into an unhealthy and dysfunctional patchwork of isolated habitat patches (State-Wide Habitat Gap Analysis Map, CCP Appendix A). Extensive forest habitat loss and fragmentation provided the impetus for the state to designate upland forested blocks greater than 250 acres in size as Key Wildlife Habitats in its Wildlife Action Plan**.** Exotic species are also a concern. Of the 115 tree species found in Delaware, only 60 are native species. At the same time an estimated 273 of Delaware's wildlife species are characterized as forest-dependent species. While the Delaware Department of Agriculture's Forest Service owns and manages 9,000 acres, 81% of the state's remaining forested cover-type is in private ownership (ELI 1991; DNREC 2005).

It has been estimated that there are currently over 1600 vascular plant taxa native to Delaware. Despite this fact, Delaware has lost "the highest percentage of its native species than any other state within the United States". Key sources of loss of biological integrity, diversity, and environmental health in Delaware are the loss and fragmentation of upland forested and wetland habitats, habitat degradation, proliferation of exotic and invasive species, and serious water quality impairment (ELI-1999; DNREC-2005; Broadkill River Pollution Control Management Plan-2008).

The loss of upland habitats has taken a huge toll on migratory songbirds and forest interior breeding birds that require large contiguous blocks of forested habitat. These include black-and-white warbler, whip-poor-will, cerulean warbler, hooded warbler, and American redstart. Also the severe habitat fragmentation and loss has caused the extirpation of the Delmarva fox squirrel from Delaware (ELI 1999). Many of the songbirds that have experienced regional and state declines are those bird species that are area sensitive to forest fragmentation. The Delaware Natural Heritage Program estimated that 41% of Delaware's historically common forest-dependent birds have been extirpated or today are extremely rare. Declines are attributed to increased nest parasitism by edge species, increased rates of predation, and loss of quality nesting and wintering forested habitats (Heckscher 1997).

Creating and conserving larger patches of contiguous forested habitats are the best strategies to conserve and manage for area-sensitive vertebrate species, especially breeding and migrating songbirds, and the Delmarva fox squirrel. The state plan has targeted many landbird species of greatest conservation need (e.g., summer tanager, black-and-white warbler, yellow-throated vireo, Kentucky warbler, worm-eating warbler, hooded warbler, and veery), as requiring more restored upland habitats and more intensive forest management to increase the size and provide higher quality forest patches (DNREC 2005).

The federally endangered Delmarva fox squirrel (DFS) is a top priority resource. Its short-term viability and conservation recovery on the Refuge will depend on actively managing and improving the current available oak dominated mixed-hardwood habitats. Improving and restoring forested habitats will provide potential to expand the current population size for the squirrel's long-term viability on the refuge, while simultaneously providing for and improving the conservation of forest interior dwelling birds.

Our wildlife and habitat analysis described in the CCP identified the DFS, forest interior dwelling birds (FIDS), and other forest-dependent species as high priority management species, and identified forest habitats as a priority refuge habitat to manage for and restore within the next 15 year horizon. Once high priority forest focal species were identified, their life history requirements served as determinants of future forest conditions on the refuge. This habitat analysis determined that sustaining and enhancing a mature mid-Atlantic coastal plain mixed hardwood forest matrix with a high oak component, juxtaposition around a red maple-seaside alder-Atlantic-white cedar/coastal plain depression swamp matrix is the most important ecological contribution the refuge can make to recover the endangered DFS and conserve forest interior bird species in the region.

The 15 year scope of our CCP falls short of the decades we expect it will take to create and enhance this forest matrix and future desired forest conditions with the expectation that it will take at least 100 years to fully implement some of our forest management goals and objectives. This time frame is based on our prediction of how long it will take to achieve the desired forest matrix composition and structure of existing stands. Reducing forest fragmentation through reforestation projects would ensure the long-term viability of the DFS for the next 100 years. Within this 100 year horizon, our long-term objective is to improve refuge forest habitats by developing a structurally diverse forest in terms of size, class, and growth forms (trees, shrubs, vines, and forbs) within a heterogeneous forest canopy. These forest stands will have canopy gaps, based on habitat suitability models for the Delmarva fox squirrel, that maximizes annual hard mast production of existing oaks and hickories, supports natural regeneration of shade tolerant tree species (oaks), and encourages two to six super canopy trees.

Silviculture management can also be used to reduce the potential impact of gypsy moth and southern pine beetle threats to DFS habitat. The gypsy moth *Lymantria dispar* (L.) and southern pine beetle, *Dendroctonus frontalis* are the two most significant potential disease threats of the forests at PHNWR. Although annual surveys since 1990 for gypsy moth have revealed that insect presence or densities have

never reached defoliating levels, oaks are still highly susceptible to gypsy moth infestations. Monotypic stand representing greater than 80% of pines offer the highest risk for pine beetle infestation.

Encouraging the development of mixed hardwood stands and reducing monocultures of pines through silviculture management can decrease the likelihood of spot pine beetle infestation originating from monotypic stands. Assessing disease hazards (high, moderate, and low) in specific areas when cruising timber stands will provide improved information to plan prescribed forest management actions to protect DFS habitats.

Upland forest management enhancement will also benefit nesting and migrating bald eagles on the refuge. The bald eagle (*Haliaeetus leucocephalus)* was removed from the list of endangered and threatened wildlife in July of 2007 by the Service. However, other protections remain in place under the Bald and Golden Eagle Protection Act and Migratory Bird Treaty Act. To provide further clarity in the management of bald eagles after delisting, the Service published a regulatory definition of "Disturb" as it relates to bald eagle management (50 CFR Part 17) plus National Bald Eagle Management Guidelines to ensure that eagle populations will continue to be sustained in the future.

The bald eagle due to its rarity and high level of threats in Delaware remains listed as a state endangered species. The refuge currently has two active bald eagle nests. Some birds disperse off refuge but many birds remain where summer roosts average between 5 to 10 birds and winter Refuge roosts may contain 15 – 25 birds. We will follow the State and National management guidelines when establishing nest and landscape buffer zones for bald eagle protection and actively manage and protect current bald eagle nesting and roosting sites on the refuge which vary in numbers and locations each year.

Climate Change and Sea Level Rise Adaptation

Forest communities are expected to change in the face of climate change, as many tree species shift their ranges northward over time in response to changing conditions. Forest birds, as a group, are generally predicted to adapt well to climate change, with the exception of certain species. The State of the Birds 2010 Report on Climate Change, prepared by the USFWS in conjunction with numerous partners, addresses climate change impacts to various bird groups and attempts to quantify vulnerability on the basis of the following five factors of sensitivity: migration status, habitat specificity, dispersal ability, niche specificity, and reproductive potential (NABCI 2010). Only 2% of forest bird species show high vulnerability to climate change. However, more than half of the species with medium or high vulnerability were not previously considered to be species of conservation concern (NABCI 2010). In other words, climate change effects could pose new challenges for species that are not at high risk today.

Expected shifts in eastern forest community distribution could lead to changes in the avian species communities on the refuge in the long term. The U.S. Forest Service provides predictions on these shifts in their Climate Change Atlas. They incorporated both climate variables and tree-species distributions (to quantify habitat availability) to model the current distribution patterns of 147 common bird species in the Eastern United States (Matthews et al. 2007). The Forest Service used two climate model scenarios to forecast the shift in forest and bird distributions: the Canadian Climate Center model (CCC) and the Hadley Center for Climate Prediction and Research model (Hadley). The two models span the spectrum of predicted climate change using projected atmospheric CO2 concentrations. Some forest species identified by NABCI (2010) to be especially vulnerable to climate change are predicted by the Forest Service Climate Change Atlas (Matthews et al. 2007) to increase in Delaware, perhaps presenting future conservation opportunities, even if they are not currently priority resources of concern. Examples include Chuck-will's-widow and hooded warbler. Species which are common in the area of the refuge, but predicted to incur a clear shift northward and decline in Delaware, such as the house wren, may serve as indicators that predicted change is occurring.

It is not possible to predict exactly how forest communities or associated wildlife species will respond to climate change, and some of these changes are likely to manifest beyond the timeframe of this plan. However it is imperative to begin managing the refuge now with this challenge in mind. In order to meet the long-term needs of forest-dwelling species as describe above, we will manage refuge forests in a way that minimizes the factors associated with sensitivity to climate change, to the extent possible. This will maximize the likelihood of species persistence or adaptation, as appropriate.

Noss (2001) suggests a number of management guidelines that will promote the resilience of forest ecosystems in the face of climate change. Our forest management strategies for climate change adaptation capture those recommendations which are applicable to a local scale. For example, the refuge seeks to protect its largest patches of forest, which are most buffered by change. The refuge will also utilize prescribed fire and thinning to avoid high-intensity fires. Programs that reduce outbreaks of invasive species, damaging insects, and diseases, also enhance forest health and long-term sustainability. The State of the Birds Report (NABCI 2010) recommends that forest management focus on processes (such as fire regime and hydrology) rather than structure and composition, which will increase the resilience of forests to accommodate gradual changes. The emphasis is on healthy and diverse forests. Indeed, as Noss (2001) notes, good forest management principles are largely the same in the face of a changing climate as they are during more static conditions.

Sustainable forest management is the practice of managing forest resources to meet long-term forest goals while maintaining the biodiversity of the forested landscape. The primary goal is to restore, enhance and sustain a full range of forest values. One of those values is the forest's ability to sequester carbon. Carbon sequestration is one mitigation strategy used to offset effects of climate change. The U. S. Forest Service provides widely-accepted calculations of carbon stored in various forest types (Smith et al. 2004). Opinions in the literature regarding the effect of active forest management on carbon sequestration capability of forests are not consistent among scientists (Nunery and Keeton 2010, Hennigar et al. 2008). Management of refuge forests will be focused on providing wildlife habitat, and as such would not generally involve intensive or widespread harvest of trees. Practices may include supplemental planting of poorly stocked lands, age (rotation) extension of managed stands, thinning and/or fire management and risk reduction. These practices are consistent with refuge objectives to promote healthy native forests, and also support the ability of refuge forests to sequester carbon effectively. These strategies also support the carbon sequestration activities within the Service's proposed climate change objectives, as outlined in the draft strategic plan for responding to accelerating climate change (USFWS 2009b).

Objective 2.2 (Mixed Hardwood Forest Restoration)

In the next 15 years reduce forested habitat fragmentation and promote habitat connectivity between upland forest patches to improve quality habitat for the Delmarva fox squirrel (DFS) and conserve focal forest interior dwelling birds. Restore appropriate "old field" and cropland areas to forest to reflect the historic range of variability for mature upland forest vegetation to sustain the long-term viability of the DFS. Create approximately 870 additional acres of forested habitats to maintain at least two core habitat patches (~435 acres/patch) with connecting corridors. Expand forested habitat acreage will provide greater opportunities to increase the Refuge's DFS population size and benefit migratory landbirds.

Rationale

Population numbers and refuge acreage to improve DFS management on the Refuge are based on the latest scientific information from population analysis modeling data for the Delmarva fox squirrel. Managing for conditions that benefit DFS will simultaneously conserve and protect migratory birds of greatest conservation concern.

Contemporary human activities and land use changes have extirpated DFS from Delaware's landscape, while habitat fragmentation of the Refuge's upland habitats has been one of the primary factors in limiting the expansion of DFS numbers. Although Refuge populations have been stable since the re-introduction of squirrels in 1986 and 1987 (25 squirrels ± 15), this small population size has little probability of being sustained for the long term with current Refuge habitat acreage.

The most recent population viability analysis (PVA) data has been incorporated into reforestation objectives. From PVA data, a minimum viable population (MVP) on the Refuge of 130 individuals would be the smallest number of individuals required to maintain a population with a 95% probability of persisting for 100 years. This provides a quantitative measure for sustaining DFS on the Refuge for the long term. Reforesting 700 to 800 acres and creating new habitat would take 50 to 100 years for areas to mature with the potential of providing habitat for at least 250 individuals.

Reducing habitat fragmentation by reforesting the Refuge's landscape also increases carbon sequestration at our location, addresses long term habitat needs and requirements to sustain a healthy DFS population and simultaneously provides conservation benefits for focal breeding forest interior dwelling birds (FIDS) and other migratory landbirds.

The loss of upland forests has taken a huge toll on migratory songbirds and forest interior breeding birds that require large contiguous blocks of forested habitat. These include black-and-white warbler, whip-poor-will, cerulean warbler, hooded warbler, and American redstart. The severe forest habitat fragmentation and loss has caused the extirpation of the Delmarva fox squirrel from Delaware (ELI 1999). Many of the songbirds that have experienced regional and state declines are those bird species that are area sensitive to forest fragmentation. The Delaware Natural Heritage Program estimated that 41% of Delaware's historically common forest-dependent birds have been extirpated or today are extremely rare. Declines are attributed to increased nest parasitism by edge species, increased rates of predation, and loss of quality nesting and wintering forested habitats (Heckscher-1997).

Forest interior dwelling species (FIDS) require large forest areas to breed successfully and maintain viable populations in the future. This diverse group includes songbirds (tanagers, warblers, and vireos) that breed in North America and winter in Central and South America, as well as residents and short-distance migrants, like woodpeckers, owls, hawks, and eagles. According to Breeding Bird Survey (BBS) data since 1966 there has been a 60% decline in occurrence of individual birds of neotropical migrant species in Maryland and an 83% decline in Delaware from 1980 to 2007 (Sauer et al 2008). Many factors are contributing to these declines but the loss and fragmentation of forests in breeding grounds in North America and the Delmarva Peninsula is today playing the most critical role in these declines (USDA 1996: Jones et al 2001).

The conservation of FIDS requires the inclusion of their nesting requirements including minimal area as well as structural characteristics of their habitat. As continental or regional populations of various forest bird species decline, there is more concern over the number of breeding pairs necessary to conserve appropriate gene pools. Increasing available contiguous forest patches helps to provide more breeding areas to retain more species of the forest-breeding avifauna in the Middle Atlantic State (Chandler et al 1989). Increasing the size of refuge forest tracts supports more pairs of focal bird species (Blake et al 1984) and provides greater food resources for migrating and wintering landbirds.

The DFS acts as an "umbrella species" not only by encompassing the structural nesting characteristics of FIDS but also providing for a wide variety of other forest-dependent species. Expanding forest acreage and baseline habitat to meet DFS life history requirements also provides a wide variety of ecological forest benefits. These forests provide a more complete ecosystem of plants and animals that sustain

greater numbers of target wildlife species, protect and restore seed dispersal and nutrient recycling processes, and buffer Refuge wetland and aquatic ecosystems from pollution.

Many of the refuge's upland fields proposed to be reforested in accordance with objectives 2.1 and 2.2 have been part of the refuge's cooperative farming program. In the past, the primary objective of the farming program was to provide food for certain waterfowl species (mallard, American black duck, northern pintail, and Canada geese during the fall, winter, and spring. A secondary objective of the farming program was duck production where croplands in grass/clover stages of rotations were designed to provide nesting habitats for ducks. In recent years, duck species seldom or never used cropland field habitats due to plentiful wetland and aquatic habitats available on Refuge marsh habitats. Sufficient natural foods are also produced to satisfy the needs of Canada geese in these habitats, especially if measures are taken to reduce snow goose numbers. Also, waterfowl production is no longer a management objective for Prime Hook NWR. In addition, the elimination of farming on the refuge is consistent with recommendations in the Service's Final Environmental Impact Statement on the Management of Light Geese (USFWS 2007), which encourages refuges to reduce areas planted to agricultural crops that serve as a supplemental food source for overabundant greater snow geese. Reforestation of a portion of these previously-farmed acres better serves numerous refuge objectives.

Climate Change and Sea Level Rise Adaptation
Further discussion can also be reviewed under Objective 2.1.

Corridors provide connectivity and improve habitat viability in the face of conventional challenges such as deforestation, urbanization, fragmentation from roads, and invasive species. Because dispersal and migration become critical for species of all taxa, as vegetation shifts and conditions change in response to climate changes, corridors also offer a key climate change adaption tool. Management of connectivity between protected habitats is an important conservation strategy (Hannah et al. 2002). Reforestation provides an opportunity to increase connectivity of forested habitats. In many areas, forested riparian corridors provide connectivity among conservation units.

Reforestation, rather than relying on local seed sources and natural succession, can proactively incorporate individuals from a wide range of localities, and perhaps should emphasize sources from lower elevations or latitudes (Noss 2001). This has the potential to increase genetic diversity in the forest which may promote genetic adaptation to climate change as local conditions evolve over time. Choosing planting sources from lower elevations or latitudes anticipates the expected species range shift northward expected by most scientists for eastern tree species (Iverson and Prasad 1998). In addition, this objective promotes the implementation of practices, such as soil preparation, erosion control, and supplemental planting to ensure conditions that support forest growth following establishment.

Increasing forest and tree cover provides additional benefits for mitigation of greenhouse gases through carbon sequestration. Regenerating or establishing healthy, functional forests through afforestation (on lands that have not been forested in recent history, including agricultural lands) and reforestation (on lands with little or no present forest cover) contributes to carbon sequestration on the refuge. Forest patches should be sufficient in size to function as a community of trees and related species. Forests planted on land not currently in forest cover will likely accumulate carbon at a rate consistent with accumulation rates of average forest cover in the region (Matthews et al. 2007). Therefore, carbon sequestered by afforestation activities can be assumed to occur at the same rate as carbon sequestration in average Delaware forests. These strategies also support the carbon sequestration activities within the Service's proposed climate change objectives, as outlined in the draft strategic plan for responding to accelerating climate change (USFWS 2009b).

Objective 2.3 (Wetland Forest Communities)

Protect and manage 1,238 acres of forested wetland cover-types with less than 10% invasive species for breeding and migrating birds of greatest conservation need identified in DWAP, BCR30, and PIF 44 plans and provide critical late winter and early spring feeding habitats for Delmarva fox squirrel. Improve habitat quality and manage appropriate patch sizes (>250 acres) for breeding Acadian flycatcher, prothonotary warbler, yellow-throated vireo, migrating and wintering landbirds, and other species of conservation concern (e.g., carpenter frog, hydrangea sphinx).

- Wetland refuge cover-types targeted for conservation and protection include red maple/seaside alder swamp, Atlantic white cedar/seaside alder saturated forest, Coastal Plain depressional swamp, Coastal loblolly pine wetland, buttonbush coastal plain pond, and cottonwood swamp.

Rationale

Breeding and wintering birds

In the BCR 30 and PIF 44 plans, Swainson's warbler, Cerulean warbler, Kentucky warbler, Acadian flycatcher, Yellow-throated vireo, and Prothonotary warbler are all species associated with forested wetlands and have high conservation concern scores within the mid-Atlantic Coastal Plain Region, as well as in Delaware (DNREC 2005). The following are brief descriptions of focal species habitat requirements:

> *Yellow-throated vireos* utilize a diversity of forest types from mixed upland forests to mature deciduous they appear to reach their highest densities in forested wetlands. However, it has been suggested that they require a high percentage of landscape in forest cover to breed successfully. They generally do not breed in forest interiors but prefer edges and openings (Rodewald & James 1996).
>
> *Prothonotary warblers* select mature deciduous swamp forests during the breeding season. Habitat characteristics include a relatively low, open canopy with a high density of small stems and a variety of natural cavities 2 to 35 feet high over water. As cavity nesters, cavity availability may serve as a limiting factor to habitat selection and use. Flooded breeding areas usually have higher occupancies due to greater numbers of nest sites and greater prey species densities (Petit and Petit 1996).
>
> *Acadian flycatchers* typically occupy moist deciduous forests along creeks and streams and wetland forested habitats. It is generally associated with closed canopy forests with an open understory. Nests are also placed near or over water. Acadians have been shown to be area-sensitive with populations only reaching 44% of maximum breeding densities in patches below 70 ha (168 acres) (Whitcomb 1981).

Rare Forested Wetland Flora and Fauna

The mid-Atlantic Coastal Plain forested wetlands include a highly diversified gradient of forest types (Cowardin et al 1979). On the Refuge this diversity is typified by some of the rarest communities remaining in the Delaware landscape. These include Red Maple/Seaside Alder Swamp, unique in Delaware and found nowhere else in the state, Coastal Plain Depression Swamp, Atlantic White Cedar/Seaside Alder Saturated Forested, Coastal Loblolly Pine Wetland, Swamp Cottonwood Coastal Plain Swamp, and Buttonbush Coastal Plain Pond (McAvoy et al 2007). These habitats are dominated by woody species that are adapted to tolerate saturation of the root zone for varying duration and frequency throughout the growing season. Nationally and locally, forested wetlands have also experienced dramatic fragmentation and losses. Much of this loss has been due to the harvest, filling or draining of forested wetlands for conversion to agriculture or urban development (Cowardin et al 1979; ELI 1999). As with upland forests, occupation of these habitats by forested wetland-dependent birds is influenced by a number of factors including patch size, vegetation structure, and hydrology.

Several studies and inventories have been conducted by the DNHP in 2004 and 2005 of Refuge forested wetland communities contracted by the Service (McAvoy 2007). These inventories and studies were part of the Refuge's CCP preplanning efforts to assess the current status of its natural resources. Botanical and zoological surveys focused on identifying the presence/absence of rare flora and fauna and assessed the current condition of the Refuge's biological diversity. Survey data identified a diverse assemblage of rare flora and fauna in the following refuge forest community types: Red Cedar Maritime Forest, Coastal Plain Depression Swamp, Atlantic White Cedar/Seaside Alder Saturated Forest, Swamp Cottonwood Coastal Plain Seasonal Pond, and Coastal Loblolly Pine. A description of rare flora and fauna found within these habitats is located in *Chapter 2, Section 2.4 Current Refuge Condition Tables 2-7 and 2-8.*

Notable Flora: Within the Coastal Plain Depression Swamp community type about 25 individuals of the state-rare cattail-sedge *(Carex typhina*, S3) in Unit III along with scattered colonies of slender blue-flag iris (*Iris prismatica*, S2) were recorded by DNHP. Both species are growing in closed canopy and would prefer more sun to expand populations. This could be achieved by selective thinning or girdling some adjacent trees in the areas (McAvoy & Coxe 2007). Several rare plants were inventoried in Atlantic White Cedar/Seaside Alder Saturated Forest growing in association with Atlantic White Cedar. These species included: seaside alder, S3, G1), coast sedge *(Carex exilis, S1)* bayonet rush *(Juncus militaris, S2)* and flattened pipewort (*Eriocaulon compressum, S2)* (McAvoy 2007). Within Coastal Loblolly Pine Wetlands, the southern twayblade orchids (*Listeria australis, S3)* distribution and abundance is significant. Two locales have been documented with 500 to 1,000 plants occurring between both locations. This species can easily be overlooked due to its small size (15 cm/6 inches) and ephemeral nature (blooms in early spring and persists for only a few weeks). Also growing here is Walter's Greenbriar (*Smilax walteri, S3)*. This species is an uncommon woody vine in Delaware that is an obligate wetland species and prefers swampy habitats. The fruit of Walter's greenbriar is red in color, as opposed to other greenbriar species with black fruit.

Notable Fauna: Most (S1) species were directly associated with large tracts of shrub swamps bordering Prime Hook Creek in Unit III either as residents of open water along the creek, as associates of host plants occurring within the shrub swamp, or as residents of the peat wetlands and bogs embedded within forested wetland habitats. The State Zoologist emphasized the need for future inventories as there is a high probability that many additional rare or uncommon species of Delaware will continue to be discovered on the Refuge. The refuge report (2007) states, "it is possible that nowhere else on the Delaware Coastal Plain maintains such a high concentration of rare invertebrate animal species."

The carpenter frog was found in freshwater wetland forest and emergent wetland ecosystems around the Prime Hook creek drainage. It is a very rare amphibian species in Delaware and the Refuge's populations is only one of two that are left in the state (Heckscher 2007). The great purple hairstreak is another insect species of very high concern in Delaware (DNREC 2005). This butterfly's host plant is mistletoe *(Phoradendron flavescens)* and a large concentration of this parasitic plant occurs on the refuge. Adjacent fallow fields and open wetland areas where adult nectar plants occur, such as milkweed, several species of goldenrods, and buttonbush, provide important food resources for this and other lepidopteran species (McAvoy & Heckscher 2007).

Hydrangea sphinx was found in several locations throughout the Refuge's freshwater shrub and swamp communities. However, it is very rare across the Delaware landscape. The last confirmed state record prior to the Refuge discovery in 2004/2005, was in 1886 (Heckscher 2007, Jones 1928). Host plants for this species are buttonbush *(Cephalanthus occidentalis)* and waterwillow *(Decodon verticillatus).*

Praeclara underwing *(C. praeclara)* populations were found in Red Maple/Seaside Alder along Prime Hook creek Coastal Plain Depression Swamp, and Coastal Loblolly Pine Wetland Forest. The host plant for this species is red chokeberry *(Aronia arbutifolia).* Due to its rarity in the state landscape DNHP

suggested making this species and its host plant a conservation target on the Refuge. Red chokeberry is also a known host plant for *Catocala pretiosa*. Although not found during 2004/2005 surveys on the Refuge, if it is found in coming years, its discovery would warrant consideration as an extremely high conservation target as only a few secure populations are known worldwide (Heckscher 2007).

Although no rare plants were found in the Swamp Cottonwood Coastal Plain Pond community, the presence of the rare marbled underwing *(Catocala marmorata*) was recorded and considered highly notable by the DNHP. It is state, regionally, and globally rare and an uncommon species in Delaware (S1, Tier 1, G3). The species was found with its suspected host plant swamp cottonwood *(Populus heterophylla)*. This species is the largest underwing moth in eastern North America and is confirmed from only one other location in the state of Delaware. From a global perspective, the marbled underwing in the rarest animal species recorded by the DNHP with the possible exception of state record firefly species *(Photuris pyralomimus)* and new Delphacid species to science, a plant hopper secured from the Refuge's peat bog community currently being studied for taxonomic classification.

Climate Change and Sea Level Rise Adaptation
Wetlands with long periods of inundation or surface saturation during the growing season are especially effective at storing carbon in the form of peat, though there are uncertainties associated with carbon storage in wetlands. Riparian wetlands can also capture carbon washed downstream in litter, branches, and sediment. Because they accumulate sediment and bury organic matter, floodplain and tidal wetlands, including forested wetlands, are especially effective as carbon sinks. These lands also reduce nutrient, sediment, and other pollution into the Delaware Bay and other bodies of water.

4.3 GOAL 3. (Refuge Impounded Marsh Complex)

Maintain the quality of the wetland habitats within and surrounding the refuge's wetland impoundment complex for migrating shorebirds, breeding rails, wading birds, American black ducks, and migrating and wintering waterfowl consistent with the BIDEH policy. Support other native wetland dependent species and provide fish passage and nursery habitats for anadromous fish species.

Objective 3.1 (Wetland-dependent breeding and migrating birds)

Provide up to 4,200 acres of healthy impounded/semi-impounded brackish wetlands and salt marsh to meet the needs of a wide variety of wetland-dependent migratory birds, including rails, bitterns, terns, migrating shorebirds, and migrating and wintering waterfowl, by restoring salt marsh vegetation communities and natural wetland processes in the impounded wetlands in Unit II and Unit III. Successful restoration will include the following elements:

- Restoration of the natural tidal range and salinity with a physical connection with the marine environment for exchange of nutrients, organic matter, and biota
- Restoration of the natural sediment budget to counter wetland subsidence
- Improvement of water quality realized by restored salinity and pH
- Control of invasive plants to less than 5% cover, once salt marsh vegetation is established
- Re-establishment of native salt marsh vegetation communities, with a moderate (20-25%) component of open water/mudflats
- Return of native salt marsh wildlife species, including salt marsh obligate birds
- Improvement of estuarine fish and shellfish habitat

Rationale

The refuge's impounded marshes represent large wetland patches greater than 1,000 acres or more, which are attractive to wetland-dependent breeding and migrating bird and significantly contribute

to wetland biological diversity and integrity at both the refuge and state landscape levels. Even as these wetlands undergo changes as a result of storm activity and coastal processes, the refuge remains committed to providing high quality wetland habitat for a diverse assemblage of migratory birds, in a manner that is effective and sustainable. The emphasis under this objective is on active restoration of healthy salt marsh and brackish wetland conditions within wetlands formerly managed as freshwater impoundments. This shift in habitat management serves as an immediate response to manifestations of sea level rise and climate change, and a proactive adaptation in anticipation of further future changes. However, given the road infrastructure in place, these wetlands will remain at least partially impounded for the foreseeable future, and thus require active management and restoration. Active management of water levels will continue to play a role in influencing habitat conditions, and potentially as a tool for salt marsh restoration. Management strategies in sensitive freshwater wetlands and restoration in inland wetland areas will still be pursued, to the extent feasible.

The SLAMM model (Scarborough 2009) and the State's Inundation maps (DNREC, unpublished) predict accelerated rates in sea level rise in the next 50 to 100 years. Portions of the refuge's marshes and/or impoundments may have already reached a tipping point. It is important to note that the timeframe of impoundment management has been relatively short on the refuge, in relation to the timeframe of natural coastline processes. Relatively speaking, freshwater impoundment management is not a long-standing management regime on the refuge. It was conceived to meet valid wildlife management objectives. However, it was established in part using existing roads as dike infrastructure, which had not been formally engineered for long-term water level management. In the development of a Memorandum of Agreement with DNREC, during the time the impoundment infrastructure was established, it was acknowledged that the lifespan of the facilities would be 20 years, a time span which has now passed. Evidence from numerous sources, as described in Chapter 3, clearly indicate that the wetlands on the refuge were historically salt marsh, although there had always been areas of freshwater marsh due to natural freshwater inputs and/or altered hydrology resulting from human activity.

As information in Chapter 3 of the CCP outlines, portions of the managed impoundments are losing ground to sea level rise. While the visible vegetation and wildlife response was favorable during the decades of impoundment management, significant problems were developing beneath the surface. For example, Unit II is accreting new sediment at a pace that is half the documented rate of local sea level rise. It is not reasonable to expect that such a large deficit in "elevation-capital" can be recovered within Unit II utilizing freshwater impoundment management strategies. Freshwater marshes dominated by annual vegetation differ from salt marshes in that predominantly annual wetland plant vegetation contributes to high above ground biomass, whereas the persistent below-ground organic matter of perennial vegetation, such as that found in tidal salt marshes, make greater contributions to vertical accretion (Cahoon et al. 2009). Impounded freshwater wetlands would be difficult and costly to re-establish, and more importantly are not sustainable in a dynamic coastal setting for the long term.

Our refuge goals and objectives strive for successful management of a variety of wetland habitat types, including both salt marsh and freshwater wetlands. But, it is our responsibility to manage for these community types where conditions are appropriate. As our evaluation of the available data illustrates, a shift in management is necessary to ensure healthy wetlands, rather than permit artificially created freshwater wetlands to convert to open water because they are not keeping pace with rising water levels. Although open water environments are not without ecological value, such an outcome would not directly support the wetland objectives outlined in this HMP. It is neither responsible nor sustainable to maintain freshwater impoundments along a coastal environment indefinitely.

Management action will be necessary to stabilize the health of the degraded impounded wetland system. If no active restoration is undertaken, it is unclear how quickly or effectively the wetlands, in

Unit II in particular, would revert to salt marsh vegetation on their own, given the existing elevations and degraded state of the sediments (Williams and Orr 2002). It is also possible that large areas of open water will form instead (Pearsall and Poulter 2005; Williams and Orr 2002; Portnoy and Giblin 1997; DeLuane et al. 1994). The most practical and economical management alternative to re-stabilize the impounded wetlands is carefully executed restoration. Furthermore, an established salt marsh will be able to migrate landward into adjacent uplands, as sea levels rise, in a process that represents the natural adaptation of the coastal ecosystem.

Ultimately, restoration of the refuge impoundments to health brackish and salt marsh will encourage the conditions most resilient to sea level rise, while still providing valuable habitat for waterfowl, salt marsh obligate passerines and waterbirds, shorebirds, and other wildlife. Furthermore, additional healthy salt marsh in the refuge's wetland complex would provide benefits to neighboring human communities that the freshwater impoundments could not provide, or certainly could not provide in a self-sustaining manner. The presence of salt marsh vegetation in coastal marshes can reduce shoreline erosion by dissipating wave energy completely within 100 feet of the shoreline, which in turn increases the potential for sediment deposition (Morgan et al. 2009; Broome et al. 1992). Because they are perennials, salt marsh plants develop extensive root systems that improve soil stability through deposition of belowground biomass, thus over time salt marshes will accrete vertically to better keep up with sea level rise (Cahoon et al. 2009; Reed et al 2008; Knutson 1988), providing a buffer to adjacent uplands. Through greater stability and resilience, a healthy salt marsh will provide neighboring communities with more flood protection than an artificially sustained freshwater wetland or open water. Restoration of salt marsh vegetation within impounded wetlands is a key climate change adaptation approach.

Active restoration is more effective than passive restoration in wetlands with degraded conditions (NOAA 2010). The preferred means of restoration will be the incremental increase in the exchange of tidal floodwaters between the Delaware Bay and at the water control structure in Slaughter Canal. Ideally, tidal restoration will occur gradually over an extended period and will entail concurrent monitoring of environmental response to assess the achievement of project objectives, including assessment of public and stakeholder concerns (Smith et al. 2009). This method is advantageous because the rapid reintroduction of salt water to a system which has been primarily fresh can cause rapid and extensive death of salt-sensitive plants, which can impose further problems with sediment loss, erosion, and subsidence through peat collapse (Smith et al. 2009; Pearsall and Poulter 2005; Weinstein et al. 2000; Portnoy and Giblin 1997; DeLuane et al. 1994). It is difficult to successfully monitor such a rapid change and, regardless of our monitoring and management efforts, the response will be difficult to accurately predict. A critical factor in the restoration design process is to achieve tidal flooding up to the spring high tide elevation in order to restore ecologically sustainable estuarine communities, by restoring sufficient tidal exchange to flood as well as drain the wetland effectively (Williams and Orr 2002).

The refuge must also evaluate and address the elevation of the wetlands to be restored, in relationship to the growth range of desired species (e.g., *Spartina alterniflora*), because elevation is a critical factor in establishment of salt marsh vegetation (Weinstein et al. 2002; McKee et al 1989; Baca and Kana 1986). The sand-starved system may require decades or more to naturally recoup the elevation already lost in portions of the wetland complex, due to peat collapse in the manipulated freshwater sediments. In the absence of sufficient elevation, portions of the wetlands will convert to open water (this has already occurred in some areas). Ideally, open water should comprise only 20% of restored Delaware Bay salt marsh wetlands (Weinstein et al. 1996). Although open water environments are not without value to wildlife, they can contribute to erosion and inhibit the return of salt marsh vegetation, especially in large sites such as Unit II and Unit III (Williams and Orr 2002). Salt marsh vegetation will establish more readily if there is sufficient elevation in place, which in turn will facilitate further accretion and salt marsh development (Boumans et al. 2002). This prompts the consideration of "assisted accretion"

through the addition of supplemental sediment by some means (e.g., thin layer deposition of dredge material or modified beach nourishment) and/or through engineering techniques that reduce wind and wave fetch across expanses of open water and encourage the natural capture and deposition of sediment throughout the wetland complex (Weinstein et al 2000). In addition, the refuge will limit the control of *Phragmites* to only areas identified in the Fire Management Plan as a "zero tolerance" zone for the purposes fuels control. Although not a preferred wetland species for habitat value, the presence of *Phragmites* can help to trap sediment, preserve wetland elevation, and reduce peat collapse.

While a carefully monitored, gradual reintroduction of salt water into the impoundment complex is a preferred management option (Smith et al. 2009), the feasibility of such an approach is dependent on some factors beyond the refuge's immediate control. The shoreline, for example, is extremely vulnerable to overwash, but cannot readily be engineered to prevent breaches, and thus the refuge may have little control of water levels and salinity within the impounded wetland without substantial intervention. In addition, it can be difficult and costly to find large amounts of supplemental sediment for restoration of elevation, but the refuge will work with partners to seek such opportunities. The restoration plan for the wetland will include an iterative and adaptive approach to manage incremental restoration in response to observed and measured conditions (Teal and Weinstein 2002). Although the conditions at the refuge are somewhat unique, given the management history, there are examples of successful salt marsh restoration projects throughout the eastern U.S., including in the Delaware Bay, which provide valuable guidance (NOAA 2010; Smith et al. 2009; Herring River Technical Committee 2007; Teal and Weinstein 2002; Warren et al. 2002; Weinstein et al. 2000, 1996; ACOE 1996; Roman et al. 1995; Baca and Kana 1986).

For Unit III, the future of management is less certain, although management capabilities are still somewhat intact, and management infrastructure is not as compromised. The natural freshwater inputs within Unit III dictate that under any management or restoration scenario, it would likely retain more brackish marsh characteristics and vegetation than Unit II would. However, it may also be at risk for new Phragmites invasion. Although the objective for Unit III is also to develop a healthy self-sustaining wetland (rather than continue to manage strictly as a freshwater impoundment), the specific fate of Unit III may depend on the actions taken and outcomes realized in Unit II restoration efforts. It is anticipated that this will be a salt marsh dominated system in the areas dominated by salt water inputs and brackish to freshwater in areas with greater freshwater source. Factors such as the pace of Unit II restoration, how natural storms events may affect the wetland complex, modifications of Prime Hook Rd by DelDOT, when and whether sediment from outside sources are added, etc. may all affect the pace of restoration actions, but not the long-term goal, which is to end up with a habitat that is consistent with BIDEH. The refuge will need to adapt future management direction and actions in Unit III, depending on the progress of management and restoration in Unit II, which directly influences Unit III. Coastal refuges in Region 5 are currently developing a structured decision tool that can be used to weigh the costs and benefits of maintaining an impoundment, and reach a decision about whether to restore or maintain it. Since this model will be science-based, developed through a structured decision-making process, have technical expert review, and consistency with other refuges, Prime Hook NWR plans to use the Coastal Impoundment SDM model to evaluate future management direction for the Unit III impoundment. Currently the refuge is collecting the data necessary to populate the decision model in order to further evaluate management options.

While the active restoration of salt marsh within the refuge's impounded wetlands is the underpinning of this objective, the development of a detailed and site-specific wetland restoration plan is outside the scope of this HMP process. However, a number of potential restoration strategies have been identified in consultation with a wetland management and restoration advisory team. During the latter stages of preparing this the refuge CCP and this HMP, the refuge convened a group of world-renowned wetland management and restoration experts from outside Delaware for a meeting with refuge staff and a

number of DNREC scientists and managers. The invited group of scientists included Dr. Donald Cahoon (U.S. Geological Survey, Patuxent Wildlife Research Center), Dr. Norbert Psuty (Rutgers University), Dr. Charles Roman (National Park Service, Cooperative Ecosystem Studies Unit, University of Rhode Island), and Patricia Rafferty (National Park Service, Jamaica Bay Wildlife Refuge, New York). These scientists represent a wealth of experience in studying, managing, and restoring degraded wetlands throughout the U.S.

During a meeting in May 2011, these state, federal, and invited scientists and managers reviewed preliminary monitoring data and toured the refuge's shoreline and wetlands firsthand, and provided feedback and recommendations both at the end of the meeting and during follow-up discussions. The resulting suggestions have been incorporated into the CCP and this HMP (in Chapter 5) as potential restoration strategies. The refuge proposes to continue working with this advisory team as restoration plans are developed and introduced to the public. Potential restoration strategies to be considered are derived from the salt marsh restoration scientific literature, as well as from consultation with this advisory team. The public will be given opportunities to learn about restoration plans as they are developed, and provide feedback to the refuge staff and restoration team. Public involvement is recognized as a critical element for successful restoration projects (NOAA 2010). Some or all of the restoration strategies may be implemented in some combination, as determined to be appropriate, feasible, and fundable, during the later development of a detailed restoration plan.

Objective 3.2 (Manage water quality for trust fishery resources, migratory birds, and resident wildlife)

Over the next 15 years protect and improve the water quality of 6,000 acres of impounded marsh and waterways, aquatic habitats and delineated buffer zones to provide clean water to safeguard and enhance the quality of breeding and nursery habitats for river herring (alewife, blue-back herring), American and hickory shad, striped bass, American eel, and other fishery resources, to conserve healthy populations of fish, breeding and migrating birds and resident wildlife.

Rationale

Many of the refuge's natural resources are water-dependent, and adequate quantities and quality of freshwater are of paramount importance to conserve and manage trust wildlife resources. Protecting healthy aquatic habitats and conserving fish and other aquatic organisms and managing targeted migratory and breeding birds identified in this CCP will require clean water and good water flow and circulation within the refuge impounded wetland habitats. Cyclic ditch cleaning is the only way to preserve good water circulation within the impoundments.

In addition to perpetuating healthy migratory bird populations, the Service is committed to restoring and conserving America's fisheries resources (National Fish Habitat Action Plan 2006). Over one third of the Nation's freshwater and anadromous fish species are threatened. It is increasingly urgent to identify and implement actions that will reverse declining trends in fish health and populations before it is too late. Protecting the health of aquatic habitats and restoring fish and other aquatic resources is a very high Service priority.

The Atlantic States Marine Fisheries Commission data and management plans targeting declining species was used to identify and prioritize refuge aquatic and fisheries resources for this CCP. River herring, striped bass, and elvers are top resources of concern for the refuge. The conservation of river herring (alewife and blue-back herring), striped bass, and other anadromous fish plus the American eel depend on freshwater habitats that are used by spawning adults and required by fry and early juveniles of these species.

4.4 GOAL 4. (Early Successional Upland Habitats)

Maintain, enhance and restore the native vegetation, biological diversity and ecological integrity of early successional upland habitats to create an assorted mosaic of early successional habitats mixed with transitional forested areas to conserve migratory birds, breeding landbirds, endangered species, and to maximize benefits for other priority resources of concern.

Objective 4.1 (Transitional habitats: Grasslands, Shrublands and Young trees)

Within the next 15 years restore and maintain early successional areas to represent the historic range of variability for upland transitional habitats. These habitats will be dominated by native vegetation reflecting several seral-stages that mimic natural conditions. Transitional habitats will usually be small in size and imbedded within a matrix of wetlands and upland forested habitats. Create a continuum of natural habitats to include a mosaic of grassland, transitional, young, and old shrublands, and young forest habitats on 2,000 acres undergoing restoration to native vegetation (including those areas planted in trees or transitioning through natural succession for DFS management purposes).

Maintain at least 20% of the above acreage in an early successional condition (shrubland and/or grassland mix) to meet the needs of priority resources of concern. These habitats will support high priority breeding and migrating birds identified in BRC 30, PIF 44, DWAP and Birds of Conservation Concern (USFWS 2008) lists and include the following: prairie warbler, blue-winged warbler, Northern bobwhite, brown thrasher, whip-poor-will, willow flycatcher, eastern towhee, field sparrow, and Henslow's sparrow.

Rationale

Our habitat vision statement supports the notion that in the next 15 years we will strive to restore Refuge habitats to natural communities and manage for wildlife species dependent upon the native plants representative of the Delmarva Coastal Plain Ecosystem. This includes restoration of several early successional upland habitats consisting of agricultural and fallow "open fields" to natural, native conditions. By managing native plant succession from early pioneering stages through climax communities through seral stages, we will simultaneously accommodate multiple priority focal species that will be able to use a wide diversity of ecological niches that develop with this habitat management scheme. These lands will be managed in a transitional and ever-changing state.

Early successional grassland and shrub-dominated habitats were historically widely distributed throughout the Northeast, including the mid-Atlantic, but are rare today. Historically, coastal areas were susceptible to large disturbance patterns like wild fires and hurricanes, so patches of early successional forests, barrens, and grasslands represented at least 20% of land area cover-types of the coastal state of New England, Long Island, New Jersey, Maryland, and Delaware (Litvaitis 2006). Shrub-dominated habitats are the most altered and most rapidly declining habitat types in the Northeast (Litvaitis et al. 1999; Litvaitis 2006). National breeding bird survey data indicate that populations of thicket specialists (thickets defined as sites dominated by persistent shrubs or seedling to sapling sized trees) continue to also decline in the Northeast (Askins 1998). Bird species that rely on open grasslands and shrublands for breeding are among the highest priority management targets due to the greatest rates in population declines both in the BCR 30 and PIF 44 regions.

The reduction in areas and diversity of shrub-land dominated communities has also taken a toll on obligate invertebrates of this habitat type. Tiger beetle conservation status throughout the northeast also exemplify the rarity of shrublands on the landscape. Two are federally listed and 19 are ranked as S1 by several Heritage Programs throughout the region. Likewise more than two thirds of Lepidoptera listed as S1 and S2 throughout the Northeast are obligates of non-forested early successional communities. The

native forbs that grow interspersed in a thicket matrix also support substantial invertebrate richness and abundance (Litvaitis et al. 1999).

Ecological Model for Managing Shrubland Birds: Most early successional communities are temporary and dynamic in nature, constantly changing as more shade-tolerant trees replace sun-loving shrub species. Since old-fields and shrubland habitats are relatively short lived (20-25 years), recurring active management must be conducted to maintain desired habitat structure. Shrubland communities are disturbance dependent, but no single prescription effectively manages every successional community. Given the highly ephemeral nature of these successional communities, maintaining specific stages will require strategic periodic disturbance activities to sustain them and constant monitoring to cue the management actions.

Peterjohn (2006) suggests that it is more practical to direct management towards maintaining generalized categories of shrubland seral stages rather than targeting specific plant community composition. To manage shrubland seral stages on the Refuge, we will use his ecological model for managing breeding shrubland birds in the mid-Atlantic region. These managed successional stages include transitional shrublands, young shrublands, and older shrublands.

Shrubland Bird Ecological Requirements: All the priority shrubland species listed in objective 4.1 utilize old-fields with different levels of woody intrusion. Prairie warblers, field sparrows, and willow flycatcher prefer relatively young "old fields" with scattered shrubs and trees with moderate shrub cover. Neither of these species likes later successional stages where shrubs and/or saplings form dense continuous tangles. By comparison, brown thrasher, Eastern towhee and blue-winged warbler prefer later stage old-fields with moderate to dense shrub cover and white-eyed vireo and yellow-breasted chat also benefit (See CCP-Appendix E Table 6 of focal species life history requirements for early sucessional habitats).

Review of the life history requirements of targeted birds show that none of the shrubland-dependent species has very specialized habitat requirements, so they can be readily placed into the three distinct shrubland bird guilds (Field specialists, ubiquitous species, or multiple habitat species) described by Peterjohn (2006) for shrubland birds in the mid-Atlantic. (See Table 12)

- Field Specialists: Restricted larger (2-20 ha / 5-50 acres) patches of shrubland habitats.
- Ubiquitous Species: Occurring along linear edge habitats and fields, such as bushy woodland edges, roadsides, hedgerows, and other corridors less than 10 meters (33 ft) wide.
- Multiple Habitat Species: Requiring other habitats in addition to shrublands for breeding.

Table 12. Shrubland Bird Ecological Requirements

Shrubland Bird Ecological Requirements	
FIELD SPECIALISTS	***HABITAT REQUIREMENTS***
Field sparrow	Transitional Shrubland
Common yellow throat	Transitional Shrubland
Prairie warbler	Young Shrubland
Willow flycatcher	Young Shrubland
Yellow-breasted chat	Young Shrubland

Shrubland Bird Ecological Requirements	
White-eyed vireo	Young Shrubland
Blue-winged warbler	Young Shrubland
Yellow warbler	Young Shrubland
UBIQUITOUS SPECIES	
Brown thrasher	Young Shrubland
Eastern towhee	Young Shrubland
Blue grosbeak	Young Shrubland
MULTIPLE HABITAT SPECIES	
Northern bobwhite	Transitional Shrubland
Black-billed/Yellow-billed cuckoos	Older Shrubland
Whip-poor-will	Older Shrubland

Restoring, improving, and maintaining shrubland areas interspersed with grassland and forested areas is conducive to creating a continuum of shifting mosaics of various sized patches and configurations that will benefit a large suite of priority breeding and migrating songbirds. For example, many birds of mature forests heavily use shrubland habitats during the postbreeding period. Dense vegetation and abundant fruit resources found in early successional forest and shrubland habitats have been shown to be very important for survival of mature forest birds during the postbreeding period (Vitz and Rodewald 2007).

Abundant fruit resources produced in shrubland habitats provide an easily captured food source but also attract insects, further enhancing foraging opportunities for both adult (AHY) and juvenile (HY) mature-forest dependent birds during migrational periods. Dense shrub cover also decreases the need to move widely in search of food, reduces energy loss and exposure to predators. Fruits have high sugar content that aids in accumulating fat reserves to facilitate migration (Parrish 2000).

The Vitz and Rodewald study (2007) results have shown that during the postbreeding period birds (especially red-eyed vireo, worm-eating warbler, ovenbird, hooded warbler, and scarlet tanager) seek out structurally complex and low vegetation structure ($\geq$ 4.5 m) that shrub and sapling habitats provide. These habitat factors showed the highest capture rates during migration, demonstrating their importance for seasonal frugivores. It was concluded that early successional stands have legitimate conservation value to mature-forest breeding birds as well as early-successional breeding birds, as shrubland habitats promote their survival and improve postbreeding season condition for migrants.

Objective 4.2 (Grassland Bird Habitat Management)

Manage for an interspersion of habitat structures for breeding, migrating and wintering? bird species that utilize grasslands, during breeding as well as non-breeding seasons, by maintaining a mixture of short, medium, and tall native grassland vegetation in areas of the refuge not well-suited to reforestation. This may be accomplished in varying amounts in rotation with shrubland and forest management. This will provide breeding habitats for Northern bobwhite, Northern Harrier, and other obligate grassland nesting birds, and also provide migrating and wintering habitats for Canada geese, shorebird, and songbird species.

Specifically, manage 50 hectares or more of grasslands adjacent to salt marsh habitat to meet the needs of breeding Henslow's sparrows and wintering northern harriers.

- Habitat characteristics include patch sizes of no less than 30 ha (75 acres) in moderately tall grassy vegetation (> 30 cm) with well-developed litter layer, woody species accounting for less than 10% habitat coverage, a forb component of about 25%, and less than 10% of non-native grasses and/or invasive plant species.

Rationale

Grassland birds are those birds that rely on grassland habitats for nesting and include various species of waterfowl, raptors, shorebirds, upland gamebirds, and songbirds that require native grasslands for nesting and other habitat functions. We will use habitat generalizations to create a mosaic of grassland habitat conditions to provide quality food and cover resources for a wide spectrum of grassland nesting and wintering birds.

Grassland bird use will vary with the physical habitat structure, disturbance patterns, and other factors (Table 13). For each bird species, these grassland habitats can provide protective cover for nesting and broodrearing activities in the spring and summer. They provide a diversity of native plants that produce important food items – mostly insects and other invertebrates that include grasshoppers, crickets, beetles, caterpillars, ants, katydids, dragonflies, cutworms, wasps, flies, spiders, snails, sow bugs, etc. for nesting female birds and young. These habitats provide important raptor prey items like mice, voles, shrews, rabbits, groundhogs, snakes, lizards, songbirds and other wildlife species and provide food and cover resources for migrating and wintering Canada geese, Northern bobwhite, black-bellied plover, sparrows, and other grassland-dependent bird species

Table 13. Habitat Preferences of Some Birds using Grasslands

Species	Preferred Grassland Growth			Avoid Woody Vegetation
	Short	Medium	Tall	
Northern Harrier			X	X
Barn Owl	X	X	X	X
Short-eared Owl		X		X
Northern Bobwhite			X	
Willet	X	X		X
Canada Goose	X	X		X
Horned Lark	X			X
Sedge Wren			X	
Black-bellied plover	X	X		X
Bobolink		X		X
Eastern meadowlark		X		
Vesper sparrow	X			
Savannah sparrow	X	X		
Grasshopper sparrow	X			
Dickcissel		X	X	
Henslow's sparrow		X	X	X

Henslow's Sparrow is one of the fastest declining songbirds in North American and is in danger of extinction within its historic range in the northeast. This decline is due to loss of suitable grassland nesting habitat and hence is a Service and a state species of management concern (USFWS 2008; Steinkamp 2008; DNREC 2005) as well as a high priority species in PIF 44 plan due to drastic population declines of the past 30 years. Henslow's sparrows have been extirpated from the state landscape (last reported May 1982 – Hess et al. 2000) and they previously bred on the Refuge in Unit IV where cattle grazing operations maintained early successional grassland habitats near salt marsh areas up until the late 1970s (pers comm. O'Shea). Along the Atlantic coast, the species bred on the edges of salt marshes before the arrival of settlers (Schneider et al. 1992; Smith et al. 1992). Prior to European settlement, small open grassland habitats within the mid-Atlantic Coastal Plain were maintained by Native Americans within a forested landscape (Pyne 1982).

Although perpetual grassland maintenance is not a focal component of our habitat management program, we have the opportunity to meet the needs of several species of conservation concern. By focusing some grassland management in areas adjacent to high salt marsh, our efforts can target Henslow's sparrow as a priority species while also serving to "umbrella" habitat requirements for other grassland species, such as Northern bobwhite, and for various species of waterfowl, raptors, shorebirds, upland gamebirds, and songbirds that need grassland habitats for nesting and other habitat functions. The Henslow's Sparrow nests in the highest portion of high marsh zones within the marsh/upland ecotone. This habitat is often linear and is characterized by stands of salt meadow hay interspersed with shrubs that grade into patches of switch grass. Availability of switch grass seems to be important to the distribution of these sparrows (Zimmerman 1988 & Smith 1992). Maintaining grassland habitats near high salt marsh areas would also benefit Coastal Plain swamp sparrow, short-eared owl, eastern meadowlarks, migrating savannah sparrow, vesper sparrow, grasshopper sparrow, willet, sedge wren, horned lark, Northern harrier, black-bellied plover and Canada geese. In addition to birds, species such as migrating and resident butterflies, Frosted elfin, American burying beetle, Eastern box turtle, milk snake, least shrew, and rare native plant species would benefit.

As with shrubland management, maintenance of grassland communities will require periodic disturbance, resulting in a range of seral stages over time and/or space. The result of this is a diversity of grassland structure (short, medium, tall) at any one time and/or in any particular place, each potentially serving the habitat needs of different suites of species.

Many of the refuge's upland fields proposed to be managed in accordance with objectives 4.1 and 4.2 have been part of the refuge's cooperative farming program. In the past, the primary objective of the farming program was to provide food for certain duck species (mallard, American black duck, northern pintail, and wood duck) and Canada geese during the fall, winter, and spring. A secondary objective of the farming program was duck production, where croplands in grass/clover stages of rotations were designed to provide nesting habitats for ducks. In recent years, duck species seldom or never used cropland field habitats due to plentiful wetland and aquatic habitats available on Refuge marsh habitats. Sufficient natural foods are also produced to satisfy the needs of Canada geese in these habitats, especially if measures are taken to reduce snow goose numbers. Also, waterfowl production is no longer a management objective for Prime Hook NWR. Finally, the elimination of farming on the refuge is consistent with recommendations in the Service's Final Environmental Impact Statement on the Management of Light Geese (USFWS 2007a), which encourages refuges to reduce areas planted to agricultural crops that serve as a supplemental food source for overabundant greater snow geese. Management of a portion of these previously-farmed acres as grassland and other transitional habitats better serves numerous refuge objectives.

Chapter 5. Habitat Management Strategies and Prescriptions

5.1 Development of Management Strategies and Prescriptions

This chapter identifies management strategies and prescriptions to address the habitat management goals and objectives discussed in Chapter 4. Management strategies identify the tools and techniques (e.g., burning, mowing, water-level manipulation, chemical application, etc.) utilized to achieve the habitat objectives. Prescriptions provide the details behind the specific means by which the strategies will be implemented (e.g., timing, frequency, and location). A review of available literature related to potential strategies and prescriptions was incorporated during their development. The identified treatments were selected in consultation with other Refuge biologists, managers, and experts, to ensure their effectiveness. Many environmental factors including wildlife populations, weather, seasonal variations, and habitat conditions affect the selected prescriptions and their ability to achieve objectives from year to year. As such, many of prescription details will be identified in the Annual Habitat Work Plan. Prescriptions outlined herein are discussed on a conceptual level. General management prescriptions are also depicted in HMP Maps 8 – 12.

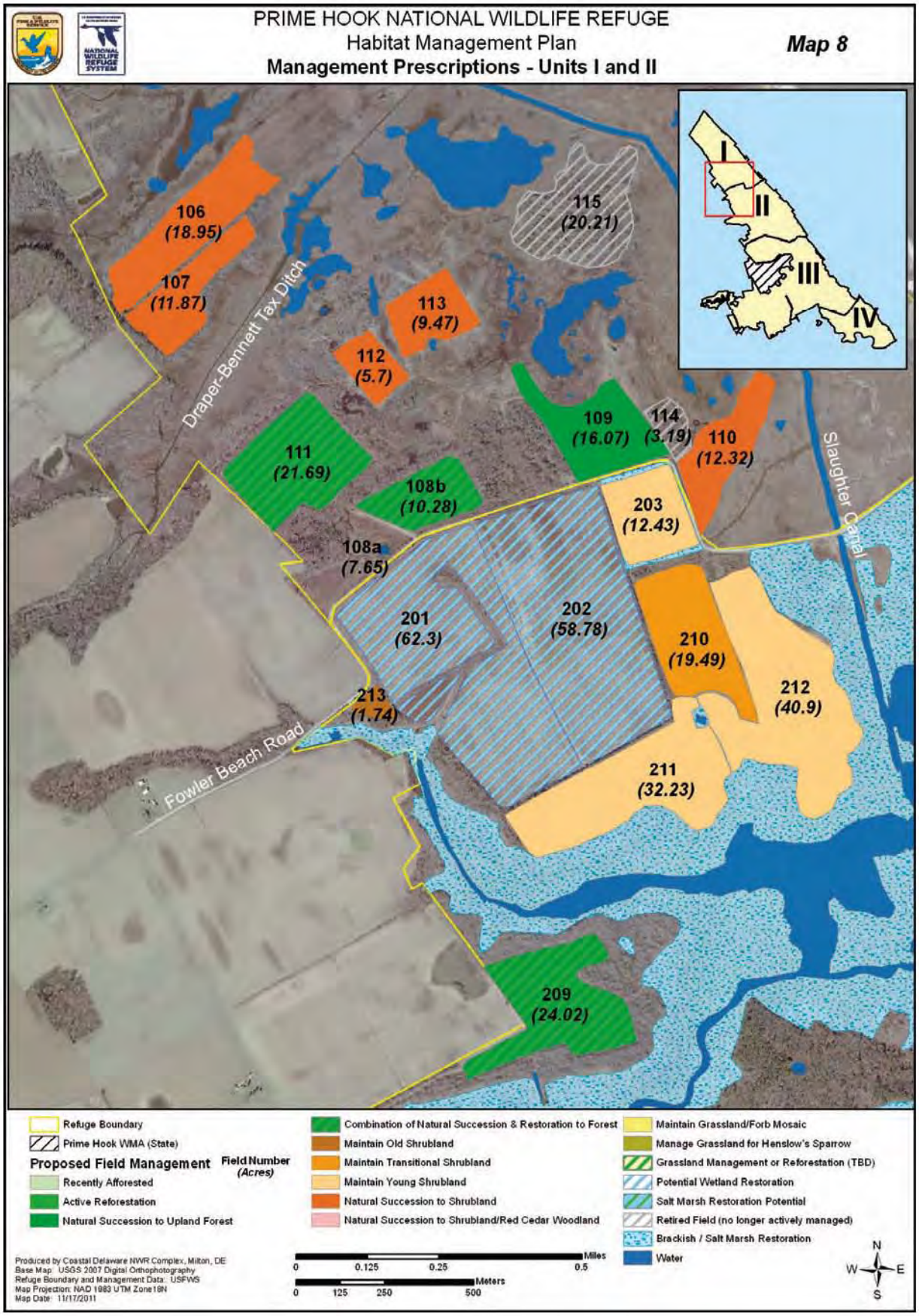
The natural world contains a myriad of extremely complex and dynamic systems. As land stewards and habitat managers, we can never completely understand every aspect of these continually changing systems, but must be ready to react to its ever-changing geophysical, ecological, social, and political factors that influence status of biodiversity and its conservation. Despite the extensive planning efforts undertaken within this Habitat Management Plan, there will undoubtedly be additional need to address changes to physical, ecological, social, political, and financial factors that influence biodiversity and its conservation. Specific details concerning implementation of the inventory and monitoring prescriptions will be identified in the Inventory and Monitoring Plan. The management prescriptions outlined here represents a comprehensive effort to guide management primarily over the next fifteen years. However, it is impossible to predict the full suite of management strategies and prescriptions required over this period.

5.2 Habitat Management Units

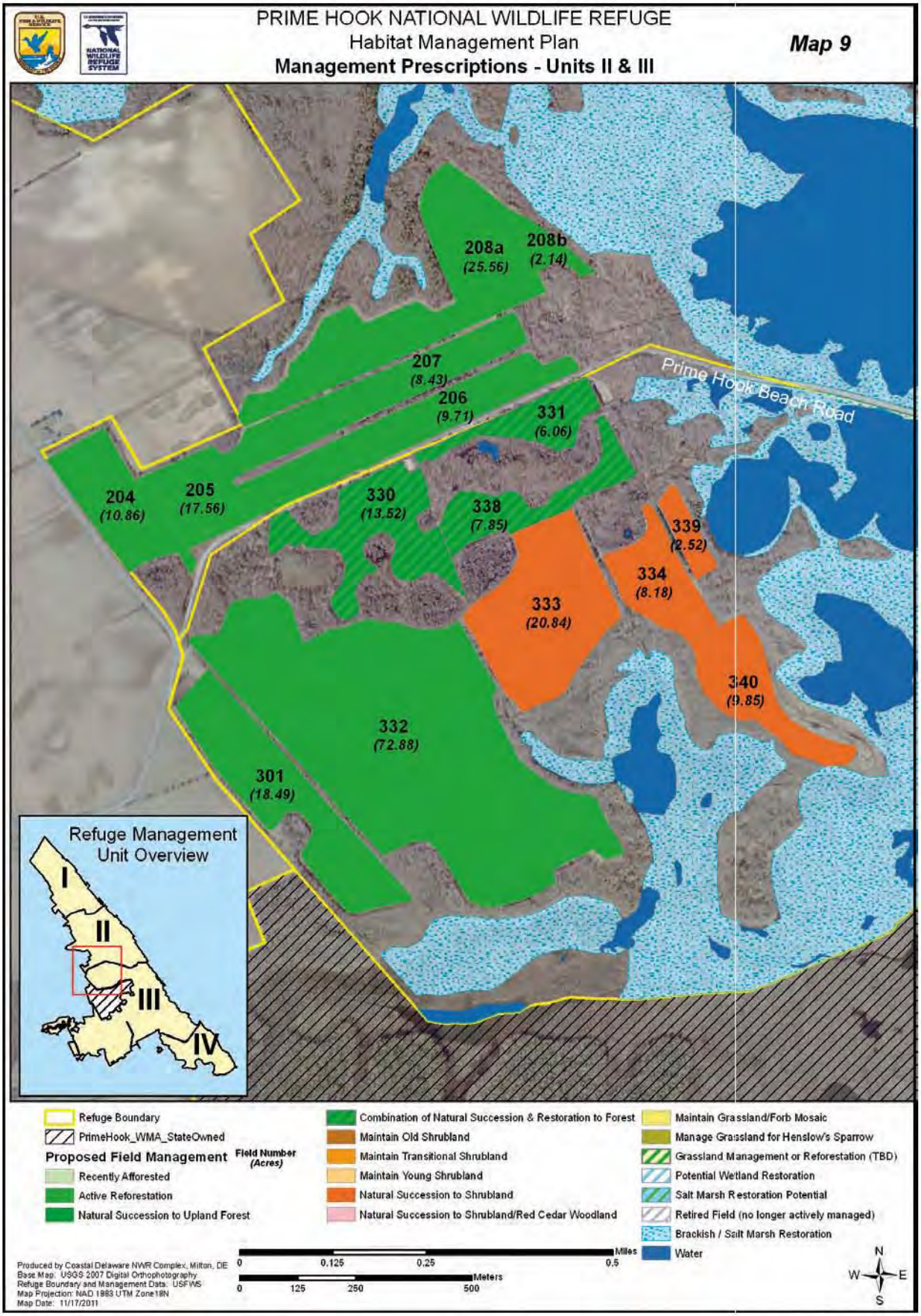
For the purpose of meeting habitat management objectives, Prime Hook NWR is divided into four main Refuge Management Units. These Management Unit boundaries were delineated based on physical features, such as a road or large waterway, as well as refuge boundaries. Within these units, individual fields have been delineated through past management actions, and are numbered to correspond with historical management references. See HMP Maps 3–7 for management unit boundaries and refuge field numbers.

See HMP Chapter 2 Section 2.2 for a description of NVCS Natural and Anthropogenic Vegetative Community Types represented within each Refuge Management Unit (HMP Maps 2–7). Where appropriate, Natural Plant Communities have been summarized by Refuge Management Unit for each Objective in Section 5.3 below. In the case that desired future condition differs from the current condition within a Refuge Management Unit, additional tables are provided to identify field and unit numbers and affected acres.

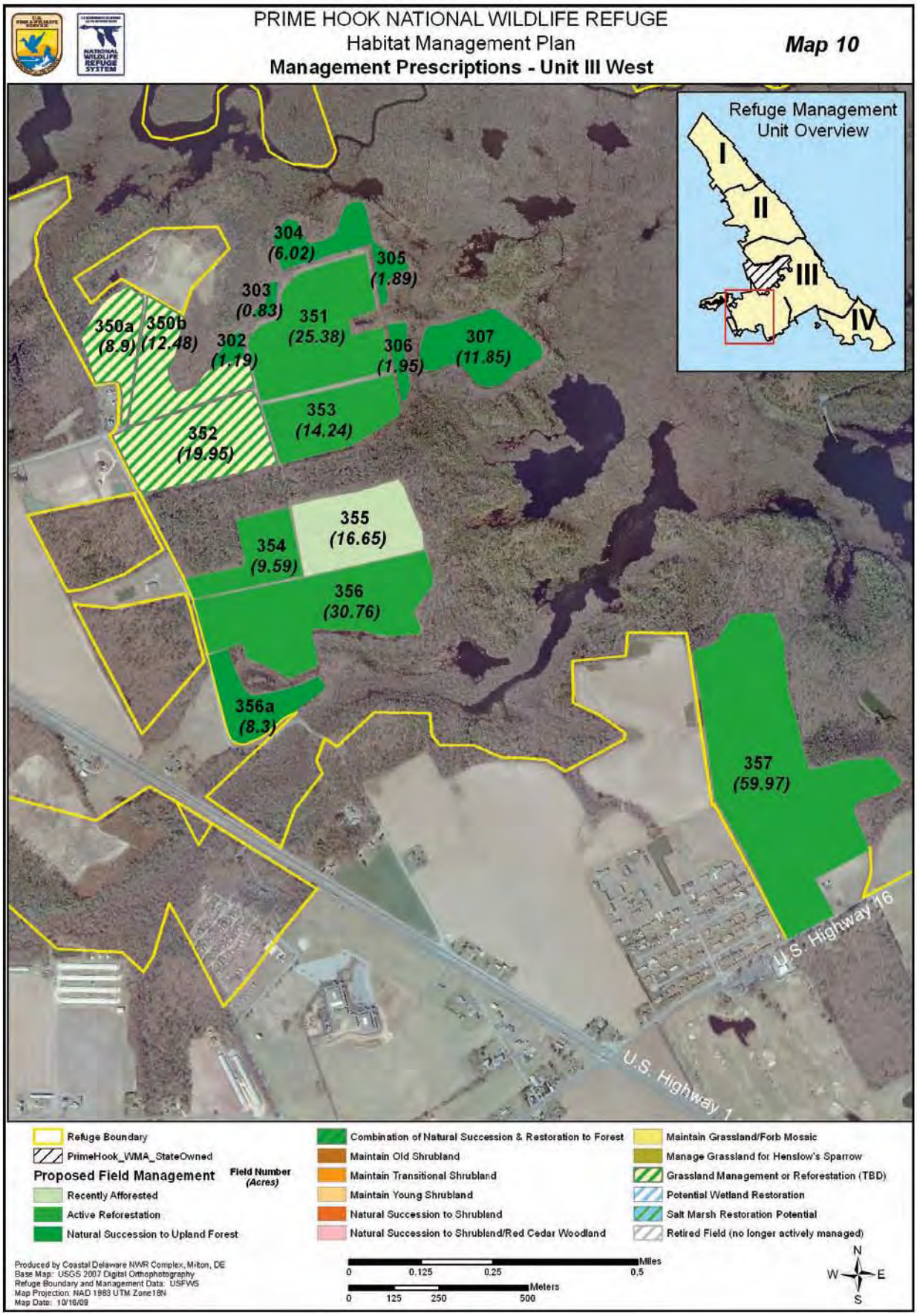
Map 8. Management Prescriptions - Units I & II



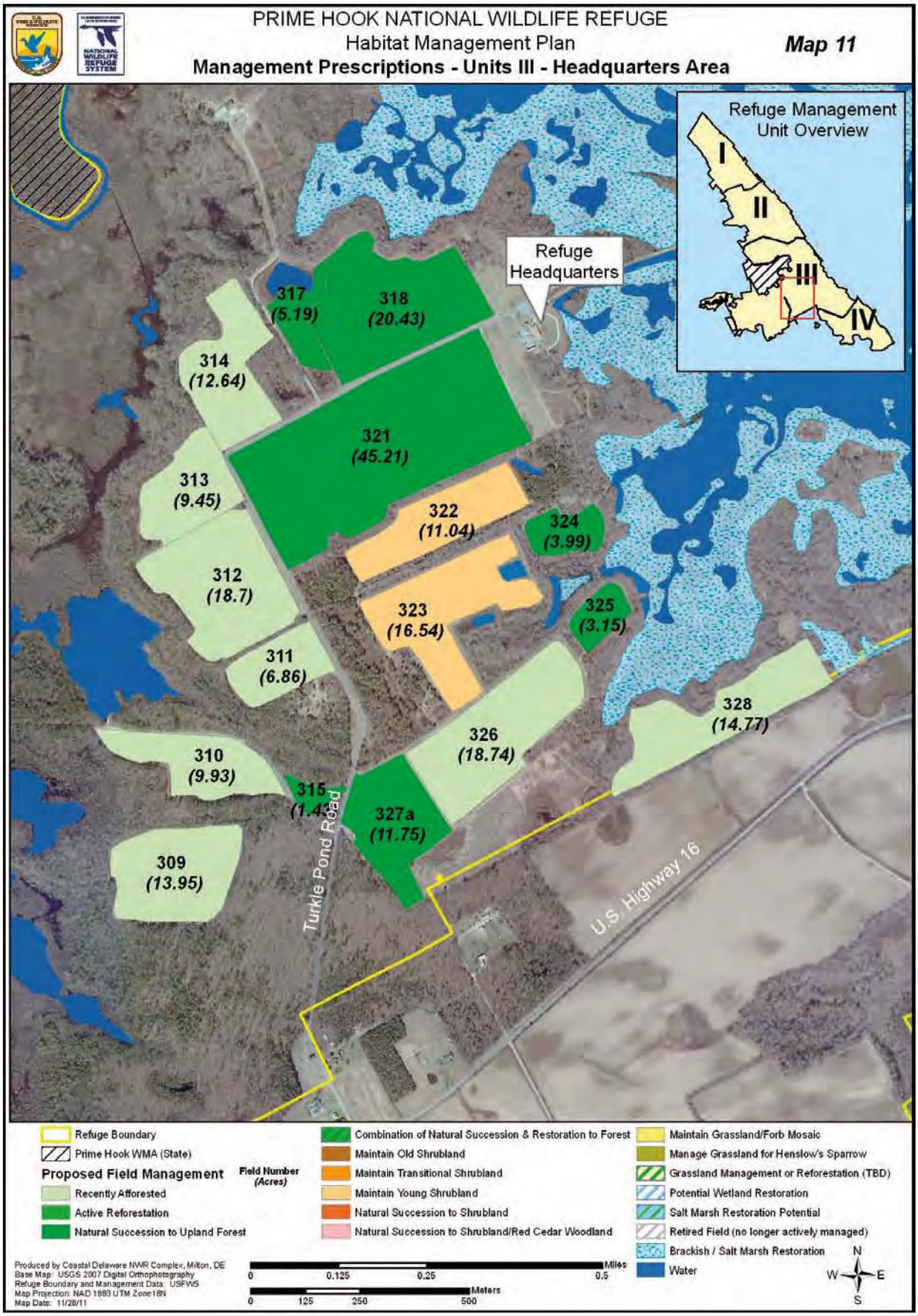
Map 9. Management Prescriptions - Units II & III



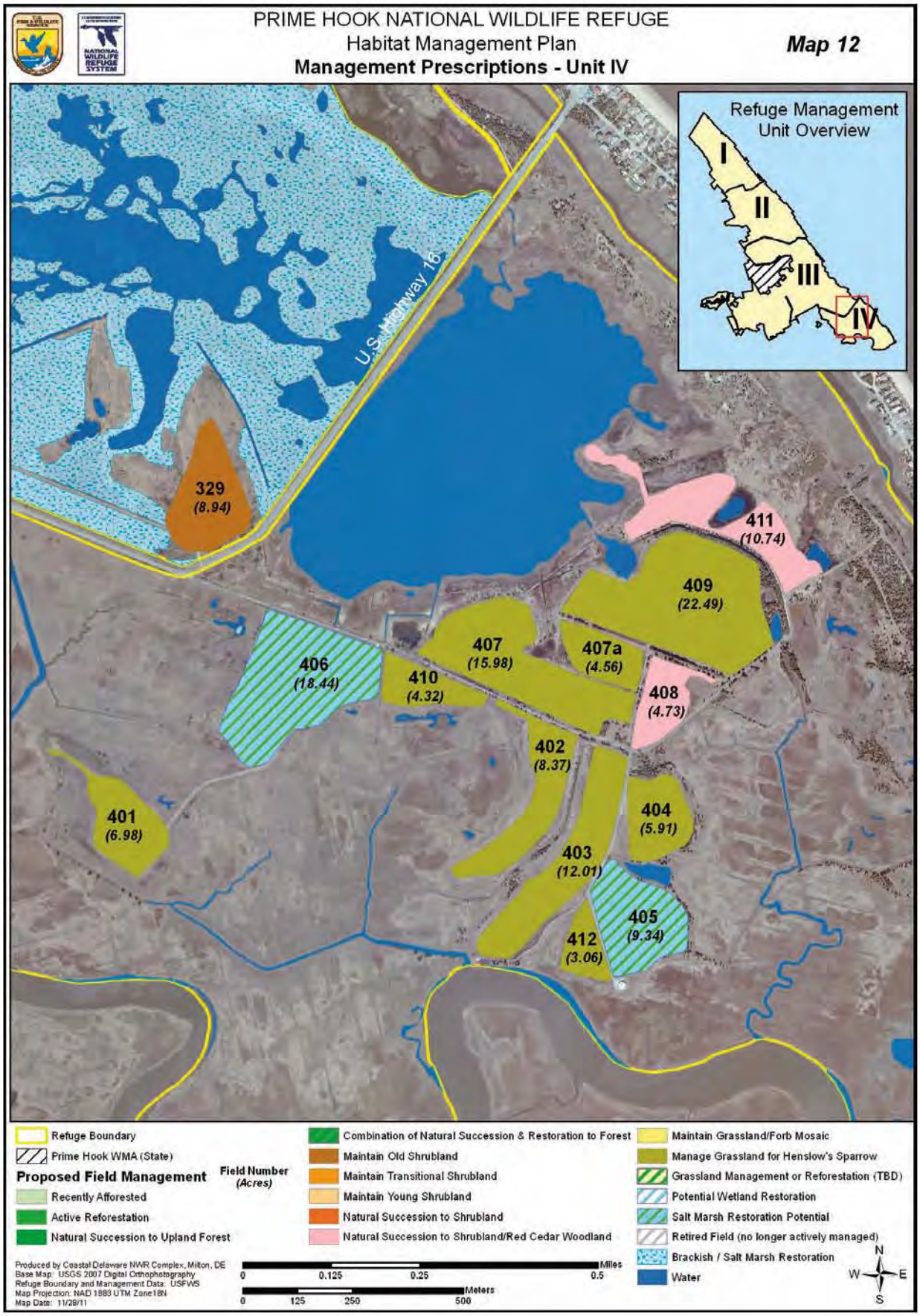
Map 10. Management Prescriptions - Unit III (West)



Map 11. Management Prescriptions - Unit III (HQ Area)



Map 12. Management Prescriptions - Unit IV



5.3 Management Strategies and Prescriptions by Habitat Objective

Objective 1.1 (Overwash, Sandy Beach and Mudflat Habitats)

Table 14. Objective 1.1 Natural Community Types and Acres by Refuge Management Unit

NVCS - Natural Community	Unit #	Acres
Beachgrass/Panicgrass Dune Grassland	I	12.5
	II	22.6
	III	0.0
	IV	0.0
Overwash Dune	I	5.1
	II	4.2
	III	0.2
	IV	0.0
Total Acres:		**44.6**

Management Strategies and Prescriptions

- Allow the natural processes of inlet formation, sand migration, and/or overwash development;
- Avoid artificial dune stabilization to occur where tidal flow from the Delaware Bay is naturally restoring salt marsh habitats;
- Develop a site-specific restoration plan for Unit II, with the input of an advisory team of subject matter experts, which will include recommendations for short-term and long-term shoreline management which will maximize the success of salt marsh restoration efforts (See Objective 3.1);
- Control invasive plant species (mostly *Phragmites australis* and *Salsola kali*);
- Seasonally protect beach berm, wrack-line, and associated dune edge, and overwash from human disturbance and predators to protect listed breeding and migrating shorebirds, establishing and enforcing nesting area closures from March 1st to September 1st;
- Develop a Refuge-specific piping-plover contingency management plan should piping plovers establish nesting sites on Refuge over-wash areas;
- Consider the use of enclosures to protect state and federally listed shorebird species that establish nest sites on barrier beach island habitats; and,
- Determine the potential number of nesting pairs of American oystercatcher, piping plover and other focal species that could be supported by available overwash, sandy beach, and dune grassland habitats by 2012, to fine-tune protection prescriptions.

Monitoring Elements

Conduct appropriate monitoring and survey programs as funding and staffing permits to measure our success with respect to our objectives. The results may trigger adjustments to management strategies, or a reevaluation or a refinement of our objectives. Examples of monitoring or surveys that we may implement include:

- To determine number of nesting pairs of American oystercatcher, least and common terns, and piping plover and estimate productivity, conduct annual surveys during the breeding and nesting season;

- Prevent new invasive species from becoming established by utilizing Early Detection Rapid Response Techniques that detect newly established invasive species and immediately addresses those populations through the appropriate control measure. This approach will incorporate a combination of plant identification and inventories, maintaining updates of new invasive species present in the region, as well as having knowledge of the appropriate management techniques prior to conducting control efforts; and,
- Establish annual habitat assessment protocols of overwash areas and mini-inlet openings and closures along Unit I and Unit II strand beach habitats to monitor expansion and contraction of overwash acreages, creation and plugging of mini-inlets, and tidal flow changes feeding Unit I salt marshes and Unit II impounded wetlands using GPS/GIS tools;
- Conduct shoreline position and topography monitoring along the full length of refuge coastline, consistent with National Park Service (NPS) protocols and in coordination with other Northeast refuges.
- Conduct surveys to determine presence/absence of Northeastern beach tiger beetles to assess the health of overwash, dune grassland, and sandy beach habitat;
- Develop and implement weekly bird use censusing protocols. Utilize data to document the on-going effectiveness of water level management activities and adjust management protocols as necessary;
- Monitor habitat impacts from public use and impacts to resources of concern during the spring and summer periods;
- To maintain suitable nesting habitat for beach nesting shorebirds, monitor presence of red fox, raccoon, feral cats, and other predators and implement predator removal measures in collaboration with USDA Wildlife Services;
- Work collaboratively with DNREC Coastal Programs to set up physical markers on the ground to establish baseline of overwash formations, sea level rise changes, and changes in tidal flow patterns;
- Re-survey and calibrate all refuge water control structures to reflect the true local mean sea level of refuge marshes and water inflows and outlets;
- Reset all gauges to one common vertical datum; and,
- Establish several tides gauges, starting with locations in Slaughter canal in Unit I and Broadkill River in Unit IV.

Climate Change and Sea Level Rise Adaptation Strategies and Monitoring:

- Train USFWS staff to conduct shoreline survey data as per National Park Service (NPS) protocols for Northeast Coastal and Barrier Network (NCBN)-Geomorphological Monitoring Protocol for shoreline position (Natural Resource Report (NPS-NCBN-NRR-2010/185). Protocols include a number of highly detailed SOPS that are intended to ensure scientific consistency and repeatability; Conduct these surveys in early spring (mid-March to late April) and early fall (mid-September to late October) – a period that coincides with the peak expression of seasonal beach variability.
- Co-ordinate Refuge shoreline monitoring efforts with other R5 Coastal refuges to integrate NCBN database to foster DOI-wide sharing of standardized monitoring data. NPS Vital Signs Program- "Shoreline Position Monitoring Protocol" is the first of a series protocols being developed by NCBN; Upcoming protocols, such as documenting and monitoring shoreline topography, will be implemented as they are developed by the NPS.
- Staff will seek training and annual refreshers as needed to maintain competency in:
    - Basic Coastal Geomorphology
    - Mission Planning (Seasonal timing/tides/storms/survey windows using long-term identification of neap tide conditions using NOAA tide gauge data)

- Conducting survey, dealing with shoreline perturbations, collecting benchmarks, preparation of equipment, and keeping informed of protocols and SOP changes and improvements
- Post-survey Processing of spatial data
- Update knowledge of improved and new sampling protocols and SOPs

Objective 1.2 Maritime Shrub and Maritime Forested Habitats

Table 15. Objective 1.2 Natural Community Types and Acres by Refuge Management Unit

NVCS - Natural Community	Unit #	Acres
Atlantic Coast Interdune Swale	I	0.3
	II	20.1
	III	15.8
	IV	30.5
Maritime Red Cedar Woodland	II	1.9
	III	7.8
	IV	66.2
Successional Maritime Forest	II	71.3
	III	90.6
	IV	22.0
Interdunal Switchgrass Brackish Depression	III	0.7
	IV	5.7
Mid-Atlantic Maritime Salt Shrub	I	10.8
	II	7.2
	III	1.5
	IV	40.4
	Total Acres:	**392.8**

Table 16. Objective 1.2 Desired Future Condition/Prescription by Refuge Management Unit and Field Number

Habitat Management Prescriptions for all Units (HMP Map 12)				
Desired Future Condition	**Unit #**	**Field Number**	**Current Condition**	**Size (acres)**
Natural Succession to Shrubland/Red Cedar Woodland	**IV**	408	Interdunal Switchgrass Brackish Depression	6.0
		411	Northeastern Successional Shrubland	12.0
		Total Acres:		**18.0**

Management Strategies and Prescriptions

- Maintain and/or enhance native vegetation communities using prescribed fire where appropriate; consult with Service Region 5 fire ecologist to determine, if, when, and where prescribed fire would be appropriate to reduce invasive species, or maintain shrub habitats, or maintain or enhance successional maritime forest community health.

- Prevent new invasive species from becoming established by utilizing Early Detection Rapid Response Techniques that detect newly established invasive species and immediately addresses those populations through the appropriate control measure;
- Permit natural succession to shrubland/red cedar woodland in prescribed fields (Table 16);
- Eliminate the use of mosquito adulticides over these habitats with the exception of a documented public health emergency, to reduce negative impacts on non-target invertebrates;

Monitoring Elements

Conduct appropriate monitoring and survey programs as funding and staffing permits to measure our success with respect to our objectives. The results may trigger adjustments to management strategies, or a reevaluations or a refinement of our objectives. Examples of monitoring or surveys that we may implement include:

- Re-evaluate Refuge breeding bird survey points to determine whether they are placed appropriately to monitor birds of conservation concern identified in DWAP, BCR 30, and PIF 44 plans, and establish spring, fall, and breeding landbird survey points in these habitats types, where needed;
- Monitor the little wife underwing moth as an indicator of healthy Red Cedar Woodland and Successional Maritime Forested habitats that contain southern bayberry as a vegetative component;
- Conduct annual habitat condition assessments, survey for invasive species problems, and prioritize treatment areas;
- To evaluate achievement of the objective for breeding and migrating birds conduct bird surveys for priority species. Utilize data to document the effectiveness of management activities and adjust management protocols as necessary;
- Prevent new invasive species from becoming established by utilizing Early Detection Rapid Response Techniques that detect newly established invasive species and immediately addresses those populations through the appropriate control measure. This will incorporate a combination of plant identification and inventories, maintaining updates of new invasive species present in the region, as well as having knowledge of the appropriate management techniques prior to conducting control efforts;
- Evaluate bird use by conducting point count surveys during spring and fall migration and breeding periods in these habitat types;
- To evaluate the effectiveness of prescribed burning to reduce invasive species or maintain shrub habitats conduct post-burn surveys to measure the area, the intensity, and the success of the burn.

Objective 1.3 (North Atlantic Low and High Salt Marsh Habitats)

Table 17. Objective 1.3 Natural Community Types and Acres by Refuge Management Unit

NVCS - Natural Community	Unit #	Acres
Spartina High Salt Marsh	I	75.2
	IV	7.8
Spartina Low Salt Marsh	I	982.0
	IV	774.8
Brackish Tidal Creek Shrubland	I	73.9
	II	3.3
	III	1.3
	IV	17.7
	Total Acres:	**1,936.0**

Table 18. Objective 1.3 Desired Future Condition/Prescription by Refuge Management Unit and Field Number

Habitat Management Prescriptions for all Units (HMP Map 12)				
Desired Future Condition	**Unit #**	**Field Number**	**Current Condition**	**Size (acres)**
Salt Marsh Mitigation Potential	**IV**	405	Irregularly Flooded Eastern Tidal Salt Shrub/ Northeastern Successional Shrubland	9.3
		406	North Atlantic Low Salt Marsh/ Atlantic Coast Interdune Swale	19
Brackish / Salt Marsh Restoration Planned	**II**	N/A	Generic Marsh	2500
	III	N/A	Generic Marsh	1500
		Total Acres:		**28.3**

Management Strategies and Prescriptions

- Assist with the development and use of Region 5's "Salt Marsh Integrity Index" (SMI) that will result in the development of multi-metric salt marsh integrity (SMI) Index to score habitat condition; use the Index as a performance measure to improve annual habitat management planning and restoration actions when scores are low;
- Enhance/restore any degraded wetlands including salt marsh and adjacent upland habitats that buffer all Refuge salt marsh habitats, and including impounded wetlands within Unit II and Unit III;
- Restore the natural hydrology to tidal marshes whenever feasible and allow natural processes to occur that increase tidal flows to salt marsh habitats;
- Develop an Adaptive Management Framework for *Phragmites* control so that treatments are monitoring and evaluated for effectiveness. The refuge will be using an integrated approach to *Phragmites* control, which will consider restoration of natural processes, herbicides, prescribed burning, biocontrol, and other tools as they are developed;
- Control additional invasive species if and when they are encountered in the salt marsh
- Use obligate salt marsh passerines as indicators of biological integrity, diversity, and environmental health (BIDEH) for salt marsh habitats;
- Within 1-2 years of CCP approval, develop monitoring protocols and an annual biological monitoring and inventory program to document annual salt marsh condition, prescriptive management action taken and response to management actions; and,
- Consider continuing or resuming snow goose hunting to alleviate some snow goose use in salt marsh areas, to reduce salt marsh "eat-outs."
- Mow fields 405 and 406 annually and keep in reserve as easy salt marsh restoration sites as possible mitigation sites for future Refuge road improvement projects and functional water control culvert replacements

Mosquito Control Strategies

- Modify mosquito Integrated Pest Management (IPM) strategies to conserve and protect nontarget species by eliminating the use of adulticides unless they are required during situations of documented public health emergency;
- Collaborate with Federal and state vector control personnel to develop specific action thresholds then are currently used that would trigger adulticide spray interventions and begin efficacy reporting of all spray events to compile with Service end-of-the-year reporting requirements;

- Prepare a Refuge Mosquito Management Plan in collaboration with the state to address human and wildlife health risks to mosquito-borne diseases and use action thresholds that trigger chemical interventions to be incorporated in a refuge decision-making response matrix;
- Allow populations of native mosquito species to exist unimpeded unless they pose a specifically identified threat to wildlife, domestic animals, and/or human health risks supported by documented data;
- Per Mosquito Management Plan thresholds, permit limited use of larvicides in OMWM systems if appropriate data supports the assertion that the OMWM system has failed to function properly and thus is ineffective for controlling mosquitoes;
- OMWM excavation will be limited to the maintenance of currently existing OMWM systems; OMWM projects may not be expanded nor any new projects initiated on Refuge lands until marsh elevation data is collected and analyzed. Additional studies that address effects on obligate saltmarsh passerines may be required before any decision will be made to resume construction of new OMWM treatments in previously grid ditched marshes.
- Educate refuge users and other public audiences about avian diversity and how it can help buffer human populations from mosquito borne and other diseases like Lyme's disease

Monitoring Elements

Conduct appropriate monitoring and survey programs as funding and staffing permits to measure our success with respect to our objectives. The results may trigger adjustments to management strategies, or a reevaluations or a refinement of our objectives. Examples of monitoring or surveys that we may implement include:

- Develop a salt marsh monitoring program which incorporates the R5 Salt Marsh Integrity (SMI) Index, in accordance with guidance still in development;
- Develop monitoring protocols and an annual biological monitoring and inventory program to document annual salt marsh condition, prescriptive management action taken and response to management actions;
- Prevent new invasive species from becoming established by utilizing Early Detection Rapid Response Techniques that detect newly established invasive species and immediately addresses those populations through the appropriate control measure. This approach will incorporate a combination of plant identification and inventories, maintaining updates of new invasive species present in the region, as well as having knowledge of the appropriate management techniques prior to conducting control efforts;
- Continue research using open marsh water management (OMWM) scoring data collected specific to PHNWR salt marsh habitat conditions and incorporate in SMI Index assessments;
- Develop habitat monitoring protocols in cooperation with other R5 refuges to quantify impacts (both positive and negative) of snow goose herbivory, like shorebird and waterfowl use of eat-outs, increases/decrease of moist-soil invertebrate production, loss of low marsh acreage, and quantify wintering carrying capacity of Refuge habitats;
- To evaluate achievement of the objective for obligate salt marsh passerines, conduct bird surveys during the breeding season. Utilize data to document the effectiveness of management activities and adjust management protocols as necessary;
- Develop appropriate monitoring elements for mosquito control, in cooperation with DNREC Mosquito Control Section

Climate Change and Sea Level Rise Adaptation Strategies and Monitoring:

- Within 1 to 2 years, establish a Refuge-wide marsh elevation and water monitoring program, to include the following components and steps:

  - Establish 3 monitoring stations within each of two existing salt marsh areas (and an additional 3 stations in each area of impounded wetlands), with surface elevation tables (SETS) and marker horizons, in the same locations of 210Pb and 137Cs radiometric cores currently being monitored on the Refuge; Read SET measurements minimally four times per year (seasonally), but ideally once per month, to track seasonal and periodic storm effects on marsh elevation
  - Establish a real-time USGS-type tide gauge on Slaughter Canal to begin to monitor localized storm effects on refuge
  - Establish geodetic benchmarks in select upland refuge sites and calibrate to newly established SETS, tide gauges(s), and staff gauges located on water control structures, all to the same geodetic control (such as NAVD 88)
  - Conduct RTK-GPS surveys using regional/national protocols to connect prior survey-data points (veg data, groundwater wells, bird points, etc) to same common geodetic control as used above
  - After a minimum of 3 years, determine if areas of the marsh with SETS are experiencing shallow subsidence – i.e. is the upper marsh horizon, despite accretionary processes, still losing elevation relative to local Sea Level Rise?
- The stresses imposed by climate change and SLR will force a shift in quantity and quality of available waterbird habitat on local and regional scales. As a means to ameliorate the loss, the refuge will employ the protocols and directives of the Integrated Waterbird Management and Monitoring Project, now under development.
- Permit the natural replenishment of sediments (through overwash) to allow the marsh to keep pace with sea level rise. Where it is determined this will not be sufficient to overcome elevational capital deficits, the use of artificial renourishment or "assisted accretion" may be appropriate.
- As new research and monitoring results on sea level rise and obligate salt marsh breeding birds come to light, we may in fact wish to fill/restore extant grid ditches and OMWM systems as an adaptation measure in response to climate change.
- Consult with federal and state coastal scientists and other subject matter experts regarding the most effective way to restore salt marsh within the Unit II (and possibly Unit III) wetland impoundments; Restoration options may include addition of supplemental sediment, planting of desirable species, or a host of other techniques. (See Objective 3.1)

Objective 2.1 (Mixed Hardwood Forest Communities)

Table 19. Objective 2.1 Natural Community Types and Acres by Refuge Management Unit

NVCS - Natural Community	Unit #	Acres
Southern Red Oak Heath	III	289.1
Mesic Coastal Plain Oak Forest	I	49.6
	II	99
	III	43.8
Mid-Atlantic Coastal Loblolly Pine	III	41.5
	IV	9.7
Successional Sweetgum Forest	I	31.2
	II	9.4
	III	88
Mesic Coastal Plain Mixed Hardwood Forest	III	19.2

NVCS - Natural Community	Unit #	Acres
Loblolly Pine-Sweetgum Semi-Natural Forest	III	39
Loblolly Pine Plantation	III	10.6
Pond Pine Woodland	III	7.2
Mesic Rich Forest	I	10.6
	III	24.5
	Total Acres:	**772.4**

Management Strategies and Prescriptions

- Manage refuge forest stands to meet the habitat requirements of Delmarva fox squirrels which are similar enough to also meet habitat requirements of priority forest interior dwelling birds listed as focal forest bird species; Criteria described in Table 20.
- During forest inventories, conduct assessment of potential for each stand to harbor gypsy moth and southern pine beetle using a high, moderate, or low disease hazard rating; assessment should be correlated to habitat suitability for DFS (good, fair, poor);
- Maintain and/or enhance forest health through the development of monitoring protocols for insect/disease vectors
- Treating detected insect or disease infestations may include salvage cuts, thinning, and other mechanical techniques, prescribed fire, and insecticides (e.g., Bacillus thuringiensis var. kurstaki (Btk) or Gypcheck for gypsy moths);
- Participate with other refuges in developing Forest Integrity Index
- Use prescribed fire where appropriate to maintain and enhance habitat structural requirements for the DFS and migratory birds;
- Increase and/or improve active forest management to enhance habitat quality for targeted songbirds through sound silvicultural practices such as thinning, selective cuts, and other stand improvement techniques; These stand improvement techniques will occur in small patches less than 5 acres (2 ha);
- Minimize forest fragmentation; in all stand improvement activities avoid fragmenting larger forest patches when possible;
- Regeneration cuts should be designed in a pattern that minimizes edge; circular or square cuts have the least amount of edge produced;
- Leave uncut forested buffers along creeks, ditches, streams, and adjacent to wetlands habitats; the wider the buffer, the more benefit it will provide to forest interior birds.
- Utilize triggers outlined in Table 20 as thresholds for stand improvement interventions to maintain and enhance wildlife habitat needs for priority focal management species;
- Manage bald eagle nest sites in accordance with State and National Bald Eagle Guidelines (USFWS 2007c), utilizing forest management techniques and/or prescribed fire, and observing recommended time-of-year restrictions and buffer zone guidelines;
- Promote consistent annual mast production by using selection cuts where hard mast trees are greater than 15”dbh to develop larger, well-formed crowns and with a species composition target of 1/3 white oak, 2/3 red oak, and a mixture of hickory and walnut trees (McShea and Healy 2002);
- Den trees and trees adjacent to den trees will not be cut during silvicultural treatments. Adjacent trees provide shade the bole of the den tree, keeping it cooler;
- To promote establishment of den sites, trees interfering with mast tree crown development will be left standing and killed by girdling or using systemic herbicides (BNWR 1994);

- Explore opportunities to supplement the refuge DFS population through translocations; and,
- Field management prescriptions outlined in Table 21, and depicted in HMP Maps 8–11, will add to existing forested communities, and then be managed according to this objective.

Guidelines listed below for desired future forest stand condition(s), suggest that to provide for regeneration of shade intolerant trees, one to three acre patches should be harvested on five to ten percent of the stands. Leaving 4 to 6 trees per acre within these small regeneration cuts will maintain some overstory and use of these harvested sites by forest birds will be more likely. Additionally, some of these "seed trees" may develop into super-canopy trees (defined as large trees > 35 inches dbh with big crowns above the plane of the forest canopy). Patches should be located where regeneration of shade intolerant tree species is present or highly likely. As a general guideline between 30 to 60 percent, preferably 40 to 50 percent, of most stands should be hard mast producing tree species.

Table 20. Objective 2.1 Mixed Hardwood Forest Community Maintenance and Enhancement Prescriptions

Objective 2.1 - Mixed Hardwood Forest Community Maintenance and Enhancement Prescriptions	
Target Forest Conditions	**Condition to Trigger Mgmt Action**
>80% canopy cover in the stand	< 80% canopy cover in the stand
Basal area 70 to 90 ft^2 / acre (16 to 20 m^2/ha)	Basal areas > 100 ft^2/acres (> 28 m^2 / ha)
60% to 80% stocking	> 100% stocking
Vines in overstory on 40%-60% of inventory (cruise) plots	Vines in overstory on < 30% of inventory (cruise) plots
"Super-canopy" trees on 10% to 20% of inventory (cruise) plots [= 4 to 6 super-canopy trees per acre]	"Super-canopy" trees < 5% of inventory (cruise) plots
Mid-story canopy cover on 30% to 60% of stand	Mid-story canopy on < 20% of stand
Vines in midstory on 50% to 70% of inventory (cruise) plots	Vines in midstory < 30% plots
Understory canopy cover less 30%	Understory canopy cover > 30% of stand
<30% ground cover occupancy average across inventory (cruise) plots	>30% ground cover occupancy average across inventory (cruise) plots
Regeneration of hard mast tree species (oaks and hickories) on 30% to 50% inventory (cruise) plots	Regeneration of hard mast tree species (oaks and hickories) on < 20% of inventory (cruise) plots
2 to 4 logs/acres that provide coarse woody debris	< 2 logs/acres providing coarse woody debris
4 to 6 cavity trees (snags) > 4 inches dbh/acres	< 4 cavity trees (snags) > 4 inch dbh/acres
1 to 4 large "den" trees or "unsound cull" trees per 10 acres	< 1 large "den" tree or "unsound cull" tree per 10 acres

We expect that many stands have current conditions or site capabilities that may warrant more restrictive forest management options, or multiple management actions, to achieve desired forest conditions. We recognize that there is no single recipe for achieving desired results. Focal species priorities and forest management objectives are going to require evaluation on a site by site basis that involve the skill of foresters and biologists working together to establish site-specific objectives, evaluate current stand conditions, write site-specific prescriptions, monitor pre and post habitat conditions and respective wildlife use of treatment sites, and evaluate results.

Monitoring Elements

Conduct appropriate monitoring and survey programs as funding and staffing permits to measure our success with respect to our objectives. The results may trigger adjustments to management strategies, or a reevaluation or a refinement of our objectives. Examples of monitoring or surveys that we may implement include:

- Prevent new invasive species from becoming established by utilizing Early Detection Rapid Response Techniques that detect newly established invasive species and immediately addresses those populations through the appropriate control measure. This approach will incorporate a combination of plant identification and inventories, maintaining updates of new invasive species present in the region, as well as having knowledge of the appropriate management techniques prior to conducting control efforts;
- Establish forest inventory schedules on PHNWR to document stand specific information of tree species composition, health of crown overstory trees, regeneration in stands, presence/absence of exotic insects at damaging levels, stocking levels, and map invasive plants to guide future Refuge forest habitat maintenance, management, and reforestation decisions;
- Improve point-count monitoring surveys for listed forest communities in Objective 2.1; include the monitoring of annual habitat condition and characteristics with associated points to assess bird use; monitoring should capture both breeding and migrating forest bird species;
- Monitor changing bald eagle nesting sites and make public use modifications or other habitat management actions necessary to protect sites during critical nesting periods;
- Use the presence of the long-horned beetle as an indicator species for patch size and environmental health of mature forest stands dominated by oaks; this beetle requires healthy, oak dominated mix-hardwood patch sizes of greater than 250 acres
- Coordinate with the Chesapeake Bay Field Office (CBFO) to implement improved Delmarva Fox Squirrel monitoring techniques, such as motion-activated cameras, as well as trapping and/or nest box checks, as recommended.

Climate Change and Sea Level Rise Adaptation Strategies and Monitoring:

- Reduce the impacts of stresses that can exacerbate the effects of climate change, particularly from wildland fire, insects, and diseases.
- Step up measures to prevent and control the spread of invasive species.
- Prevent or reduce barriers to species migration, such as forest fragmentation.
- Improve forest health monitoring for early detection of climate change impacts.
- Help forests regenerate after disturbances, e.g. through reforestation.
- Support research to better understand forest vulnerability to multiple stressors and to find ways to enhance forest resilience.
- Within one year of CCP completion, conduct a complete forest inventory of forest lands and repeat the monitoring every 10-15 years.
- Consider establishing a continuous forest inventory monitoring system

Objective 2.2 (Mixed Hardwood Forest Restoration)

Table 21. Objective 2.2 Desired Future Condition/Prescription by Refuge Management Unit and Field Number

Habitat Management Prescriptions for all Units (HMP Maps 8-11)				
Desired Future Condition	**Unit #**	**Field Number**	**Current Condition**	**Size (acres)**
Active Reforestation	II	204	Agricultural Field	10.8
		205	Agricultural Field	17.6
		206	Agricultural Field	9.7
		207	Agricultural Field	8.4
		208a	Agricultural Field	25.6
		208b	Northeastern Successional Shrubland	2.1
	III	301	Agricultural Field	18.5
		332	Agricultural Field	72.9
		351	Agricultural Field	24.2
		353	Agricultural Field	13.6
		354	Agricultural Field	8.5
		356	Agricultural Field	27.4
		357	Agricultural Field	60
Natural Succession to Upland Forest	I	109	Brackish Tidal Creek Shrubland / North Atlantic Low Salt Marsh	12
	III	302 –Lead Shot Site	Successional Sweetgum Forest	12.5
		303	Successional Sweetgum Forest	0.8
		304	Successional Sweetgum Forest	6
		305	Successional Sweetgum Forest	1.9
		306	Successional Sweetgum Forest	2
		307	Successional Sweetgum Forest	11.9
		315	Successional Sweetgum Forest	1.4
		317	Successional Sweetgum Forest	5.2
		318	Agricultural Field	20.4
		321	Agricultural Field	45.2
		324	Northeastern Successional Shrubland	4
		325	Northeastern Successional Shrubland	3.1
		327a	Successional Sweetgum Forest	11.8
		356a	Agricultural Field	8.3

Habitat Management Prescriptions for all Units (HMP Maps 8-11)				
Natural Succession or Reforestation (TBD) to Upland Forest	I	108b	Agricultural Field	10.2
		111	Agricultural Field/ Northeastern Successional Shrubland/ Irregularly Flooded Eastern Tidal Salt Shrub/ Successional Sweetgum Forest	21.7
	II	209	Agricultural Field/ Northeastern Successional Shrubland	24
	III	330	Agricultural Field	13.5
		331	Agricultural Field	6.1
		338	Agricultural Field	7.8
		Total Acres:		**529.1**

Management Strategies and Prescriptions

- Reduce fragmentation of Refuge forested habitats through reforestation projects to improve management of area-sensitive wildlife, especially endangered DFS and breeding songbirds listed as Refuge Priority Resources of Concern in Appendix E of the CCP - Table 6;
- Use Population Viability Analysis (PVA) modeling data to set Refuge DFS population objectives, refine objectives as new data becomes available and to design core habitat patches for reforestation for the long term viability of Delmarva fox squirrels;
- Design reforestation projects to promote habitat connectivity on the Refuge and improve management of area-sensitive wildlife;
- Work with private landowners and partners to establish safe harbor agreements for DFS;
- Explore opportunities to supplement the refuge DFS population through translocations, as suitable forest habitat is restored;
- Install speed bumps in refuge entrance road to reduce DFS road mortalities on refuge
- Implement field restoration prescriptions outlined in Table 21 and depicted in HMP Maps 8–11;
    - Active reforestation will incorporate planting of seedlings and/or saplings, incorporating recommendations of experienced partners (e.g., USFWS Delaware Bay Coastal Program staff)
    - In the case of active reforestation, attempts will be made to reforest entire individual fields at one time, for efficiency
    - Passive reforestation will involve permitting natural succession, which relies on neighboring seed sources, avian dispersal, etc.
    - In some fields, additional local analysis will dictate if active reforestation or natural succession is more appropriate

Monitoring Elements

Conduct appropriate monitoring and survey programs as funding and staffing permits to measure our success with respect to our objectives. The results may trigger adjustments to management strategies, or a reevaluation or a refinement of our objectives. Examples of monitoring or surveys that we may implement include:

- Prevent new invasive species from becoming established by utilizing Early Detection Rapid Response Techniques that detect newly established invasive species and immediately addresses those populations through the appropriate control measure. This approach will incorporate a combination of plant identification and inventories, maintaining updates of new invasive species present in the region, as well as having knowledge of the appropriate management techniques prior to conducting control efforts;

- Continue to work with partners to fine-tune population monitoring methodology, habitat assessment techniques and habitat improvement projects;
- Coordinate with the CBFO to implement improved Delmarva Fox Squirrel monitoring techniques, such as motion-activated cameras, as well as trapping and/or nest box checks, as recommended.
- Assess landbird point count monitoring program and, as necessary, locate new points in areas undergoing reforestation, to monitoring bird community response.

Climate Change and Sea Level Rise Adaptation Strategies and Monitoring:

- Consider the impacts of climate change in selecting planting stock and choosing planting methods (e.g., emphasize sources from lower elevations or latitudes).
- Target riparian areas for reforestation to provide or increase buffers along streams, as well as promote vital habitat connectivity
- Keep careful inventory of acres reforested (amount and type) to quantify carbon sequestration contributions of the refuge into the future.

Objective 2.3 (Wetland Forested Communities)

Table 22. Objective 2.3 Natural Community Types and Acres by Refuge Management Unit

NVCS - Natural Community	Unit #	Acres
Red Maple-Seaside Alder Swamp	III	699.3
Atlantic White Cedar-Seaside Alder Woodland	III	9.8
Coastal Plain Depression Swamp	I	39.9
	II	47.2
	III	248.7
Coastal Loblolly Pine Wetland Forest	I	34.2
	III	56.3
Buttonbush Coastal Plain Pond	III	0.8
Swamp Cottonwood Coastal Plain Pond	III	1.5
	Total Acres:	**1,137.7**

Management Strategies and Prescriptions

- Protect large patches (>250 acres) of habitat structural components required by Refuge priority resources of concern which include yellow-throated vireo, prothonotary warbler, and Acadian flycatcher. Management for these species will also provide critical late winter and early spring feeding habitats for the DFS, migrating landbirds, and other wetland-forest dependent wildlife;
- Schedule prescribed burns to sustain and enhance Atlantic White Cedar communities with adequate precautions to protect extant rare faunal and floral species. Consult with Regional Fire Ecologist for the best habitat management recommendations;
- Reduce and/or eliminate factors contributing to site eutrophication of Swamp Cottonwood Coastal Plain community. Enhance existing and create new forested buffer zones and reconnect fragmented blocks of all forested wetland cover-types to mitigate eutrophication inputs from off-refuge sources;
- Treat current areas infested with Japanese stiltgrass, *Phragmites,* and other problematic invasive plant species. Monitor all cover-types for invasive encroachment on an annual basis and treat when coverage exceeds 10% of the areas;

- For *Phragmites* control, develop an Adaptive Management Framework so that treatments are monitored and evaluated for effectiveness. The refuge will be using an integrated approach to phragmites control, which will consider restoration of natural processes, herbicides, prescribed fire, biocontrol, and other tools as they are developed;
- Restore natural hydrology of Coastal Plain Depressions Swamp communities (UNIT III south of Prime Hook Beach Road);
- Consider selective thinning or girdling trees adjacent to sensitive cattail-sedge (*Carex typhina*, S3) and slender blue-flag iris (*Iris prismatica*, S2) within the Coastal Plain Depression Swamp community;
- Utilize best management practices and other management actions to protect rare plant communities, such as the Red Maple/Seaside Alder community, southern twayblade orchid, and swamp cottonwood, as is feasible and consistent with other management objectives.

Monitoring Elements

Conduct appropriate monitoring and survey programs as funding and staffing permits to measure our success with respect to our objectives. The results may trigger adjustments to management strategies, or a reevaluation or a refinement of our objectives. Examples of monitoring or surveys that we may implement include:

- Prevent new invasive species from becoming established by utilizing Early Detection Rapid Response Techniques that detect newly established invasive species and immediately addresses those populations through the appropriate control measure. This approach will incorporate a combination of plant identification and inventories, maintaining updates of new invasive species present in the region, as well as having knowledge of the appropriate management techniques prior to conducting control efforts;
- Establish point-count monitoring surveys for each habitat cover-type listed in objective 2.3 to determine nesting landbird use of targeted wetland forest resources of concern;
- Obtain GPS location data from Delaware Natural Heritage Program (DNHP) to document rare flora and fauna locations on Refuge GIS database;
- Continue inventories for rare species to better determine their distributions on the Refuge through the establishment of monitoring plots and assess conservation status every 3-5 years.

Objective 3.1 – (Wetland-dependent breeding and migrating birds)

Table 23. Objective 3.1 Natural Community Types and Acres by Refuge Management Unit

NVCS - Natural Community	Unit #	Acres
Marsh	I	33.2
	II	918.9
	III	1,314.7
	IV	4.1

Table 24. Objective 3.1 Desired Future Condition/Prescription by Refuge Management Unit and Field Number

Habitat Management Prescriptions for all Units (HMP Map 9)				
Desired Future Condition	**Unit #**	**Field Number**	**Current Condition**	**Size (acres)**
Potential Wetland Restoration	**II**	201	Agricultural Field	62.3
		202	Agricultural Field	58.8
Brackish / Salt Marsh Restoration Planned	**II**	N/A	Generic Marsh	2500
	III	N/A	Generic Marsh	1500
		Total Acres:		**4,121.1**

Management Strategies and Prescriptions

- Implement water level management and vegetation control strategies, to the extent conditions warrant and permit:
  - Unit III water levels, in accordance with deed restrictions, will not be permitted above a level of 2.8 ft mean sea level (MSL) between October and March 10th;
  - Manage water levels in the 200 acre brackish impoundment in Unit IV to maximize habitat benefits for migratory shorebirds and waterfowl.
  - Control invasive species using chemical control, prescribed fire and other techniques as appropriate so that 95% native vegetation is achieved. The exact number of acres treated will depend on funding and management capability;
  - Restore prior converted wetlands and riparian areas on approximately 250 acres;
  - Restore artificially drained and ditched upland areas to improve hydrology around vulnerable communities;
  - Consider planting of a green browse crop, such as clover, over managed areas when manipulating the soil to set back succession, in order to provide supplemental food for waterfowl;
- Utilize the R5 Impoundment Management Structured Decision Making Model in order to evaluate and validate management options for refuge impoundments.
- Discontinue all management and/or construction of dunes on private land
- In partnership with DNREC Coastal Program, develop a model to enhance the ability to predict the response of the wetland complex under different scenarios, such as: closed inlets; opened inlets; one inlet opening in response to a storm event or purposeful deepening; Fowler Beach Road removed; Prime Hook Rd culverts closed; additional Prime Hook Rd openings installed; water control structure at Slaughter Canal/Fowler Beach Rd removed; Etc. Model will help evaluate what hydrological and vegetation responses may be expected under each scenario.
- Continue consultation with a restoration advisory team consisting of State and Federal coastal scientists and other subject matter experts, to further explore management options and develop a wetland restoration plan for refuge impoundments
- Host public forums during restoration planning to describe the process and techniques under consideration and provide the opportunity for public input.
- Within 5-15 years, implement the resulting restoration plan to restore healthy self-sustaining wetlands in refuge impoundments, utilizing methods determined with the assistance of the restoration advisory team and other experts to be most appropriate and effective; Following establishment of healthy salt marsh, strategies outlined under Objective 1.3 would become applicable. Specific potential strategies include:

- Continue to gather data needed to populate a hydrological model, as described above
- Use coconut logs, "Christmas tree fences", other living shoreline techniques within Unit II to slow wave fetch across large expanses of open water, which may reduce marsh erosion and facilitate the deposition of sediment and establishment of salt marsh vegetation.
- Explore the potential benefit of constructing temporary dikes or berms to create cells within the impoundments to foster sediment deposition and salt marsh vegetation establishment
- Work with the Army Corps of Engineers to assess the availability of suitable dredge material to assist in restoring lost elevation within Unit II and/or Unit III, necessary for the establishment of Spartina
- Evaluate the option of deepening and/or widening one of the existing inlets in Unit II, to increase tidal range in the wetlands, including the movement of water back out to the Bay.
- Examine the financial and ecological feasibility of reintroducing sand from an outside source into the local sediment transport cycle through a modified beach nourishment project; it must be clear that such a project would not be conducted to create a static beach or dune, but would restore coastal sediment dynamics by replacing lost sand, which would then be naturally transported into the back barrier wetlands to improve elevations for vegetation growth;
- Work with DelDOT on the abandonment and eventual removal of Fowler Beach Rd to provide unimpeded tidal flow between Unit I and Unit II, or minimally the installation of large openings under the road to increase and improve tidal flow.
- Determine the potential benefit of clearing internal channels within Unit II, such as the old Slaughter Creek channel, with the cookie cutter, to improve tidal flow throughout the Unit.
- As areas of suitable growing conditions are achieved in portions of the impoundment complex, through the management strategies above, consider supplementing the vegetation establishment through planting of salt marsh plants (e.g., Spartina spp.).
- Cease the treatment of Phragmites in areas that are susceptible to marsh loss; although not a desired vegetation species, its presence in vulnerable areas will help retain sediment elevation and slow conversion to open water. Phragmites would still be treated in areas identified in the Fire Management Plan as "zero tolerance" zones.
- Work with DelDOT on improvements to Prime Hook Rd. that will permit optimal management and/or restoration of Unit III, based on the outcome of modeling analysis.

Monitoring Elements

- Resurvey all water-control structure staff gauges to a single geodetic reference and accurately re-position gauges to reflect current mean sea level (msl)
- Within 1 to 2 years, establish a refuge-wide "elevation-capital" (marsh surface elevation) monitoring program across the two management units, as outlined in more detail in the climate change adaptation strategies under Objective 1.3; In addition to monitoring stations in existing salt marsh, 12 stations will be established in currently-impounded areas (6 in Unit II and 6 in Unit III) with surface elevation tables (SETs) and marker horizons
- Expand efforts to use RTK surveys to monitor elevation throughout the wetland complex, which is less precise than SET measurements, but can be conducted on a broader geographic scale.
- Continue to collect water quality samples through grab-sampling and automated sampling; samples are analyzed in partnership with DNREC through a cooperative agreement
- Implement the NPS Vital Signs Program's "Shoreline Position Monitoring Protocol" and "Shoreline Topography Monitoring Protocol". Coordinate refuge shoreline monitoring efforts with other coastal refuges to foster DOI-wide sharing of standardized monitoring data.

- Monitor the use of refuge impoundments by waterfowl, shorebirds, passerines, and other waterbirds, in all phases of transition and restoration, in accordance with established protocols such as IWMM; As feasible, coordinate research with academic partners, such as the University of Delaware, and with DNREC.
- Seek opportunities to monitor other species groups, such as fish, within the wetlands during all phases of transition and restoration, potentially through partnerships with academic institutions, such as Delaware State University, or other organizations.
- Utilize the Region 5 salt marsh integrity (SMI) index as a measure of the success of restoration efforts over the next 15 years
- Update existing vegetation mapping within the wetland complex to reflect changing vegetation and open water conditions, and repeat as needed and practical; Explore the utility of archived satellite imagery for vegetation/open water change analysis.
- Utilize Early Detection Rapid Response Techniques that detect newly established invasive species and immediately addresses those populations through the appropriate control measure.
- Develop improved monitoring and inventory program, such as outlined in the Intergrated Waterbird Management and Monitoring (IWMM) Program, to assess annual habitat conditions created through management and restoration in all wetland areas, and associated bird use.
- Implement water/soil salinity monitoring to inform decisions about wetland response to management and restoration.
- To determine whether annual seed production in moist-soil management units have met the annual objective of 1,200 lbs per acre using a grid sampling technique (Fredrickson 1991; Laubhan 1992a).
- Obtain location and distribution data of known rare plant and animal populations from DNHP and store on refuge GIS database;
- Continue research inventories and studies on the viability and persistence of existing rare plant populations and associated rare faunal species; determine life history requirements for rare plants and animals currently on the refuge to improve future habitat management.

Objective 3.2 (Manage water quality for trust fishery resources, migratory birds, and resident wildlife)

Management Strategies and Prescriptions

- Repair, replace, and upgrade water control structures, fish weirs, flapgates, flaplogs, and conventional logs as needed;
- Conserve and improve tidal flows into the salt marshes Units I and IV;
- Continue to provide and improve optimal fish passage capability for anadromous fish in Units II and III;
- Create new or widen existing vegetated riparian buffers greater than 300 feet comprised of native vegetation (trees & shrubs), by connecting isolated or disjunctive patches around refuge creeks, waterways, and marshes, through assisted reforestation projects or allowing natural succession to occur;
- Retrofit road culvert systems connecting Units II to III to protect and maintain the Refuge's freshwater resources and aquatic habitats;

- Maintain and/or restore water movement and circulation within existing drainage networks of the Refuge's impoundment complex to improve water level management capabilities by developing a rotational cleaning schedule between Unit III & IV impoundments every 5 years; drainage networks include up to 6.2 miles of ditches in Unit II Impoundment, up to 7.5 miles in Unit III Impoundment, and up to 3,300 linear feet in Unit IV Impoundment;
- Participate in partnerships with other state and Federal agencies to address interjurisdictional fish and State rare fish issues;
- Participate in Spill Prevention, Control, and Countermeasure Plans or other environmental emergency action plans as related to protection of Prime Hook's aquatic and terrestrial resources; and,

Monitoring Elements

Conduct appropriate monitoring and survey programs as funding and staffing permits to measure our success with respect to our objectives. The results may trigger adjustments to management strategies, or a reevaluation or a refinement of our objectives. Examples of monitoring or surveys that we may implement include:

- Conduct refuge fishery inventories every five years to assess fishery health and water quality of aquatic habitats. Document information such as species composition, class size and distribution, abiotic conditions and other information to adjust management prescriptions as needed and recommended by the Service's Fishery Division. Surveyed areas should include Turkle, Fleetwood, Goose, and Flaxhole Ponds, and Prime Hook Creek. Analyze data and provide management recommendations (seasonal closures, creel size and species limits or catch and release) to adjust public fishing permitted on these closed systems;

Objective 4.1 (Transitional habitats: Grasslands, Shrublands and Young trees)

Table 25. Desired Future Condition/Prescription by Refuge Management Unit and Field Number

Habitat Management Prescriptions for all Units (HMP Maps 8-11				
Desired Future Condition	**Unit #**	**Field Number**	**Current Condition**	**Size (acres)**
Maintain Young Shrubland	**II**	203	Marsh	12.4
		211	Northeastern Successional Shrubland/ Successional Maritime Forest / Marsh	15
		212	Northeastern Successional Shrubland/ Irregularly Flooded Eastern Tidal Salt Shrub/ Marsh	25
Maintain Transitional Shrubland	**II**	210	Northeastern Successional Shrubland	19.5
Manage as Young Shrubland	**III**	322	Agricultural Field	11
		323	Agricultural Field	16.5
Maintain Old Shrubland	**II**	213	Northeastern Successional Shrubland	2
Manage as Old Shrubland	**III**	329	Northeastern Successional Shrubland	8.9

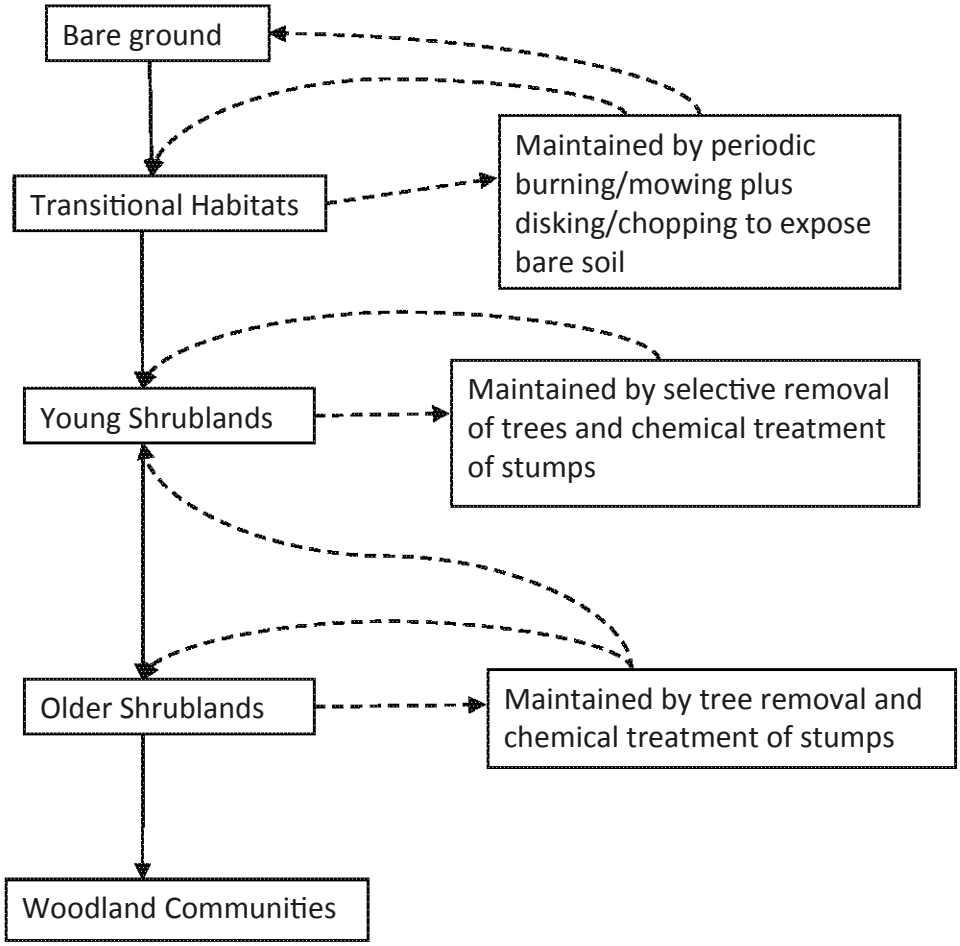
Habitat Management Prescriptions for all Units (HMP Maps 8-11				
Recently Afforested	III	309	Mid/Late Successional Loblolly Pine-Sweetgum Forest	12.5
		310	Successional Sweetgum Forest	9.9
		311	Successional Sweetgum Forest	6.9
		312	Northeastern Successional Shrubland	18.8
		313	Northeastern Successional Shrubland	9.5
		314	Northeastern Successional Shrubland	12.6
		326	Agricultural Field	18.7
		328	Successional Sweetgum Forest	14.8
		355	Agricultural Field	14
Natural Succession to Shrubland	I	106	Northeastern Successional Shrubland	18.9
		107	Northeastern Successional Shrubland	11.9
		110	Northeastern Successional Shrubland/ North Atlantic Low Salt Marsh	12.5
		112	Northeastern Successional Shrubland	6
		113	Northeastern Successional Shrubland	10
	III	333	Agricultural Field	20.8
		334	Agricultural Field	8.2
		339	Successional Sweetgum Forest	2.5
		340	Agricultural Field	9.8
		Total Acres:		**328.6**

Management Strategies and Prescriptions

- Transitional Shrublands: represent the earliest seral stage community transitioning from bare soil. To maintain this stage the following trigger points are used ➔ Open Field characteristics > 50% annual herbs and native grasses and < 50% of scattered shrubs and saplings less than 1 meter (3 feet) in height covering the field. To maintain this stage will require the following treatments as necessary: burning and/or mowing; disking to expose bare soil every 2-4 years;
- Young Shrublands: woody vegetation is dominant but patches of herbaceous vegetation remain. To maintain this stage calls for open field with 50 to 75% of woody plants less than 3 meters (10 feet) tall dominated by shrubs and vines. To maintain this stage will require the following treatments as necessary: hand removal of saplings to maintain shrubs; chemical treatment of stumps and sprouts every 3-5 years;
- Older Shrublands: To manage older shrubland habitats in Unit III, characterized by nearly complete cover of woody vegetation (> 90%), will require the following treatments as needed: hand removal of saplings to retain open canopy and shrub dominance; chemical treatment of stumps and sprouts every 3-5 years;
- Implement field management and restoration prescriptions outlined in Table 25.
- These proactively restored or naturally succeeding areas will occur as a shifting mosaic of patches across the Refuge's landscape (Figure 2) as we implement decisions to allow open fields to grow to shrub, and young forest, maintain early successional grassland patches near salt marsh habitats, or retain field openings adjacent to upland mature forests;

- Increase shrubland and forested buffered areas (> 200 m) adjacent to Refuge creeks, depressional swamp and emergent wetland habitats, and/or restore prior converted wetlands for targeted species in both Objectives 4.1 and 4.2.
- Use the USGS publication *"Conceptual Ecological Model for Management of Breeding Shrubland birds in the mid-Atlantic Region"* (Peterjohn 2006) as a guide to restore and/or maintain shrubland habitats;
- Engage the public in outreach and education about the benefits of pollinators, instilling a greater appreciation for invertebrates and their essential links to biological integrity, diversity, and environmental health;
- Engage the public in outreach and education about the benefits of pollinators, instilling a greater appreciation for invertebrates and their essential links to biological integrity, diversity, and environmental health.

Figure 2. Scheme of management decisions and habitat management actions concerning development of secondary successional shrubland habitats on PHNWR



Monitoring Elements

Conduct appropriate monitoring and survey programs as funding and staffing permits to measure our success with respect to our objectives. The results may trigger adjustments to management strategies, or a reevaluation or a refinement of our objectives. Examples of monitoring or surveys that we may implement include:

- Prevent new invasive species from becoming established by utilizing Early Detection Rapid Response Techniques that detect newly established invasive species and immediately addresses those populations through the appropriate control measure. This approach will incorporate a combination of plant identification and inventories, maintaining updates of new invasive species present in the region, as well as having knowledge of the appropriate management techniques prior to conducting control efforts (see Appendix C for an Inventory of Vegetation documented in Old Fields during 2004, 2005, and 2006);
- Develop monitoring protocols for targeted breeding and migratory birds dependent on early successional habitats;
- Conduct annual habitat condition assessments to determine what habitat management actions should be prescribed in AHWP; and,
- Develop GIS monitoring layers (e.g, RLGIS or similar) needed to document restoration and habitat management actions by field number, along with RMAD to tract shifting mosaics of transitioning habitats.
- Explore the possibility of applying current arthropod index of biological integrity for shrubland landscapes (Karr et al. 2003) and other shrubland metrics, in consultation with other Refuges, as a standardized multi-metric index tool to assess the condition and restoration efforts of early successional upland habitats

Objective 4.2 (Grassland Bird Habitat Management)

Table 26. Objective 4.2 Desired Future Condition/Prescription by Refuge Management Unit and Field Number

Habitat Management Prescriptions for all Units (HMP Maps 10, 12)				
Desired Future Condition	**Unit #**	**Field Number**	**Current Condition**	**Size (acres)**
Manage Grassland Adjacent to High Salt Marsh	**IV**	401	Northeastern Successional Shrubland	6.9
		402	Northeastern Successional Shrubland/ Irregularly Flooded Eastern Tidal Salt Shrub/ Marsh	8.4
		403	Irregularly Flooded Eastern Tidal Salt Shrub	12
		404	Northeastern Successional Shrubland	5.9
		407	Northeastern Successional Shrubland/ Irregularly Flooded Eastern Tidal Salt Shrub	15.9
		407a	Atlantic Coast Interdune Swale	4.6
		409	Northeastern Successional Shrubland	22.5
		410	North Atlantic Low Salt Marsh	3
		412	Irregularly Flooded Eastern Tidal Salt Shrub	3

Habitat Management Prescriptions for all Units (HMP Maps 10, 12)				
Grassland management or Reforestation (TBD)	**III**	350a	Agricultural Field	8.5
		350b	Agricultural Field	9.8
		352	Agricultural Field	19.1
		Total Acres:		**119.6**

Management Strategies and Prescriptions:

- Implement field management prescriptions outlined in Table 26 and depicted in HMP Maps 10 and 12 ;
- Increase shrubland and forested buffered areas adjacent to Refuge creeks, depressional swamp and emergent wetland habitats, and/or restore prior converted wetlands for targeted species in both Objectives 4.1 and 4.2. These proactively restored or naturally succeeding areas will occur as a shifting mosaic of patches across the Refuge's landscape as we implement decisions to allow open fields to grow to shrub, and young forest, or maintain early successional grassland patches near salt marsh habitats or retain field openings adjacent to upland mature forests;
- Native grassland maintain in Unit III will require mowing and disking strips on a rotational basis once or twice a year and prescribed fire about every 3 to 5 years to maintain short grass vegetation less than 30 meters mixed with forbs and 20-30% bare ground or create various mosaics with short, medium, and tall grassland patches; annually monitor for invasive plants and treat as needed
- Manage Unit IV open field areas adjacent to salt marsh habitats by maintaining moderately tall vegetation (> 30 cm) with well-developed litter layer and less than 10% woody species encroachment;
- Mow fields 405 and 406 annually and keep in reserve as easy salt marsh restoration sites as possible mitigation sites for future Refuge road improvement projects and functional water control culvert replacements;

Monitoring Elements

Conduct appropriate monitoring and survey programs as funding and staffing permits to measure our success with respect to our objectives. The results may trigger adjustments to management strategies, or a reevaluation or a refinement of our objectives. Examples of monitoring or surveys that we may implement include:

- Prevent new invasive species from becoming established by utilizing Early Detection Rapid Response Techniques that detect newly established invasive species and immediately addresses those populations through the appropriate control measure. This approach will incorporate a combination of plant identification and inventories, maintaining updates of new invasive species present in the region, as well as having knowledge of the appropriate management techniques prior to conducting control efforts (see Appendix C for an Inventory of Vegetation documented in Old Fields during 2004, 2005, and 2006);
- Develop monitoring protocols for targeted breeding and migratory birds dependent on early successional habitats;
- Conduct annual habitat condition assessments to determine what habitat management actions should be prescribed in AHWP; and,
- Develop GIS monitoring layers (e.g., RLGIS or similar) needed to document restoration and habitat management actions by field number, along with RMAD to tract shifting mosaics of transitioning habitats

Appendix A

List of Potential Habitat and Wildlife Management Strategies and prescriptions for Prime Hook National Wildlife Refuge

Native Wetland and Aquatic Vegetation Management
Early Successional Upland Habitats
Invasive Plant Management
Forest Management
Integrated Pest Management
Biological Mosquito Control = Open Marsh Water Management (OMWM)
Control of Over-Abundant or Non-Native Waterfowl Populations
Predator Control and Nuisance Wildlife Management

4.1) NATIVE WETLAND AND AQUATIC VEGETATION COMMUNITIES

a) Water Level Management: Water level manipulation is the most important technique used to set back succession and manage freshwater wetland plant communities. The main objective in water level control is to maximize wildlife habitat diversity by using various drawdown and reflooding schedules. Drawdown simulates the natural flood-dry cycle of natural wetlands. As the marsh dries, dead emergent and other plants oxidize and decompose, releasing nutrients into the soil (Payne 1998).

Hydrological and seasonal variables influence the schedules for water-level manipulations. Hydrological variables include frequency and duration of flooding, water-depth, water temperature, dissolved oxygen within and outside the impoundment, turbidity, and salinity. Seasonal factors include local weather patterns, storm events, lunar phases and tidal amplitudes. Wind speed and direction also influence tidal amplitudes. The key to producing nonpersistent annual grasses and maintain freshwater conditions, is precluding salt water tidal flow into management units.

Drawdowns can be cyclic or non-cyclic, complete or partial, fast or slow, early or late (Fredrickson & Taylor 1982, Payne 1998). For example, Unit III can be drawn down completely by the last week of May to volunteer major moist-soil plants (mainly wild millet, beggarticks, fall Panicum & smartweeds) and reflooded beginning September 30 to feed migrating shorebirds in the spring and then feed migrating and wintering waterfowl, while Unit IV could be completely drawndown by July 15th and slowly reflooded after October 15th so migrant waterfowl and wading birds can feed on marsh purslane and other moist-soil seeds, invertebrates and minnows, and Unit II could be drawndown completely by August 15th to raise spikerush and fall Panicum.

To maintain a dominance of annual plants, a non-cyclic, rotating schedule between management units will be used to diversify water level regimes. This will be done by practicing asynchronous drawdown and reflooding schedules between years and among the three impounded management units. Prescriptions will be based on annual site specific capabilities, strategies needed to control invasives and knowledge of the area.

Slow drawdowns (greater than 2-4 weeks in duration) are more desirable for moist-soil plant establishment, maintaining the productivity of an impoundment and subsequent wildlife use. Slow drawdown rates generate the best seed production, lengthen the period for optimal foraging by priority bird species, and place a larger portion of invertebrates within foraging ranges of a wider array of wetland species. If salinities tend to be high within an impounded areas, slow drawdown regimes should be scheduled during late winter or early spring, when ambient temperatures and evaporation rates are lower. Slow reflooding schedules also maximize habitat heterogeneity for waterfowl utilization. Annual

water level prescriptions will be specified at the end of each year for the next management cycle in Annual Habitat Work Plan (AHWP) documentation.

b) Moist-soil Management: The dynamic nature of moist-soil management demands regular inspection and appropriate annual monitoring to track success and fine-tune management prescriptions to adjust for problems. With a scientific approach and adaptive management, moist-soil and impoundment objectives 3.1 and 3.2 can be consistently met or exceeded. Frequent monitoring and recording of plant and wildlife responses (weekly), natural conditions, weather and management actions taken are essential. The most important factors that will determine and/or limit plant responses (desirable vegetation) and annual seed yields are 1) successional stage of the native plant community; 2) soil temperature; 3) soil moisture; 4) soil chemistry; and 5) water level manipulations.

Generally, the most prolific seed producers and therefore the most "desirable plants" for waterfowl are annuals that dominate early successional seral stage. Moist-soil manipulations over a series of years tend to result in the predominance of annuals if disturbance has been frequent, or of perennials if disturbance has been lacking. Without disturbance, plant succession after several years proceeds to perennial plants that are less desirable for waterfowl food production. It will be necessary to have plant succession set back by burning, prolonged flooding or some form of soil disking every 3 to 5 years to stimulate the growth of annuals. More often than not, this disking service has been provided annually by extensive snow goose herbivory.

As it relates to the timing of drawdowns, soil temperature has a great effect on the species of plants that germinate. In moist-soil management literature, timing of drawdowns are presented as early, mid-season, and late. Fredrickson (1991) describes early drawdowns as those that occur during the first 45 days of the growing season and late drawdowns as those that occur during the last 90 days of the growing season. That suggests that a mid-season drawdown is a variable length depending on the location and length of time between average first and last frosts.

Annual moist-soil plants respond differently to wet, cool conditions verses dry, warm conditions, and to varying ground water table depths. In one year, impoundments may drain within a few days, while in another year a drawdown may extend several weeks. The resulting annual vegetation growth and production will differ accordingly. However, 25 years of scientific literature suggests moist-soil vegetation responses are fairly predictable based on type of drawdown schedules (early, mid-season, or late) that are executed each year (See Summary Table Below). Characteristics of selected moist-soil plants, including successional stage, germination dates, potential seed production, food and habitat values for wildlife are helpful information when crafting AHWP prescriptions each year (See page 8, Fredrickson & Taylor 1982).

Drawdown Date	Soil Temperature	Rainfall	Evaporation	Expected Plant Response
Early (first 45 days after average last frost)	**Cool to Moderate**	**High**	**Low**	Wild millet, smartweed, chufa, Fall panicum, spikerush
Mid-season	**Moderate to Warm**	**Moderate**	**Moderate to High**	Redroot sedge, panic grasses, wild millet, marsh purslane, spikerush

Drawdown Date	Soil Temperature	Rainfall	Evaporation	Expected Plant Response
Late (last 90 days before average first frost)	Warm	Low	High	Sprangletop, beggarticks, crabgrass, panic grass, redroot sedge, spikerush

Maintaining high soil moisture (True Moist-Soil Conditions) throughout the growing season is key to producing large quantities of desirable waterfowl foods (smartweeds, millet, chufa, sedges, panic grasses, sprangletop, etc.) consistently every year. Conducting slow drawdowns is the most effective way to conserve soil moisture throughout the growing season.

Without the ability to re-flood an impoundment artificially during the growing season, experience has shown that a better plant response is achieved by keeping water control structures closed to hold any additional rainfall after drawdowns have been completed to allow water to more slowly evaporate. The practice of opening structures to dewatering the impoundment and then leaving it dry all summer generally results in poorer moist-soil seed production.

Low soil and water salinity values provide the best growing conditions for desirable moist-soil plants. However, within the Refuge's large coastal impoundments (Unit II = 1,500 acres; Unit III = 2,500 acres; Unit IV = 200 acres), water with moderate levels of salinity can be tolerated and used as a management tool to discourage salt-intolerant invasive plants or control mosquitoes in unique situations, by timing the opening of water control structures to flood certain impounded areas.

4.2) EARLY SUCCESSIONAL UPLAND HABITAT MANAGEMENT

Grassland Management: Most of the grasses found in the state and northeast are non-native cool-season grasses, growing best during the spring and/or fall when soil and air temperatures are cool. Grasses in this group include smooth brome grass, Kentucky bluegrass, tall fescue, and orchardgrass, which will not be managed for in Refuge habitats.

Native warm-season grasses, those present in the region prior to European settlement will be encouraged to grow in designated grassland management areas. These predominant native grasses include switchgrass, bushy bluestem, silver bluestem, broom sedge, foxtail barley, and purple top. Warm-season grasses provide a multitude of ecological benefits and management opportunities (Rothbart 2006):

- They are well adapted to a variety of site conditions;
- Maintenance costs are low once stands are established;
- They provide dependable forage production, are less influenced by severe weather fluctuations, more disease and insect tolerant than cool-season species;
- Native grasses are tolerant of and stimulated by fire. They are easily maintained with prescribed burning and yield excellent nesting and brood-rearing habitats for migratory birds of conservation concern;
- Warm-season grass root systems are extensive, growing 5-15 feet deep. Root systems completely regenerate every 3-4 years increasing soil fertility, organic matter, and carbon sequestration. Most native species are "bunch grasses" that grow in clumps. The clumping nature of these plants results in more bare ground under and between individual plants, providing excellent dusting and travel areas for birds and their broods. Bunchy structure also allows a diversity of forbs, legumes, wildflowers, and insects to colonize the areas, creating excellent foraging conditions.

Although established stands of native warm-season grasses require minimum maintenance, periodic manipulations are required to reduce competition from woody plants and/or invasives. Prescribed burning is the most effective management tool to maintain and rejuvenate native grasslands with mowing as a second alternative to setting back succession. Mowing every other year at the end of the nesting season with prescribed burns applied every 3 to 5 years will be a starting point to assess and evaluate bird use and habitat response to maintain designated Refuge grassland areas.

Managing Shrubland Succession: Transitional, Young, and Old Shrubland Habitat Management Prescriptions: At the Refuge level, managing succession to produce and/or maintain the desired density and height of different stages of shrubland habitats (transitional, young, and old) can be achieved using two management approaches. These approaches are based on the Peterjohn (2006) breeding shrubland bird model in the mid-Atlantic region, and differ primarily in the amount of management effort required to maintain these seral stages. The presence of most shrubland bird species largely reflects moisture regimes and the physical structure of successional communities, so that the dominant plant species are less important. Key physical components to manage for include presence of bare ground, densities of shrubs and herbaceous cover, height of woody vegetation, and presence of a partial or complete canopy of saplings. More detailed descriptions of the three seral shrubland stages follow.

Transitional shrublands are relatively ephemeral with woody vegetation rapidly replacing herbaceous cover in unmanaged areas. Maintaining early seral stages will require cyclic mowing and/or prescribed burning to prevent establishment of dense woody vegetation, combined with mechanical disturbance (disking) to expose bare soil and allow emergence of "colonist" plants. Transitional shrubland breeding birds prefer more open fields where shrubs are scattered among dense cover dominated by forbs and grasses and small trees are scarce or absent.

Fields with transitional shrublands represent the earliest seral stage community transitioning from bare soil to shrublands, beginning with dominance by annual forbs and grasses which are rapidly replaced by perennial forbs. Woody vegetation begins to emerge during the last seral stages of transitional shrublands with scattered shrubs and saplings generally less than 1 meter (3 ft) in height covering less than 50% of the area. The avian communities in these habitats are the least diverse of all shrubland bird communities.

Young shrublands: At this stage of succession woody vegetation becomes dominant, but patches of herbaceous vegetation remain. Woody plants continue to encroach on the herbaceous vegetation as these habitats advance in age. Woody plants are less than 3 meters tall (10 feet) and dominated by shrubs and vines. This stage may naturally be maintained by specific wet or dry hydrologic conditions that inhibit establishment of trees. Young shrubland habitats will require proactive maintenance to prevent succession into young forests. These management activities are labor intensive, including the selective removal of young trees combined with chemical treatment of stumps.

Older Shrublands: This late seral stage is characterized by nearly complete (> 90%) cover of woody vegetation. Initially, these habitats are dominated by shrubs with very few saplings. As they mature, saplings expand at the expense of the shrubby cover. These habitats are featured by a partial canopy of saplings over shrubs and herbaceous layers. Saplings out grow and rapidly succeed into second-growth woods within 3 to 5 years. Composition of breeding bird communities tend to be the most diverse at this stage.

These three successional stages can be managed using two approaches: "Low management" and/or "repeated management." The low management approach implies setting aside fields where secondary succession occurs at natural rates at staggered intervals. Initiation is staggered between fields at 3 to 5

year intervals so that all seral stages (transitional, young, & old) are represented (See Figure 1). Once natural succession advances to second growth forests, these woodland areas are set back.

The advantage of this approach is that active management is not required as secondary succession advances across designated open field areas. However reverting secondary succession into the earliest shrubland stages requires extensive management activities. Reverting second-growth woods into early seral stages will require removal of all live and dead timber, repeated chemical treatment of stumps, and disking or chopping the soil to expose bare ground for by colonizing herbs.

The alternative to "low management" is the "repeated management" approach. At a designated site allow secondary succession to advance to the desired seral stage and then proactively manage the area to retain that stage of vegetation. Maintaining early seral stages requires mowing and/or prescribed burns at 2-4 year intervals combined with disking or chopping the soil to expose bare ground to allow colonizing herbs to become established. Maintaining later successional communities aims at preventing closed canopies from developing and requires labor-intensive activities like removing selected saplings combined with chemical treatment of stumps and sprouts, at 3 to 5 year intervals to maintain desired shrubland seral stages (Peterjohn 2006).

Annual maintenance will also be necessary in areas prone to support invasive species. Early detection and rapid response is the best strategy to deal with invasives before they become dominant. Eliminating invasives requires chemical treatment and/or hand removal, depending upon the characteristics of a particular invasive plant. In summary, "repeated management" approach to shrubland habitat maintenance would include:

<u>Transitional Stage:</u>

- Burning and/or mowing
- Disking/chopping to expose bare soil every 2-4 years
- Early detection/rapid response for invasives (annually).

<u>Young Shrubland Stage:</u>

- Hand removal of saplings to maintain shrubs
- Chemical treatment of stumps and sprouts every 3-5 years.
- Early detection/rapid response for invasives (annually).

<u>Older Shrubland Stage:</u>

- Hand removal of saplings to retain open canopy
- Chemical treatment of stumps and sprouts every 3-5 years.
- Early detection/rapid response fro invasives (annually).

Figure 1. "Low Management" approach for establishing and maintaining successional shrubland communities in Prime Hook National Wildlife Refuge.

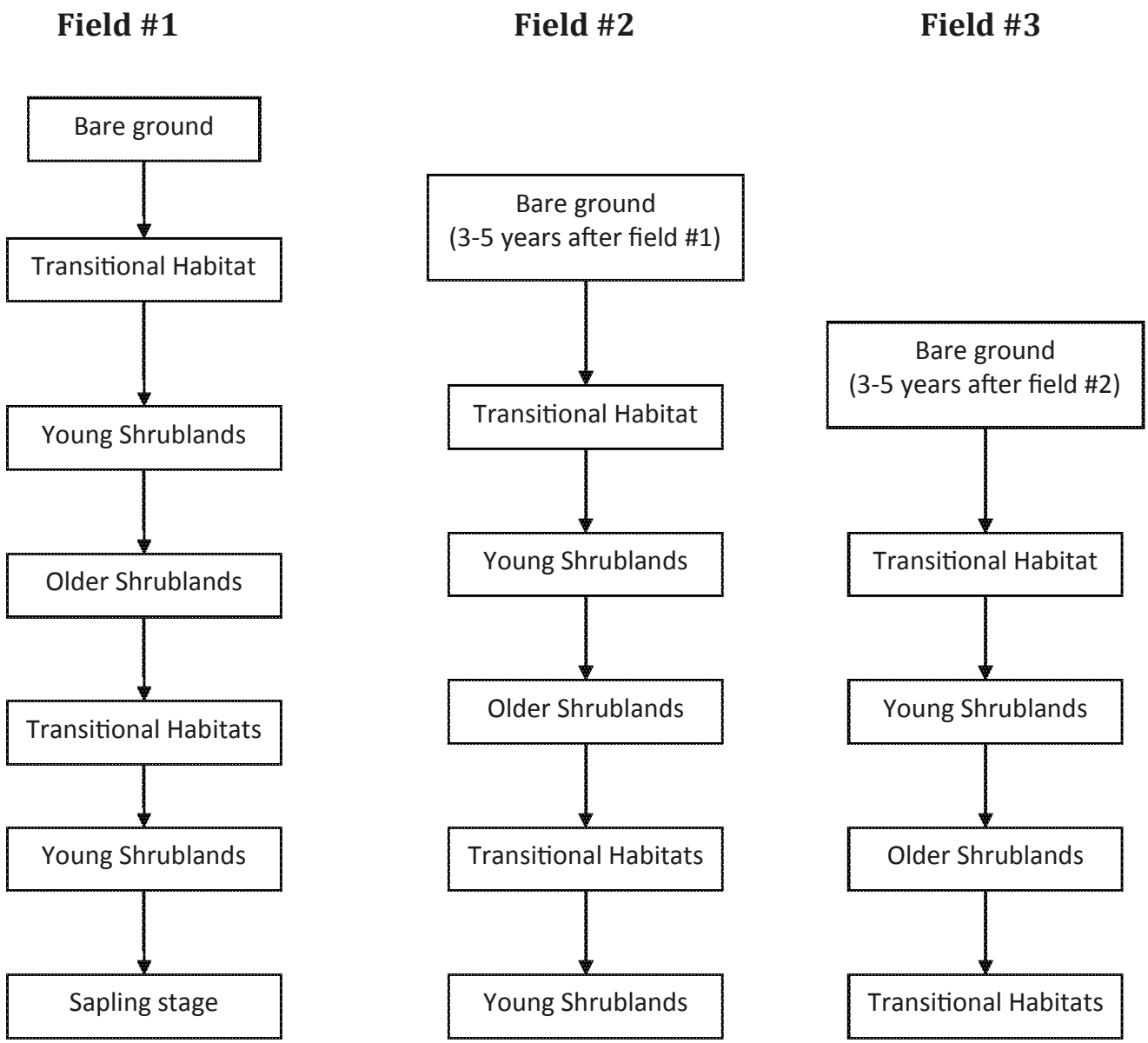
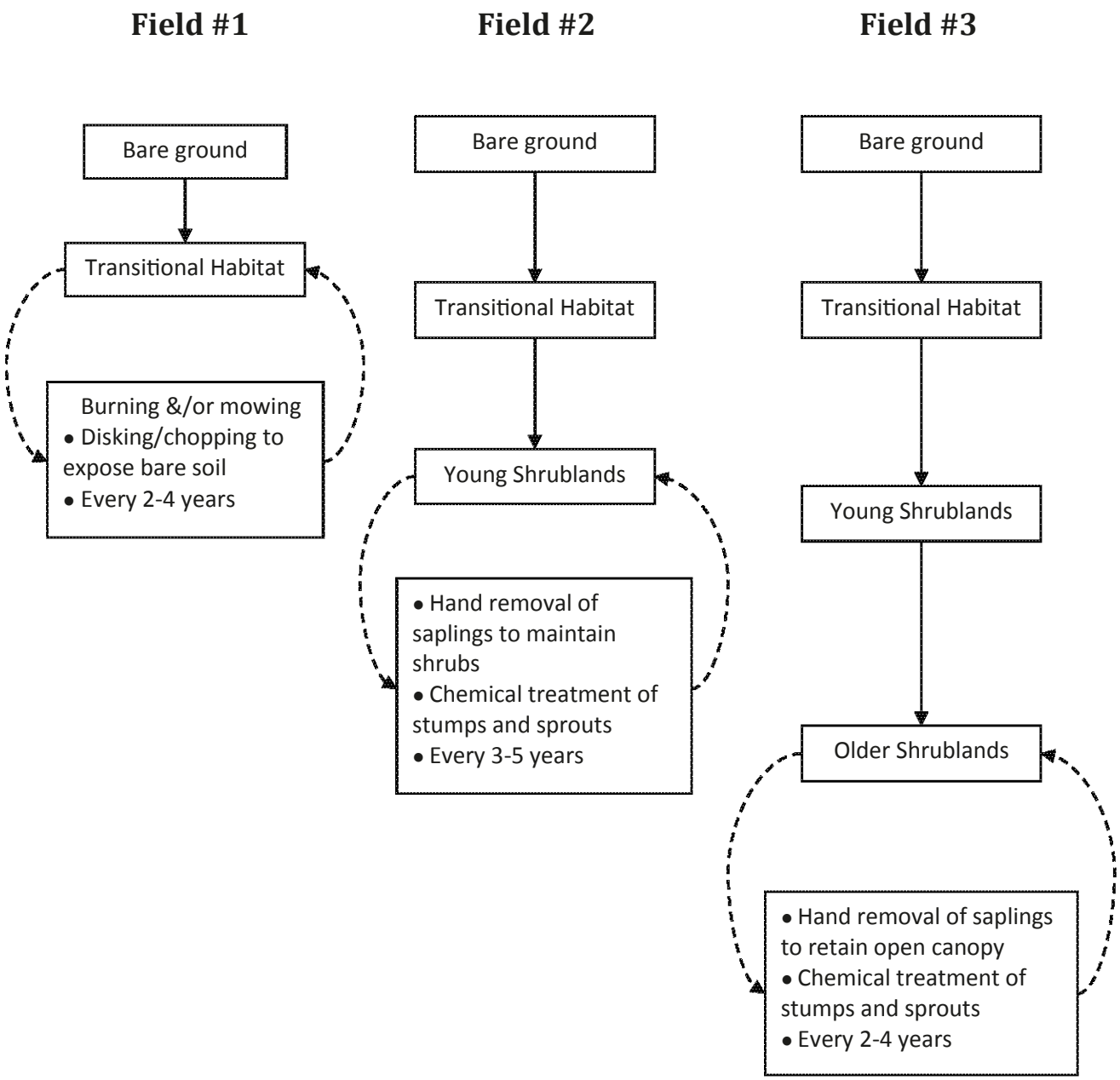


Figure 2. "Repeated Management" approach for establishing and maintaining successional shrubland communities in Prime Hook National Wildlife Refuge.



Patch Size Considerations When Creating Shrubland Habitats: Unlike grassland birds that prefer landscapes with larger patch sizes and open vistas, shrubland birds are not deterred by smaller patch sizes (Tefft 2006). An important factor to consider is the width of newly created shrubland habitats. Corridors less than 30 m (100 ft) wide will be occupied by ubiquitous shrubland birds. If managing for field specialists, then the minimum corridor width should be 50-70 m (165-230 ft) (Peterjohn 2006).

Effects of patch size on occupancy vary among shrubland bird species. Ubiquitous species require only enough suitable habitat to support their breeding territories. Patch sizes of 1-2 ha (2.5-5.0 acres) are sufficient to support most breeding pairs. However, fields smaller than 2 ha (5 acres) support few field

specialists. While available data on patch size preferences of these birds is still sparse, the few studies conducted to date indicate minimum sizes of 4-5 ha (10-12 acres) are required to attract most field specialists, assuming these habitats are at least 50-70 m (165-230 ft) wide. Patch sizes up to 20 ha (50 acres) is sufficient to attract breeding shrubland birds (Peterjohn 2006)

Prescribed Burning: Fire can either suppress or encourage any given plant species, but great care should be taken to understand the ecosystem and the life histories of the native and invasive plants of the site before using this tool. Prescribed fire as a habitat management tool is most effective when it is used to mimic natural fire regimes. Traditionally, spring and fall burns are usually conducted that are low in severity and intensity in the dormant seasons for most plants in early successional habitats. However, historical fires had no such constrains and fire effects were likely more severe than prescribed burn effects are now (Simmons 2006)

Many rare floral and faunal species depend on the effects of severe and intense burns. One way to achieve better ecological results is to apply growing season fires to achieve objectives in the long term by balancing growing season burns with habitat needs of breeding animals. In most early successional habitats, the timing, frequency, and size of fires can be adjusted so minimal damage is inflicted on populations of rare plants and animals.

Burning is more costly and requires greater planning efforts than mechanical treatments such as logging, brush hogging, mowing, and disking, which all perform well as disturbance agents capable of creating required habitat conditions in a particular habitat objective. However, fire performs some functions that these other tools cannot. Fire removes dead vegetation and recycles it into ash, smoke, and steam, and provides nutrients that are immediately available to plants.

Dead grass, thatch, and leaf litter are often completely consumed and serve to carry fire across an entire habitat patch. The removal of thatch, and leaf litter allows greater sunlight penetration to the ground surface and prepares a seed bed for naturally colonizing or planted native grasses and forbs, while other desirable native seeds require scarification by fire for germination to occur (Simmons 2006).

Fire has historically been used on Refuges in BCR 30 to maintain early successional habitats for Bobwhite and Woodcock. Prescribed fire can be used to maintain grasslands by increasing grass biomass and eliminating woody shade plants, extend the growing season by removing litter, and buffering soil chemistry and selectively controlling tall forbs or fire-sensitive woody plants (by topkilling or causing mortality), mineralize litter, and increase community diversity (by altering the composition of early-flowering plants.

Grasslands: Prescribed fire is the most effective management tool to maintain and rejuvenate native grasslands. Burns should be conducted between March 1 and April 15, or later in the summer (after September 1) to reduce woody plant invasion. Burning increases forb diversity, promotes vigorous warm-season grass growth, releases nutrients back to the soil, and suppresses invasive competition (Rothbart and Capel 2006). However, cyclic burning removes accumulation of vegetative litter from the ground which would not benefit Henslow sparrows that require thick litter accumulation. Rotational schedules between mowing with periodic burning would be best.

Shrublands: Prescribed fire may also be used to maintain an interspersion of shrub and/or grass-dominated communities attractive to shrubland passerines, by topkilling shrubs in old fields, and allowing them to re-sprout into thickets. Fire may be used to help eradicate exotic, invasive plants from open habitats, in some cases precluding the need to use chemical herbicides (Simmon 2006).

When using prescribed fire to alter woody plant cover in early successional habitats it is important to consider that many woody plants, especially shrubs, are adapted to disturbance, regenerating new shoots prolifically. Fire can increase or decrease shrub stem density in a habitat. Use of fire can either help eliminate (through direct mortality) or maintain shrub-scrub habitat structure, by pruning tall woody plants back, killing trees that are less-fire adapted, and encouraging shrub sprouting. If the goal is to decrease shrub stems, a high severity, growing season fire is best. If the goal is to increase shrub stem density, a moderate severity, dormant season fire would work better.

The key to predicting fire effects on woody plants is fire regime (frequency, seasonal timing, severity, and geographic size of fire). The regime will affect differential shrub and sapling mortality (which species die and which doesn't), mortality vs. top-kill effects, and post-fire vegetative regeneration. These are several principles that should be considered when employing prescribed fire to control woody plants in early successional habitats:

- Plant mortality is strongly tied to death of "growth points" (meristems/buds), which are more sensitive to heat damage when actively growing, and when tissue moisture is high. Applying Rx fire during the spring when target woody plants are mobilizing water and nutrients and breaking dormancy of leaf/flower buds, or during fall cold-acclimation periods, is more likely to kill growth points than during dormant periods.
- Total plant mortality is often the result of injury to several different parts of the plant. Fire applied in the dormant season "top-kill" shrubs, but fail to kill the entire plant that later re-sprouts from dormant buds. New shoots can originate from dormant buds located above ground (epicormic sprouts, root collar sprouts), and from various levels within the litter, duff, and mineral soil layers (rhizomes, root crowns).
- Fires severity (depth of fire and ground char) directly affects shrub re-sprouting capability. Moderate severity (shallow ground char), consumes litter layer and partially consumes duff layer) causes the greatest increase in stem numbers from root sprouters. High severity fires (deep ground char) remove duff layer and large woody debris and eliminate re-sprouting from shallowly buried tissues. Prolonged heating, as is generated during a slow, backing fire (verses a fast-moving head-fire) causes greater burn severity, and plant tissue death. In general, backing fires cause more woody damage than rapid head-fires (Miller 2000).
- Concentrations of metabolic compounds (sugars, salts, & lignins) vary seasonally, and have seasonal effects on shrubs. Timing of treatments may be more important than the type (cutting vs. burning) in controlling shrubs when taking total non-structural carbohydrate (TNC) levels. To maximize the reduction of woody stems, fires should be applied during periods of low below-ground carbohydrate storage (early spring growth) followed by a second treatment (mowing, herbicide) before total non-structural carbohydrate levels are replenished. Repeated burning (several consecutive years) during the low point of a shrub's TNC cycle is most effective.
- Fire reduces cover and thickness of organic soil layers. This can increase light and temperature at the soil surface, causing an increase in sprouting from woody rhizomes, so to control shrubs, a follow-up treatment (mowing, herbicide) is almost always required post-fire.

Mowing: Mowing as long been used to manage grasslands as a means to suppressing invading hardwoods. Timing is critical. Mowing should generally be scheduled outside the bird-nesting season of target species (April 15 to August 30). Utilize standard wildlife conservation mowing practices such as raising the mower blades to at least 10 inches or more, which permits the grass to recover quickly.

Force-account Farming: When grasslands, moist soil fields, and/or shrublands need succession setback, force account farming may be used. The staff will prepare and plant the fields to a cover crop such as winter wheat. This is an interim measure to keep fields open and to set back succession in preparation for

conversion to native plants and as a means to provide time to adequately plan the proper establishment of newly converted early successional habitats which would include either grassland, shrubland, or forested patches.

4.3) INVASIVE PLANT MANAGMEMENT

Controlling and managing invasive species is a strategy for maintaining the biological integrity and diversity of all habitats. The *Fulfilling the Promise* National Invasive Species Management Strategy Team developed a national strategy for management of invasive species for the National Wildlife Refuge System in 2002. The strategy recommends the following priority order of action for invasive species management:

1) Prevent invasion of potential invaders.
2) Eradicate new and/or small infestations.
3) Control and/or contain large established infestations.

Potential management strategies for preventing invasive species, prioritizing control efforts for established invasive species, and controlling invasive species are described in detail below. Prior to the initiation of invasive species control efforts, Refuge staff must understand the biology of the species to be controlled. A number of resources are available on the internet to assist with this. Some sources are included below:

National Invasive Species Information Center: *http://invasivespeciesinfo.gov/index.shtml*

- National Biological Information Infrastructure Invasive Species Information Node: *http://invasivespecies.nbii.gov/*
- The Global Invasive Species Initiative: *http://tncweeds.ucdavis.edu/control.html*
- USGS Invasive Species Program: *http://biology.usgs.gov/invasive/*
- Weeds Gone Wild: *http://www.nps.gov/plants/alien/index.htm*
- Invasive Species Mapping in Delaware by DNHP:

Refuge Staff should conduct appropriate and applicable pest detection, environmental surveillance, and monitoring before, during and after any management activity to determine whether pest management goals are achieved and whether activity caused any significant unanticipated effects. The lowest risk, most targeted approach for managing invasive species should always be utilized.

Early Detection and Rapid Response

Where prevention is not possible, early detection and rapid response is the next best strategy. Success will depend in part on participation by all Refuge staff, contractors, volunteers, and visitors in efforts to report and respond to invasions. The Refuge Manager must have access to up-to-date reliable scientific and management information on invasives and invasives management. The Delaware Invasive Species Council (DISC) of the Delaware Department of Agriculture (DDA) is an important source for information *http://www.delawareinvasives.net*.

Prioritizing Invasive Species Control Efforts

The first step in prioritizing invasive species control efforts is to determine the abundance and distribution of invasive species on the Refuge or management unit. However, control efforts should not be delayed to collect statistically rigorous survey data. Baseline data regarding the location of many invasives on the Refuge already may be available from observations of staff, volunteers, contractors, and Refuge visitors. These observations should be documented and mapped on Refuge GIS. If a more formalized mapping procedure is desired the North American Weed Management Association (*http://www.nawma.org*) has information on mapping procedures.

There are a number of ranking tools to assist land managers with the daunting task of prioritizing their invasive plant control efforts. The *Fulfilling the Promise* National Invasive Species Management Strategy Team recommends using the following order of priority to determine appropriate actions:

1) Smallest scale of infestation.
2) Poses greatest threat to land management objectives
3) Greatest ease of control.

When limited resources prevent the treatment of entire populations, the following order of priority is recommended:

1) Treat the smallest infestations (satellite populations).
2) Treat infestations on pathways of spread.
3) Treat the perimeter and advancing front of large infestations.

The following ranking systems are available for prioritizing plant species control:

- Morse, L. E. et al 2004. An Invasive Species Assessment Protocol: Evaluating Non-Native Plants for Their Impact on Biodiversity. Version 1. NatureServe, Arlington, Virigina, *Website: http://www.natureserve.org/getData/plantData.jsp*
- R.D. Hierbert and J. Stubbendieck, *Handbook for Ranking Exotic Plants for Management and Control* Natural Resources Report NPS/NRMWRO/NRR-93/08), U.S. National Park Service, Midwest Regional Office, Omaha, Nebraska, 1993.
- APRS Implementation Team 2000. Alien plants ranking system version 5.1. Jamestown, ND: Northern Prairie Wildlife Research Center Online. (Version 30 SEP2002). *Website: http://www.npwrc.usgs.gov/resource/literatr/aprs*

Incorporate Invasive Species Prevention in All Facilities and Construction Projects

Minimize ground disturbance and restore disturbed areas. Require mulch, sand, gravel, dirt, and other construction materials to be certified as free of noxious weed seeds. Avoid stockpiles of weed-infested materials.

To prevent the spread of invasives along transportation corridors, maintain invasive species-free zones along trails, around parking lots and boat launches, and at other related facilities. Inspect these areas often and control new infestations immediately. Minimize the number and size of roads on the refuge. Remove all mud, dirt, and plant parts from all equipment between projects or when equipment is moved from one location to another.

Incorporate Invasive Species Prevention in Impoundment Habitats

Minimize infrastructure development in managed wetland units to reduce unnecessary dikes, waterways, and access roads. These often are sources of infestation and pathways of spread. Plant a native cool season grass mix that will establish quickly to stabilize banks and dikes and to prevent the establishment of invasive species. Include in any native grass mix adding annual ryegrass (*Lolium perenne*) so bare soil is not exposed to erosion or to invasive plant seeds and rhizomes. This non-native plant will establish quickly and then drop out of the mix after one or two years.

Timing water manipulation activities, such as flooding and drawdowns, to minimize the germination and spread of invasive plant seeds and encourage the growth of native species. Prolonged flooding can be used to stunt the growth of some invasive species. Water level management can also be used to control invasive plants. Robust plants such as *Phragmites* require air pockets (carbon dioxide) to survive. Flooding the impoundment through all or part of a growing season, particularly after mowing or chemical application, discourages vegetative re-growth of robust invasives like *Phragmites*.

Mechanical removal of invasive organisms can be effective against some herbaceous plants, shrubs and saplings, and aquatic organisms. This is particularly effective for plants that are annuals or have a taproot. Care should be taken to minimize soil disturbance to prevent creating conditions ideal for weed seed germination. Repeated cutting over a growing period is needed for effective control of many invasive plant species. Care should be taken to properly remove and dispose of any plant parts that can re-sprout. Treatments should be timed to prevent seed set and re-sprouting. The following methods are available: hand-pulling, pulling with hand tools (weed wrench, etc.), mowing, brush-hogging, weed-eating, stabbing (cutting roots while leaving in place), girdling (removing cambium layer), mulching, tilling, smothering and flooding.

The advantages of mechanical treatment are low cost for equipment and supplies and minimal damage to neighboring plants and the environment. The disadvantages are higher costs for labor and inability to control large areas. For many invasive species, mechanical treatments alone are not effective, especially for mature plants or well-established plants. For some invasive plants, mechanical treatments alone exacerbate the problem. Mechanical treatments are most effective when combined with herbicide treatments (like girdle and herbicide treatment).

There are a wide variety of chemicals available to control invasive plants. They may work in different ways and be very target specific, or affect a wide range of species. Herbicides may be "pre-emergent," i.e., applied prior to germination to prevent germination or kill the seedling, or "post-emergent: and have various modes of action (auxin mimic, amino acid inhibitor, mitosis inhibitor, photosynthesis inhibitor, lipid biosynthesis inhibitor). Products may come in granular, pelleted, dust or liquid forms. Common application methods include foliar spray, basal bark, hack and squirt, injection, and cut stump. The timing of applications is critical to achieve good control, as the growth stage at which an invasive plant will be most effectively controlled varies with different species.

The advantages are that the right chemicals, applied correctly, can produce desired results over a large area for a reasonable cost. The disadvantages are that the chemicals may affect non-target species at the site and/or contaminate surface or groundwater. Proper planning includes using the most target-specific, least hazardous (humans and the environment), and most effective chemical for the job. Additionally, one should research minimum effective dosage, as the chemical labels often give higher than necessary concentrations. Herbicides often are most effective when used in combination with mechanical methods.

On Refuge lands, all chemicals including adjuvants designed to enhance effectiveness are covered by Service and Departmental regulations. A Pesticide Use Proposal (PUP) is required for all pesticide applications. Attention to protective gear, licensing requirements and other regulations is essential.

Fire is a critical tool to managing ecosystems. It recycles vital nutrients, stimulates growth, provides quality habitat for a variety of species, especially when it is used to destroy invasive plants like *Phragmites,* when used in conjunction with other techniques like herbicides and mechanical removal. Regular fires, part of nature's design, also helps check the risk of catastrophic fire by reducing accumulations of hazardous fuels by clearing underbush and dead vegetation.

Over 90 percent of hazardous fuels reduction on PHNWR has been accomplished through strategic use of fire in conjunction with herbiciding to reduce large stands of *Phragmites.* A comprehensive monitoring plan was established in 2002 with 45 transects spread across all 4 management units as part of the initiation of a large Wildland Urban Interface project conducted in 2002 through 2004 (See WUI Project Maps and Monitoring Plan in Appendix) These established transects will be monitored to continue to track *Phragmites* control activities and results in relationship to original 2002 treatment sites.

Biological control is the use of animals or disease organisms that feed upon or parasitize the invasive species target. Usually, the control agent is imported from the invasive species' home country, and artificially high numbers of the control agent are fostered and maintained. There are also "conservation" or "augmentation" biological control methods where populations of biological agents already in the environment (native) are maintained or enhanced to target an invasive species. The advantages of this method are that it avoids the use of chemicals and can provide relatively inexpensive and permanent control over large areas. Appropriate control agents do not exist for all invasive species. Petitions are submitted and approved by the USDA Technical Advisory Group on weed biological control before any proposed biological control agent can be released.

4.4) FOREST MANAGEMENT

Regeneration Cutting is the removal of an entire stand of trees in one cutting with reproduction obtained naturally or artificially (i.e., planting, broadcasting seeding, or direct seeding). Two common methods of regeneration cutting is patch clearcuts and strip clearcuts. These methods are considered to be even-age management. Clearcut size does have an effect on regeneration. As clearcuts increase in size they tend to favor shade intolerant species. As they become smaller they gravitate towards encouraging intermediate tolerant and tolerant species. The size and shape of the clearcut can have an effect on bird species richness as well as influence herbivore utilization.

- Patch Clearcut: can be many different shapes and sizes depending on management objectives, forest type, terrain, or boundaries. Natural regeneration from the adjacent stands is not heavily relied upon, but can have varying degrees of influence depending on patch size. All stems 2" dbh and greater should be removed unless some advanced regeneration of desired species exists.
- Strip Clearcut: is used to promote natural regeneration and growth in the harvested strips through the adjacency of the unharvested area. In harvested strips, all stems > 2' dbh are removed. The unharvested strips act as a seed source and protection for the harvested areas. Concerns related to wind damage are warranted when using this method because of the increased amount of exposed edge. This can be avoided by minimizing the width of the strips being harvested (50-100 feet on stable soil and 30-50 feet on wet soil), ensuring at least one end of the strip is cloed, and harvest as soon as cleared strips are regenerated. Strip clearcuts are more successful when applied to healthy forests found on deep, well-drained soils.

Single Tree Selection is the removal of individual trees uniformly throughout a stand. This technique is used to promote the quality and growth of the remaining trees and can also result in the regeneration of mostly shade tolerant species due to the small canopy openings created during the harvest. Use of this technique, on a continual harvesting cycle, is considered an-even aged management.

Actively managing a stand in un-even ages can result in reducing the stands' natural ability to resist insect, disease, and other debilitating health issues. Careful extraction of the trees is necessary to help limit residual stand damage, which can create an opportunity for insects and disease to attack otherwise healthy trees. Root damage by soil compaction also needs to be considered. This technique can also be used during even-aged management and when done so is commonly referred to as an intermediate thinning. Single tree selection can be used to mirror a small scale disturbance. When only large trees are selected, the large opening in the canopy will typically be utilized quickly by the crowns of adjacent older trees.

Group Selection is the removal of small groups of trees to maintain an un-even forest. Normally to be considered a group selection, as opposed to a patch clearcut, the size of the harvest group should be less than or equal to twice the height of the adjacent mature trees. This method will encourage regeneration of intermediately tolerant and tolerant species, but some intolerant species can appear towards the center of the harvest areas when the groups are at the maximum size.

The likelihood of the harvest areas regenerating combined with the ability to schedule continual harvest entries, results in this technique being a method of choice to convert even-aged stands into un-even aged stands when desired. Actively managing a stand in un-even ages can result in reducing the stands natural ability to resist insect, disease, and other debilitating health issues. Careful extraction of the trees is necessary to help limit residual stand damage, which can create an opportunity for insects and disease to enter an otherwise health stand. Root damage by soil compaction also needs to be considered.

A shelterwood System is a series of harvests carried out with the intent of regenerataing a stand utilizing mature trees that are removed at the end of the scheduled rotation. This technique is typically used to regenerate intermediately tolerant (mid-successional) and tolerant (late–successional) species, but in certain instances can be used for intolerant (early-successional) species.

Use of this technique is considered even-aged management, although variations more often found in the irregular shelterwood system can result in a multi-aged stand. In order for a shelterwood system to be considered, a stand should be reasonably well stocked with a moderate to high component of the species desired for regeneration.

Irregular shelterwood system consists of an initial harvest used to encourage regeneration, optional intermediate harvests used to encourage supplemental regeneration, and an overstory removal harvest once regeneration is established. This technique usually results in regeneration with a higher component of intermediately tolerant or tolerant species. This technique differs from other shelterwood systems by introducing the concept of leaving a component of the original stand that can either be removed during subsequent harvests or left throughout the series of harvests and beyond. The long-term residual component can be left singularly or in groups. Harvests can be applied in a variety of fashions including harvesting uniformly, in groups, or strips. The harvest would focus on undesirable species, suppressed, co-dominant, and unhealthy dominant trees. This would provide the greatest potential for seed production and resiliency to windthrow.

Seed tree system is the removal of the majority of a stand while retaining a minority of seed producing trees, left standing to retain some component of the desired species in the regenerating stand. Seed trees can be left singularly and/or in groups, and should be distributed as uniformly as possible throughout the stand. This technique is prescribed when desired species are lacking as a seed source in the overstory (negating shelterwood as an option), or regeneration composition is not a primary objective. This technique could be used to convert species composition to an earlier successional variety while retaining a small component of desired species of mixed hardwoods. Desired species that are healthy, dominant, large crowned, and well-rooted should be targeted to leave standing. The rest of the stand is removed in its entirety (2” dbh and greater). The residual trees/groups can be removed after regeneration is established or may be left to accomplish other stand objectives.

Stand Improvements consist of entering an even or uneven aged stand at any stage of development with the intent of tending to habitat needs through thinning, weeding, cleaning, liberation, sanitation, or other improvement methods. The primary function of this method is to control species composition and reduce an overabundance of stems per acre to a more desired stocking level. This translates into thinning young stands to control species composition, conducting intermediate thinnings in middle aged stands to maintain accelerated growth and remove unwanted vegetation, and control stocking levels of habitat features such as snag trees, cavity trees, den trees, downed wood and other features.

Two techniques are used to benefit wildlife; retain or create snags and the provision of coarse woody debris (CWD). Snags or live trees that fall to the forest floor are known as CWD, which can range in size from branches to bole to entire trees, and adds structural diversity, serving as hiding and thermal cover,

den sites, foraging substrate, and winter access to subnivean habitats. As the wood decays essential nutrients such as sulphur, phosphorous, and nitrogen are released. The need for creating CWD depends on the forest type, stage of succession, and management history. Allowing snags to fall naturally, felling and leaving live trees, and/or leaving tops, limbs, and other debris during stand improvement operations can augment CWD levels.

Snags play an important ecological role for at least 149 bird species, 73 mammalians, and 93 herpetiles (Thomas 1979). Based on the state of decomposition, snags can be hard (sound sapwood, rotting heartwood) or soft (rotting sapwood and heartwood). There are several ways to "create" snags, or initiate the decomposition process. Each is an effort to damage a healthy tree's integrity by creating a pathway for fungal infection. These include girdling, topping, branch removal, fungal inoculation, and herbicide injection. The density and size of suitable snags depends on the individual forest types and natural disturbance patterns.

Many treatments and numerous types of equipment are available for mechanically manipulating upland sites from one covertype to another. Selection of the type of mechanical treatment will depend on site habitat objectives. All of these tools can be used with varying degrees of effectiveness, depending on what is being cut. Special consideration needs to be given to ground disturbance when using heavy equipment. Soils may be compacted and rutted which can cause a change in vegetation component of the area. Disturbed soils are also more likely to promote germination of invasive species, an undesirable outcome of any habitat management activity. Examples of shrub and tree cutting equipment include:

- Drum mowers for removal of small trees.
- Geo-Boy to cut trees up to 6-8" dbh. Woody material is reduced to fine chips, often finer then those resulting from a roller mower.
- Roller Chopper Mower, used to knock down and chop up shrubs and trees. This technique causes significant disturbance to the soil and should be reserved for situations where the area is going to be seeded after treatment.
- Mowing and Brush Hogging: mowing is an appropriate treatment for grass, forbs, and small shrubs and saplings. Vegetation > 4 inches often needs a higher powered machine.
- Girdling: can be appropriate to remove single trees or groups of trees to open up the canopy and/or create snags. It can also cause stump sprouting.
- Chainsaw: can be used to remove single trees or groups of trees to open up the canopy. Stump sprouting may occur.
- CWD Management: different prescriptions will leave differing amounts of woody debris. Objectives will drive the best management technique for dealing with the debris. It can be left to decay on forest floor, however, if conversion to another habitat type is desired (grassland or shrubland), woody debris may be burned or removed. WCD can be chipped and broadcast on site. Depth of chips should not exceed 2-3 inches. Removal from site can be in form of chips, or whole logs and shrubs.

(Maryland PIF Committee. 1997. Habitat Management Guidelines for the benefit of landbirds in Maryland and A Guide to the Conservation of Forest Interior Dwelling Birds in the Chesapeake Bay Critical Area. 2000)

4.5) Integrated Pest Management (IPM)

Integrated pest management (IPM) is defined as "…a decision-based process involving coordinated use of multiple tactics for optimizing the control of all classes of pests (insects, pathogens, weeds, vertebrates)

in an ecologically and economically sound manner" (Ehler 2006). The term 'integrated' implies incorporation of natural predator levels into decision-making, and use of compatible, non-disruptive tactics to preserve natural predators associated with pest species. IPM is used to avoid the indiscriminate use of pesticides to avoid such problems as pest resistance, target pest resurgence, negative impacts on non-target species and environmental contamination.

On national wildlife refuges (IPM) is an interdisciplinary approach utilizing methods to prevent, eliminate, contain, and/or control pest species in concert with other management activities on Refuge lands and waters to achieve wildlife and habitat management goals and objectives. It is also a scientifically based, adaptive management process where available scientific information and best professional judgment of the Refuge staff as well as other resource experts would be used to identifiy appropriate management strategies that can be modified and/or changed over time for effective, site-specific management of pest species.

A tolerable pest population (threshold) must be determined before using chemicals. The ecology of pest species will be considered when using one or more control methods that are feasible, efficacious, and most protective of non-target resources, including native species (fish, wildlife, and plants) and Service personnel, Service authorized agents, volunteers, and the public. Staff time and available funding would also be considered when determining feasibility/practicality of various treatments.

In accordance with 517 DM 1 and 7 RM 14, an (IPM) approach to all Refuge Management activities must be utilized, where practicable, to eradicate, control, or contain pest and invasive species (herein collectively referred to as pests) on the Refuge. IPM would involve using methods based upon effectiveness, cost, and minimal ecological disruption, which considers minimum potential effects on non-target organisms and biological integrity, diversity, and environmental health of Refuge lands. Pesticides may be used where physical, cultural, and biological methods or combinations thereof, are impractical or incapable of providing adequate control, eradication, or containment.

Furthermore, pesticides would be used primarily to supplement, rather than as a substitute for practical and effective control measures of other types. If a pesticide would be needed or used on the Refuge, the most specific (selective) chemical available for the target species would be used unless considerations of persistence or other environmental and/or biotic hazards would preclude it. For example, if larval mosquito monitoring generates action thresholds of species specific mosquito larval densities indicative of an increased health risk, *Bacillus* products would be utilized as the preferred or primary method of mosquito control, due to its greater specificity to control identified mosquito disease vector species, and to minimize negative impacts that other larvicide products have on non-target invertebrate species, migratory birds, amphibians and other wildlife.

4.6) Biological Mosquito Control/Open Marsh Water Management:

Open Marsh Water Management (OMWM) is defined as any type of physical manipulation in the form of pond construction and marsh ditching which alters coastal saltmarsh habitat to accomplish source reduction and biological control of mosquitoes. OMWM evolved as a new ditching technique to replace grid-ditching that had been practiced for thirty plus years from 1930 to 1960s. OMWM is based on the following assumptions: 1) not all parts of a tidal marsh breed mosquitoes; 2) that mosquitoes are greatly reduced or absent from portions of the marsh where tidal action circulates water over the marsh surface and removes excessive water; 3) that biological control in the form of predation of marsh fishes will biologically reduce mosquito populations; and 4) that permanent pools of water on the marsh surface serve as reservoirs for mosquito-eating fishes, which can forage among the grass stems at high tide. The mummichog (*Fundulus heteroclitus)* is the dominant predator, along with other fishes, on Refuge salt marsh habitats.

Various marsh excavations and alteration methods are used with the OMWM technique to control mosquitoes. In Delaware OMWM systems are typically blends of open (tidal), sill (semi-tidal), and closed (non-tidal) alterations, using selective excavations of ponds and ditches to treat identified mosquito-breeding habitats (Meredith et al 1985). The Service has listed several unacceptable practices in Region 5 which include: OMWM excavations in unditched salt marshes; disturbance of natural pannes; low salt marsh alterations; excessive pond depth (≤ 30 to 36 inches deep). OMWM excavations on Refuges should be directed to disturbed high marsh areas where mosquito breeding occurs and control is necessary (Taylor 1998).

Spoil management in all OMWM excavations is critical. OMWM best management practices identified by Meredith et al (1985) emphasize the need to insure that excavations do not cause the mean subsurface water table to drop more than six inches below local marsh surface elevation. Delaware research data has found that the mean water table of zones of *Iva, Baccharis,* and robust *Phragmites* is usually 6 inches or more below local marsh surfaces. This creates a soil condition that is drier and more aerated than soils in salt hay or short-form cordgrass zones, where the water table is much closer to the surface (Meredith, Saveikis, & Stachecki 1983).

Conditions that result in establishing the growth of marsh shrubs and *Phragmites*, include excessive subsurface drainage and/or excessive spoil deposition, either separately or in combination that will lower water tables. Delaware-OMWM BMPs state that spoil from ditches and ponds should be spread over the marsh surface at initial depths no greater than 3 inches. After a period of spoil settlement, any permanent increase in surface elevation should be less than two inches (Meredith et al 1985).

4.7) Control of Over-abundant or non-native Waterfowl Populations

Controlling invasive or over-abundant waterfowl, such as mute swans, snow geese, and resident Canada geese is a strategy used to protect native water birds and fisheries, and prevent the destruction of wetland habitats on Refuges. Control methods include: harassment, egg addling, sterilization, removal, shooting, increased hunting pressure, and modifying historic habitat management practices.

The Atlantic Flyway Council's (2003), *"Atlantic Flyway Mute Swan Management Plan 2003-2013,"* (*http://www.dnr.state.md.us/wildlife/afcmuteplant*) outlines the coordination of state (lead) and federal wildlife agencies "to reduce mute swan populations in the Atlantic Flyway to levels that will minimize negative ecological impacts to wetland habitats and native migratory waterfowl and to prevent further range expansion into unoccupied areas." Target populations of mute swans vary by state and range from 0 to 500 free-flying birds.

In the fall of 2005, the Service completed an Environmental Impact Statement that included a multi-faceted approach for managing resident Canada geese (*http://migratorybirds.fws.gov/issues/cangeese/deis.html*). Upon recommendations from the Atlantic Flyway Council, the Service approved the use of special regulations beginning in 2007 to help curb the growth of resident Canada goose populations in the eastern US which included the expansion of hunting methods during September seasons.

The Service released the Final Environmental Impact Statement for Light Goose Management in June 2007 that examined five alternatives for future management of over-abundant Greater Snow goose populations. The preferred alternative would: 1) expand hunting opportunities within the current migratory bird hunting-season framework; 2) establish a conservation order for expanded hunting methods; and 3) modify habitat management practices on National Wildlife Refuges to decrease the amount of food and sanctuary available for light geese. (*http://www.fws.gov/migratorybirds/issues/snowgeese/FINALEIS2007/*)

4.8) Predator Control and Nuisance Wildlife Managmement

Predator control and nuisance wildlife management are valuable strategies used to manage and mitigate habitat and/or wildlife damage and protect endangered and threatened species or species of conservation concern and their habitats. A comprehensive predator control and nuisance wildlife refuge program will address a range of management prescriptions from vegetation protection, control and/or nesting habitat enhancement to non-lethal and lethal predator and wildlife control. The most effective, selective, and humane techniques available to deter or remove individual predators or problem species will be used.

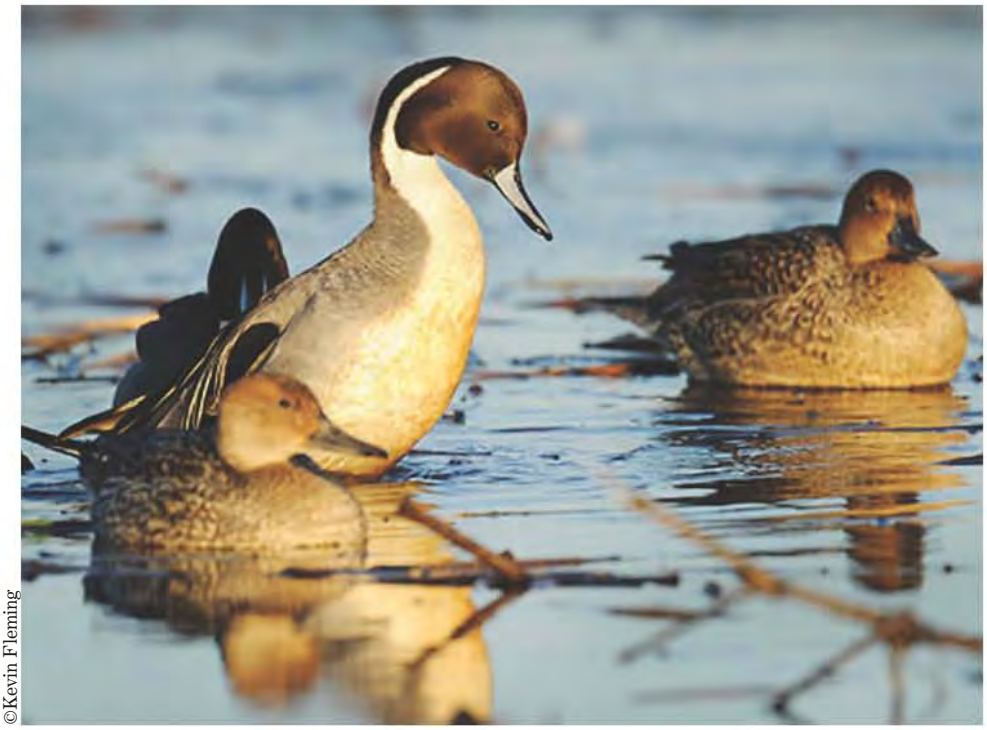
For example, control of Refuge problem species like beaver, nutria and muskrats, mute swans and/or resident Canada geese may be required when high concentrations of these species incur deleterious effects on native wetland habitats, aquatic vegetation, or refuge infrastructure. The control of mammalian and/or avian predators such as raccoons, foxes, gulls and crows, may be required that threaten or destroy nesting, breeding, or foraging habitats used by state or federally endangered species or species of special conservation concern. These species include but will not be limited to piping plovers, American oystercatchers, least and common terns, red knots and ruddy turnstones.

Trapping as a Management Strategy: Trapping and lethal control will be two major strategies used to control predators and to manage populations that negatively impact Refuge habitats or habitat infrastructure (like nutria and/or muskrats that burrow and destroy Refuge dikes, etc). Trapping and shooting to control nutria can also be used effectively to achieve desired interspersion of wetland vegetation. Trapping and shooting are important management tools that can be used for the following objectives:

- Habitat management or protection
- State or federally endangered species protection
- Migratory bird protection
- Wildlife Population Management
- Surveys or monitoring of wildlife
- Facilities protection
- Public Safety and health
- Feral Animal Control
- Disease Control

Alternative techniques to trapping and shooting will also be used to accomplish the above objectives. These include the use of electric fences, scare devices, screens and shields, and exclosures to deter predators. Any other new, effective, and selective techniques that become available to help prevent and/or mitigate habitat damage, maintain diverse and healthy wildlife populations, and protect endangered, threatened, and/or species of conservation concern, will also be considered.

Appendix C



©Kevin Fleming

Northern pintail male with two females

Draft Hunting Management Plan

DRAFT
HUNTING MANAGEMENT PLAN
Prime Hook National Wildlife Refuge
April 2012

U.S. Department of the Interior
Fish and Wildlife Service
Prime Hook National Wildlife Refuge
Sussex County, Delaware

Submitted: _____ _____
Refuge Manager **Date**

Reviewed: _____ _____
Zone Biologist **Date**

Reviewed: _____ _____
Public Use Specialist **Date**

Approved: _____ _____
Refuge Supervisor - South **Date**

Approved: _____ _____
Regional Chief - NWRS **Date**

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INTRODUCTION

Prime Hook National Wildlife Refuge (the refuge), which is managed by the U.S. Fish & Wildlife Service through the U.S. Department of the Interior, is located within the Atlantic Coastal Plain along the southwestern shore of the Delaware Bay in Milton, (Sussex County) Delaware. The refuge is located within two hours driving time of metropolitan Baltimore, MD, Washington D.C., Wilmington, DE, and Philadelphia, PA, and 22 miles southeast of the state capital of Dover (population 35,808).

The refuge's 10,132 acres are stretched parallel to the southeastern coastline of Delaware just north of Cape Henlopen. The eastern boundary of the refuge is adjacent to three beachfront communities: Slaughter Beach, Prime Hook Beach, and Broadkill Beach. Eighty percent of Prime Hook's vegetation cover types are characterized by tidal and freshwater creek drainages that discharge into the Delaware Bay, with associated coastal marshes. The remaining 20 percent are composed of upland habitats. Immediate land uses surrounding the refuge are intensive agricultural and developed residential areas.

The refuge's natural environment features the following key vegetation communities: freshwater and brackish water impoundments, interdunal wetlands, *Spartina* high salt marsh, bishop-weed mixed species brackish marsh, red maple and blackgum swamp, mixed herb deep peat wetlands, fragmented upland forested areas, early successional upland habitats, and ancient sand ridge forest. These cover types currently provide habitat for approximately 308 species of birds, 51 species of fish, 45 species of reptiles and amphibians, 37 species of mammals, dozens of rare insect species and hundreds of rare plant species [Delaware Wildlife Action Plan (DWAP) 2005].

In the early 1960s the southeastern coastal marshes of Delaware were under threat of industrial development from oil refinery and manufacturing industries. To help preserve these coastal wetlands from industrial developmental threats, the refuge was established under the Migratory Bird Conservation Act (16 U.S.C. 715-715r) as amended on August 21, 1962, "… for use as an inviolate sanctuary, or for any other management purpose, for migratory birds." Refuge boundaries were later expanded to include lands purchased under the Land and Water Conservation Fund under the authority of the Refuge Recreation Act {16 U.S.C. (460k-460k-4) as amended for the following purposes "…suitable for (1) incidental fish and wildlife-oriented recreation development, (2) the protection of natural resources, and (3) for the conservation of endangered species."

The purpose of this plan is to encourage the use of refuge lands for wildlife-dependent public recreation as outlined in various laws, regulations, and Service guidance policies governing the National Wildlife Refuge System. Hunting, which has been a tradition in Delaware for many years, is recognized by the Service as a compatible use and will be permitted on Prime Hook NWR.

CONFORMANCE WITH STATUTORY AUTHORITIES

Hunting is one of the priority public uses defined by Executive Order 12996 (March 25, 1996) and the National Wildlife Refuge System Administration Act of 1966, as amended by the National Wildlife Refuge System Improvement Act of 1997 (Public Law 105-57). This legitimate and appropriate use of a national wildlife refuge is generally considered compatible, as long as it does not materially interfere with or detract from the fulfillment of the National Wildlife Refuge System mission or the purposes of the national wildlife refuge.

U.S. Fish and Wildlife Service policy concerning hunting (605 FW1 & FW2) requires consideration of the following criteria: (1) compatibility with the refuge purpose(s) and the Refuge System mission which includes economic feasibility; (2) biological integrity, diversity, and environmental health; and (3) conflict management between user groups. In addition to a compatibility determination, the Refuge Recreation Act requires verification that funds are available for the development, operation, and maintenance of the hunting program.

Sport hunting is a tool managers use to maintain acceptable wildlife populations. In Delaware, the Division of Fish and Wildlife establishes hunting seasons and bag limits to meet population objectives and to offer people the opportunity to experience a traditional outdoor recreational activity. Game species population objectives are a function of factors such as habitat limitations and landowner tolerances, and each year the seasons and bag limits are designed to remove the harvestable surplus without long-term negative impacts to the population as a whole. The ability to effectively manage game species populations depends in large part on the ability of hunters to access land with quality habitat. Providing hunting opportunities on the refuge will aid the state in meeting its management objectives and preserve a wildlife-dependent priority public use long associated with this land.

The Service intends to continue the tradition of wildlife-related recreation on the Refuge by allowing hunting in compliance with state regulations. By allowing this use to continue, hunters can experience this traditional recreational activity, aid the refuge and State in maintaining acceptable game species population levels, gain a better appreciation of the refuge's high quality wildlife habitats, and become better informed about the refuge and the National Wildlife Refuge System.

Refuge Purpose

The refuge was approved by the Migratory Bird Conservation Commission on August 21, 1962, to protect and preserve coastal wetlands that are historically of high value as waterfowl habitat. Approval was given for acquisition of 11,576 acres. The refuge currently consists of 10,132 acres acquired in fee simple and eight flowage easements totaling 884 acres.

For lands acquired under the Migratory Bird Conservation Act, 26 USC 715-715r, as amended, the purpose of the acquisition is: for use as an inviolate sanctuary, or for any other management purpose, for migratory birds." 16 USC 715d (Migratory Bird Conservation Act)

For lands acquired under the Refuge Recreation Act, 16 USC 460k, as amended, the purpose of the acquisition is "…suitable for – (1) incidental fish and wildlife-oriented development, (2) the protection of natural resources, (3) the conservation of endangered species or threatened species…" 16 USC 460k-1 (Refuge Recreation Act).

Several laws and executive orders apply to hunting on national wildlife refuges. They are summarized below.

Executive Order 13443 (August 16, 2007)

This Executive Order, entitled "Facilitation of Hunting Heritage and Wildlife Conservation," "directs Federal agencies that have programs and activities that have a measurable effect on public land management, outdoor recreation, and wildlife management, including the Department of the Interior and the Department of Agriculture, to facilitate the expansion and enhancement of hunting opportunities and the management of game species and their habitat."

National Wildlife Refuge System Improvement Act of 1997

Signed by President Clinton on October 9, 1997, this law defines compatible wildlife-dependent recreation as "legitimate and appropriate general public use of the [National Wildlife Refuge] System." It establishes hunting, fishing, wildlife observation and photography, and environmental education and interpretation as "priority public uses" where compatible with the mission and purpose of individual national wildlife refuges.

Executive Order 12996 (March 25, 1996)

This Executive Order, entitled "Management and General Public Use of the National Wildlife Refuge System," contains a directive to: "...recognize compatible wildlife-dependent recreational activities involving hunting, fishing, wildlife observation and photography, and environmental education and interpretation as priority general public uses of the Refuge System..."

Endangered Species Act of 1973

This act, as amended, did not specifically address the Refuge System but it does directly affect management activities within the National Wildlife Refuge System. The act directed Federal agencies to take actions that would further the purposes of the act and to ensure that actions they carry out, authorize or fund do not jeopardize endangered species or their critical habitat.

The National Wildlife Refuge System Administration Act of 1966

This act (16 U.S.C. 668 dd-ee; 80 Stat. 927) authorizes the Secretary to "...permit the use of any area within the System for any purpose...compatible with the major purposes for which such areas were established..."

The Refuge Recreation Act of 1962

This Act (16 U.S.C. 460k) authorizes the Secretary of the Interior to administer such areas for public recreation as an appropriate incidental or secondary use only to the extent that it is practicable and not inconsistent with the primary objectives for which the area was established. In addition, the Refuge Recreation Act requires that funds are available for the development, operation, and maintenance of the permitted forms of recreation.

Code of Federal Regulations (CFR), Title 50

Section 31.2(e) lists hunting as a method of surplus wildlife population control.

Section 31.15 states that the privilege of hunting may be extended to the general public.

Section 32.1 states that the opening of a wildlife refuge area to hunting will be dependent upon the provisions of law applicable to the area and upon a determination by the Secretary of the Interior that the opening of the area to the hunting of migratory game birds, upland game, or big game will be compatible with the principles of sound wildlife management and will otherwise be in the public interest.

Section 32.2 has provisions applicable to each person engaged in public hunting on a wildlife refuge area.

Section 32.27 has specific regulations for this refuge and will need to be changed in accordance with this plan or policy as needed.

Section 32.3 explains the procedure for publication of special regulations.

HUNTING PROGRAM GOALS AND OBJECTIVES

Goals of the National Wildlife Refuge System

The following Refuge System goals help guide the development of comprehensive conservation plans (CCP) and the administration, management, and growth of the Refuge System:

1. Conserve a diversity of fish, wildlife, and plants and their habitats, including species that are endangered or threatened with becoming endangered.

2. Develop and maintain a network of habitats for migratory birds, anadromous and interjurisdictional fish, and marine mammal populations that is strategically distributed and carefully managed to meet important life history needs of these species across their ranges.

3. Conserve those ecosystems, plant communities, wetlands of national or international significance, and landscapes and seascapes that are unique, rare, declining, or underrepresented in existing protection efforts.

4. Provide and enhance opportunities to participate in compatible wildlife-dependent recreation (hunting, fishing, wildlife observation and photography, and environmental education and interpretation).

5. Foster understanding and instill appreciation of the diversity and interconnectedness of fish, wildlife, and plants and their habitats.

Goals of Prime Hook National Wildlife Refuge

The following goals will guide the management of Prime Hook National Wildlife Refuge:

1. (Barrier Beach Island and Coastal Salt Marsh Habitats) Manage, enhance and protect the dynamic barrier beach island ecosystem for migratory birds, breeding shorebirds and other marine fauna and flora. Perpetuate the biological integrity, diversity and environmental health of North Atlantic high and low salt marsh habitats.

2. (Forested Habitats) Manage the biological diversity, integrity and environmental health of refuge upland and wetland forested cover-types to sustain high quality habitats for migratory birds, increase quality habitat for the endangered Delmarva fox squirrel (DFS), forest interior breeding and wintering landbirds, reptiles, amphibians, and other forest-dependent wildlife.

3. (Refuge Impounded Marsh Complex) Maintain the quality of the wetland habitats within and surrounding the refuge's wetland impoundment complex for migrating shorebirds, breeding rails, wading birds, American black ducks, and migrating and wintering waterfowl consistent with the BIDEH policy. Support other native wetland dependent species and provide fish passage and nursery habitats for anadromous fish species.

4. (Early Successional Upland Habitats) Maintain, enhance and restore the native vegetation, biological diversity and ecological integrity of early successional upland habitats to create an assorted mosaic of early successional habitats mixed with transitional forested areas to conserve migratory birds, breeding landbirds, endangered species, and to maximize benefits for other priority resources of concern.

5. (Visitor Services) Provide visitors with a place to safely take part in the six priority wildlife-dependent recreational uses established by the Refuge Improvement Act, as well as such other public uses as may be allowed without interfering with refuge purposes and objectives for wildlife.

6. (Partnerships) Collaborate with the local community and partners to compliment habitat and visitor service programs on the refuge and the surrounding landscape.

Hunting Objectives of Prime Hook National Wildlife Refuge

The following objectives will guide the management of Prime Hook National Wildlife Refuge:

1. To provide a high quality hunting program that is administratively efficient and is used to maintain healthy habitats through the management of wildlife populations, where appropriate;

2. To provide high quality hunting opportunities for white-tailed deer;

3. To provide high quality hunting opportunities for waterfowl;

4. To provide high quality opportunities for upland game (rabbit, quail, pheasant, and red fox) and webless migratory birds (mourning dove, snipe, and woodcock); and

5. To provide high quality hunting opportunities for wild turkey.

Hunting on the refuge shall be in accordance with state, federal and refuge-specific regulations. The refuge hunting program will provide the public with high quality wildlife-dependent recreation opportunities. Also, the refuge hunting program will benefit the habitat management objectives of the refuge, especially in controlling the deer population. High deer densities have been shown to alter the understory of forests and negatively affect neotropical migrant birds as well as small game populations. Overbrowsing by deer in the State of Delaware in the 1990s is a well documented problem.

The negative effects of a hunting program on the refuge have been minimized through the use of refuge-specific regulations. Safety issues, game population concerns, non-target species and endangered species impacts, and "quality hunt" parameters have all been addressed in the Environmental Impact Statement, which was prepared by the Service in 2012 as part of the refuge's Comprehensive Conservation Plan (CCP). The CCP also includes a Section 7 consultation for impacts to endangered species.

ASSESSMENT

An assessment of refuge resources can be found in the CCP Environmental Impact Statement that has been prepared to address the direct, indirect, and cumulative environmental impacts of hunting on wildlife, visitor services, refuge facilities, cultural resources, and neighboring lands. Also, a Compatibility Determination has been completed for hunting which includes migratory game bird hunting, white-tailed deer hunting, turkey hunting, and upland (small) game hunting for a variety of species including rabbit, quail, pheasant, and red fox (See Appendix E). These documents address environmental impacts, population status, inter-specific competition, and effects of hunting on non-target species. In summary, the hunt program will not result in unacceptable impacts to the refuge resources. The populations of those species proposed for hunting will not be adversely affected by the hunt program, provided the refuge-specific regulations listed in this document are followed.

MEASURES TAKEN TO AVOID CONFLICTS WITH OTHER MANAGEMENT OBJECTIVES

Hunting can result in positive or negative impacts to the wildlife resource. A positive effect of allowing visitors access to the refuge will be the provision of additional wildlife-dependent recreational opportunities and a better appreciation and more complete understanding of the wildlife and habitats associated with Delmarva ecosystems. This can translate into more widespread and stronger support for the refuge, the National Wildlife Refuge System, and the Service. The following is a discussion of refuge-specific impacts, which are supported by a compilation of baseline information relative to the featured topic.

General Impacts of Public Use

Direct impacts are those impacts immediately attributable to an action. Indirect impacts are those impacts that are farther in time and in space. Effects that are minor when considered alone, but collectively may be important are known as cumulative effects. Incremental increases in activities by people engaged in the variety of allowed uses on the refuge could cumulatively result in detrimental consequences to wildlife and/or habitats. It will be important for refuge staff to monitor these impacts to ensure wildlife resources are not impacted in a detrimental manner.

Impacts on Socioeconomic Environment

The USGS-Fort Collins Science Center estimated the direct and total economic impacts of refuge management activities, including hunting, in Sussex County. Refuge management activities of economic concern included refuge purchases of goods and services within the local community, refuge personnel salary spending, revenues generated by Refuge Revenue Sharing, and spending in the local community by refuge visitors, including hunters. The economic impacts were estimated using the “Impacts Analysis for Planning” (IMPLAN) regional input-output modeling system. Refuge management activities directly related to refuge operations generate an estimated $3.3 million in local output, 30 jobs and $892.9 thousand in labor income in the local economy. Including direct, indirect, and induced effects, refuge activities would generate total economic impacts of $4.7 million in local output, 41 jobs and $1.29 million in labor income.

More specifically, overall hunting activities directly related to refuge operations would generate an estimated $93.8 thousand in local output, 0.8 jobs, and $26.9 thousand in labor income in the local economy. Including direct, indirect, and induced effects, overall refuge hunting activities would generate total economic impacts of $132.1 thousand in local output, 1.2 jobs and $38.5 thousand in labor income. A further breakdown of hunting activities on the refuge, including direct, indirect, and induced effects, reveals that big game hunting on the refuge would generate total economic impacts of $47.8 thousand in local output, 0.4 jobs, and $13.7 thousand in labor income. Waterfowl hunting on the refuge would generate total economic impacts of $82.3 thousand in local output, 0.8 jobs, and $24.3 thousand in labor income. Small game hunting on the refuge would generate total economic impacts of $2.0 thousand in local output, 0.02 jobs, and $500 in labor income.

In 2007, total labor income was estimated at $2.996 billion and total employment was estimated at 87,113 jobs for Sussex County (IMPLAN 2007 data). These total economic impacts associated with refuge operations represent less than one percent of total income (0.04%) and total employment (0.05%) in the overall Sussex County economy. Total economic effects of refuge operations play a larger role in the Prime Hook communities near the refuge such as Milton and Lewes where most of the refuge public use related economic activity occurs.

Based on these findings, the refuge expects that hunting will have negligible short-term, long-term or cumulative impacts on the economy of the towns or county in which the refuge lies. The Service would not expect this activity to considerably alter the demographic of economic characteristics of the local community. All refuge actions proposed would neither disproportionately affect any communities nor damage or undermine any businesses or community organizations. No adverse impacts are foreseen to be associated with changes in the community character or demographic composition.

This activity would result in several minor beneficial impacts on the social communities near the refuge and in the state and region as a whole. The Service expects public use of the refuge to increase, thereby increasing the number of days visitors spend in the area and correspondingly, the level of visitor spending in the local communities.

The “Recreation and Tourism” section in chapter 3 of the refuge’s CCP provides more information about national and statewide trends in the recreation of hunting.

Impacts on Cultural Resources

With a relatively small number of hunters dispersed across the refuge during the hunting season, impacts would be negligible on the refuge’s cultural resources based on our observations of past hunting impacts. Refuge lands are vulnerable to looting, despite our best efforts at outreach, education, and law enforcement. Upland areas adjacent to wetland areas have been identified for high potential for cultural resources. In addition, refuge visitors may inadvertently or even intentionally damage or disturb known or undiscovered cultural artifacts or historic properties. This problem will require, continued outreach, and use law enforcement where necessary.

For compliance with section 106 of the National Historic Preservation Act, the refuge staff will, during the early planning stages of any proposed new actions, provide the regional historic preservation officer a description and location of all projects, activities, routine maintenance and operations that affect ground and structures, details on requests for compatible uses, and the range of alternatives considered. That office will analyze those undertakings for their potential to affect historic and prehistoric sites,

and consult with the State Historic Preservation Officer and other parties as appropriate. This office will notify the State and local government officials to identify concerns about the impacts of those undertakings.

Impacts on Air Quality

Hunting is expected to have negligible adverse short-term, long-term or cumulative impacts on local or regional air quality. Localized increases in emissions from hunter's vehicles or boat motors would be negligible compared to current off-refuge contributions to pollutant levels and likely increases in air emissions in the Sussex County airshed from land development over the next 15 years. Any adverse air quality effects from refuge activities would be more than offset by the benefits of maintaining the refuge in natural vegetation. The hunting program would not violate EPA standards and would comply with the Clean Air Act.

Impacts on Soils

Hiking or walking can alter habitats by trampling vegetation, compacting soils, and increasing the potential of erosion. Soil compaction makes root penetration more difficult, making it harder for seedlings to become established. In moderate cases of soil compaction, plant cover and biomass is decreased. In highly compacted soils, plant species abundance and diversity is reduced in the long-term as only the most resistant species survive (Liddle 1975).

Using these baseline impacts, the refuge's hunt program has the potential to cause some soil compaction since off-trail foot travel occurs; however, hunting is expected to have negligible adverse short-term, long-term or cumulative impacts on soils. With a limited number of hunters dispersed across the refuge during the hunting season, impacts would be negligible based on our observations of past hunting impacts. Vehicles would continue to be confined to existing refuge roads and parking lots to minimize impacts outside of that developed footprint. Soil compaction will also occur in the immediate areas surrounding blind site stakes for waterfowl hunting in the Unit III Waterfowl Lottery Area. Impacts to bank erosion will be minimized through the use of no wake zones and a maximum motor restriction of 30 horsepower on Prime Hook Creek and Slaughter Canal.

To facilitate hunting, maintenance or improvement of facilities (parking areas, roads, trails, and boat ramps) will be needed, which are expected to cause negligible to minor short-term impacts to localized soils and waters. Negligible short-term disturbance to soils will occur during the construction of new parking areas on Fowler Beach Road and on Broadkill Beach Road to facilitate hunting.

Several rare peat bog communities have been located near Goose Pond and Flaxhole Pond and these areas are open to deer hunting. Sensitive hydric soils that support these rare plant communities are easily destroyed by trampling. Visitation to this site will be kept to a minimum in order to protect damage to hydric soils and trampling of sensitive rare plants.

Impacts on Hydrology and Water Quality

Hunting is expected to have negligible adverse short-term, long-term or cumulative impacts on hydrology or water quality based upon staff observations of past hunting impacts. The hunting program would not violate federal or state standards for contributing pollutants to water sources and would comply with the Clean Water Act.

The use of boats by hunters has the potential to affect water quality negatively by increasing erosion, stirring up bottom sediments, or introducing pollutants into waterways. The Service does not expect emissions from vehicles or boat motors to substantially affect the water quality of the region since the majority of hunters are using air-cooled mud-motors instead of water-cooled two-cycle outboard motors due to the shallow water depth in the hunt areas. Localized increases in emissions from hunter's boat motors would be negligible compared to current off-refuge contributions of boaters to pollutant levels in the nearby Broadkill River and the Delaware Bay. Furthermore, the refuge posts no wake zones and imposes a maximum 30HP restriction on Prime Hook Creek and Slaughter Canal.

Non-toxic shot is required for all hunting except lead slugs for deer/fox hunting. Public outreach and education on littering and proper waste disposal will lessen potential negative water quality impacts.

Impacts on Vegetation

Repeated visitation to any particular locale at the refuge would continue to cause minor site-specific damage to vegetation. Repeated use of an aquatic area by boats equipped with go-devils can damage to emergent and submergent vegetation beds. Portions of or whole plants can be torn, sometimes by roots, and boat wakes contribute to erosion. Accidental introduction of invasive plants, pathogens, or exotic invertebrates attached to boats or trailers, or on shoes or clothing, is another source of direct minor impacts on vegetation. In places where unmarked paths are created by hunters and anglers, little used pathways will retain their dominant vegetation species, but on medium-use pathways some plant species will be replaced and heavily-used paths will often contain invasive species (Liddle and Scorgie 1980).

Using the information previously presented as a baseline and considering staff observations of past impacts, hunting is expected to have negligible adverse short-term, long-term, or cumulative impacts on vegetation. Disturbance to vegetation is expected to increase due to an expected increase in deer and waterfowl hunters in new free roam hunting areas in upland and wetland habitats during all hunting seasons, particularly around blinds sites in the Unit III impoundments. The possibility for new trails to be developed from repeated hunter entry may occur. However, given the large expanse of both upland and wetland acreage, anticipated dispersal of hunters across hunting areas, the inherent nature of hunters to only travel as far as needed to find a hunting location, and knowing that most vegetative species will have already undergone senescence or become dormant, the impacts to vegetation are expected to be negligible from hunting.

Furthermore, the phasing out and elimination of all of the refuge's 130+ deer hunting stands and waterfowl hunting blinds will remove disturbance to impacted vegetation and soils and create a more aesthetically pleasing landscape for refuge visitors. Impacts to vegetation are also minimized by not permitting hunters to cut vegetation for shooting lanes or for use as camouflage. No natural vegetation is permitted for use as camouflage on the refuge. Impacts to vegetation are further minimized because hunting from a stand which has been attached with nails, wire, or screws or permanently attached in any other way is prohibited.

Hunting plays a role in how white-tailed deer, snow geese, resident non-migratory Canada geese, and mute swans impact vegetation. Canada goose herbivory during the growing season is a relatively new impact upon wetlands. In 2002, a research study conducted at neighboring refuges, Bombay Hook and Chincoteague NWRs, suggested that higher levels of use by geese may cause a long-term change in wetland community structure (Laskowski et al. 2002). Biomass of several species of vegetation was

significantly adversely impacted by feeding resident Canada geese at both refuges. Resident geese directly damage agricultural resources by eating grain crops and trampling spring seedlings. Heavy grazing by geese can result in reduced yields and in some instances a total loss of the grain crop (Allen et al. 1985, Flegler et al. 1987). Lethal and nonlethal Canada goose control activities outlined under all strategies common to all alternatives would be expected to significantly decrease the number of injurious resident Canada geese in specific areas, thus reducing local impacts on vegetation. The long-term viability of migrant Canada goose populations would not be affected, however. Similarly, because mute swans are highly invasive of wetland habitats, and can consume large quantities of submerged aquatic vegetation, control of mute swans on the refuge will have a local beneficial impact on wetland vegetation communities.

Various light goose (snow goose) populations in North America have reached such high levels that they are damaging habitats on their Arctic and subarctic breeding areas (Abraham and Jefferies 1997, Alisauskas 1998, Jano et al. 1998, Didiuk et al. 2001) as well as in some migration and wintering areas (Giroux and Bedard 1987, Giroux et al. 1998, Widjeskog 1977, Smith and Odum 1981, Young 1985). The increasing numbers of light-geese are viewed as a continental problem, but with real local adverse impacts on vegetation. Grubbing for rhizomes, especially in salt marshes, results in areas denuded of vegetation, typically referred to as eat-outs. Vegetation density at these eat-outs may return to previous normal levels after several years, if left alone. However, where eat-outs occur within salt marsh habitats, snow geese often return each winter to the same areas to feed. Such impacts have been observed at the refuge. It is also speculated that during the time snow geese are feeding in a salt marsh, much of the soil and sediment may be loosened and placed into suspension. In fact, recently analyzed water quality samples from the refuge impoundments have found extremely high sediment concentration in the water during times of extensive snow goose browsing on the refuge. This material may then be washed away during high or flood tide periods. After several years of successive erosive eat-outs at the same location, the lower ground elevation may further prevent the return of vegetation, causing a more long-term impact to vegetation community on the site. Reducing snow goose numbers on the refuge will reduce adverse minor-to-moderate impacts of snow goose herbivory on salt marsh habitats.

Deer overabundance can affect native vegetation and natural ecosystems and has been well-studied (Tilghman 1989, Nudds 1980, Hunter 1990; Behrend et al. 1970). White-tailed deer selectively forage on vegetation (Strole and Anderson 1992), and thus can have substantial impacts on certain herbaceous and woody species and on overall plant community structure (Waller and Alverson 1997). Over-browsing by deer can decrease tree reproduction, understory vegetation cover, plant density, and plant diversity (Warren 1991). High densities of deer have also been recognized as vectors for spreading invasive species like Japanese stiltgrass. Thus, control of the white-tailed deer population on the refuge will have a moderate beneficial impact on the vegetation communities.

Impacts on Federal and State Endangered Species

Disturbance factors resulting from public use are always considered for all listed species. The Delmarva fox squirrel *(Sciurus niger cinereus)* and piping plover *(Charadrius melodus)* are listed as endangered and threatened by the U.S. Fish and Wildlife Service and the red knot was designated as a candidate species in 2006 for possible listing. Several other species listed as endangered by the Delaware Division of Fish & Wildlife include American oystercatcher *(Haematopus palliates),* common tern *(Sterna hirundo),* Forster's tern *(Sterna forsteri*), least tern *(Sterna antillarum),* and bald eagle *(Haliaeetus leucocephalus).* Of these, the piping plover, red knot, American oystercatcher, common tern, Forster's tern, and least tern will not be impacted by hunting because they would be unlikely to use the refuge's forested habitats and/or

their occurrence on the refuge is outside of the hunting season for deer, upland game, and waterfowl. A Section 7 Evaluation has been conducted as part of this review and it was determined that proposed activities would not likely affect the Delmarva fox squirrel or piping plover. Furthermore, the hunting of any squirrel species is prohibited on the refuge to further minimize impacts to this endangered species.

While the bald eagle is no longer a federally listed species, the refuge uses the national bald eagle management guidelines for bald eagle management to implement time-of-year restrictions for nesting eagles. The guidelines do not permit any activity within 330 feet of an active nest during the breeding season, particularly where eagles are unaccustomed to such activity (U.S. Fish and Wildlife Service 2007).

Fishing, hunting, and wildlife-observation on or near Turkle Pond were existing activities prior to nesting by bald eagles on the adjacent Horse Island. When bald eagles were listed as endangered, the Section 7 Evaluation conducted on the refuge concluded that these activities in Turkle Pond would not likely affect this species and the uses were permitted. Monitoring will continue in Turkle Pond to determine if there is an impact on the eagle nest on Horse Island.

Impacts on Waterfowl

Below is a discussion of the generalized impacts of hunting on critical life history requirements of waterfowl, the use of sanctuaries to mitigate adverse impacts to waterfowl, and impacts of hunting through the harvest of waterfowl. Refuge-specific impacts of hunting on waterfowl are discussed in each of these sections.

<u>Wintering Waterfowl - Waterfowl Habitats</u>
Since the refuge consists of 80 percent wetlands, all recreational activity has the potential of impacting waterfowl, shorebirds, marsh birds, and other migratory bird populations feeding and/or resting near the hunting area(s). Conflicts arise when migratory birds and humans are present in the same areas (Boyle and Samson 1985). Response of wildlife to human activities includes departure from site (Owen 1973, Burger 1981, Korschgen et al 1985, Henson and Grant 1991, Kahl 1991, Klein 1993), use of suboptimal habitat (Erwin 1980, Williams and Forbes 1980), altered behavior (Burger 1981, Korschen et al. 1985, Morton et al. 1989, Ward and Stehn 1989, Havera et al. 1992, Klein 1993), and increase in energy expenditure (Morton et al. 1989, Belanger and Bedard 1990). McNeil et al. (1992) found that many waterfowl species avoid disturbance by feeding at night instead of during the day.

During the period of September 1 – March 15, which is when most wintering and migrating waterfowl are on the refuge, adverse impacts to these birds could result from unregulated human disturbance in optimum waterfowl habitats at the refuge. This conclusion is based on the role of disturbance as it relates to waterfowl life history requirements and behaviors such as feeding, flight, metabolic processes, molting, preening, and resting. These daily waterfowl maintenance activities are costly from an energetic standpoint and require that waterfowl have undisturbed access to quality habitats with diverse food resources to meet their daily and seasonal energy requirements. Since these activities are critical to the survival of waterfowl, a discussion of their behaviors and metabolic processes is appropriate.

Feeding: Waterfowl have complex feeding strategies, which are conducted at optimum levels only in an environment void of disturbance. Feeding is the only activity that provides energy to birds, and the amount of time allocated to feeding is dependent upon relationships between energy-nutrient requirements and foraging strategies used in meeting these needs (King 1974). Feeding on readily

available and easily consumed foods requires less time than feeding on dispersed resources or foods which require searching (e.g. mobile invertebrates) or complex foraging behavior (e.g. underground tubers) (Rapport 1980).

Generally, feeding periods for wintering waterfowl are early morning and late evening. Morton, et al., (1989) found that American black ducks (*Anas rubripes*) spent an average of 4.49 hours per day feeding, with the majority of feeding activity occurring either during the first three hours after daylight, or the last three hours of the day, and then spend the remainder of the day engaging in resting, (4.54 hours) swimming, (1.83 hours), or several other maintenance activities (balance of the day). This suggests that waterfowl, when undisturbed, prefer to feed early and late, while spending the remainder of the day in maintenance activities such as resting, preening, or courtship.

Mallards (*Anas platyrhynchos*) generally do not feed in water deeper than 40 cm (Thomas 1976), but prefer to feed in water depths of 10 cm or less (Fredrickson and Taylor 1982), which is indicative of the habitat provide in the refuge's managed impoundment complex. Accordingly, unregulated access in these provided habitats could adversely impact the feeding strategies of waterfowl using the refuge.

Flight: Many research projects have been conducted on the basic energy requirements of waterfowl, and these projects emphasize the importance of readily available food resources. As birds arrive in Delaware during fall migration, they need areas to rest and feed to replenish energy reserves. And, although migratory flight is often associated only with migration, it is important to recognize that approximately 90 percent of the migration period is spent in a stationary mode at successive stopover sites (Hedenstrom and Alerstam 1998). Birds at stopover sites spend their time resting and foraging as they rebuild protein and energy stores in preparation for their next migratory flight (McWilliams, et al 2004). It is also important to recognize that the cost associated with flight is a very expensive activity from a metabolic perspective and forcing birds into flight creates the need to replace lost energy reserves that could have been used for other maintenance activities. Protection is needed to allow waterfowl the opportunity to forage and replenish energy reserves depleted during migration, or to avoid the energetic costs associated with being forced into unnecessary flight.

Metabolic Processes: Along with rebuilding protein and energy stores, one must recognize that in addition to flight, there exists the basic energy maintenance requirement of birds. These daily requirements, which include the energy costs of thermoregulation, maintenance of basal metabolic rate (BMR), and other activities, combine to account for 40-60 percent of the annual energy budget (Walsberg 1983). Thus, without reliable access to high quality food resources, waterfowl must either migrate to better habitats or suffer reduced fat reserves, which can result in below optimum body condition. As an illustration of the food resources required to maintain body condition, Magee (1996) found that, in waterfowl, the energetic cost of flight for one hour would require enough foraging effort to consume 19.6 grams of corn (75 kernels) or 117.8 grams of amphipods (6250 individuals) to replace lost energy reserves. And, from the standpoint of how fat deposition relates to reproductive potential, Heitmeyer (1985) discovered that hen mallards in the Mingo Basin of Missouri needed to reach a minimum weight threshold of 1360 grams (>3 pounds) when they left the wintering grounds to ensure there would be adequate fat reserves to initiate nesting activities upon arrival at the breeding grounds. At Chincoteague NWR, Morton et al (1989) found that wintering black ducks experienced reduced energy intake while doubling energy expenditure by increasing the time spent in locomotion in response to disturbance. Black ducks consumed 10.4 times more energy in flight than at rest, and 1.8 times more energy in alert behavior or swimming than at rest, suggesting that human disturbance of wintering black ducks impaired their physiological condition, thereby reducing winter survival and/or nutrient reserves carried to the

breeding grounds. Subsequently, during migration stopovers, waterfowl must be afforded the time and opportunity to forage in high quality habitat to attain the desired body mass and fat depots, and replace lost energy reserves. To meet these metabolic demands, waterfowl rely on many Federal, State, and private wetlands, including the refuge, to rest, feed, and reacquire lost fatty deposits.

Molting: Feather molts are very costly from a metabolic standpoint, as waterfowl are converting from the alternate (summer) plumage to their basic (breeding) plumage. Most feathers are replaced during this period, as these birds are preparing for courtship rituals and pair bonding. Heitmeyer (1985) describes the prebasic molt of female mallards as extensive and intense, as these birds replace approximately 50 grams of feathers in a 6-7 week period, which requires a substantial amount of energy reserves to complete. This increase in nutrient demand translates to the need for individual mallards to be afforded the opportunity for undisturbed foraging. Excess disturbance may negatively impact the ability of waterfowl to secure nutrients, thus disrupting molting processes and associated reproductive strategies.

Preening: Maintenance of feathers by preening has been previously correlated to molt activity and is undoubtedly influenced by molt chronology. Male mallards preen most often during autumn; but preening declines throughout early winter, which corresponds with declining molt activity (Combs 1987). Adverse impacts to preening activities would be similar to those associated with the molting process.

Resting: Resting appears to be a complementary activity to feeding, molting, and preening. As feeding declines from morning to afternoon, resting increases, which is necessary to allow birds to digest food consumed during previous periods of feeding (Paulus 1984b, Clark et al. 1986), and to rejuvenate muscle fibers that may have been damaged during periods of flight (McWilliams et al. 2004). The inability of waterfowl to rest may have a direct negative impact on the ability of waterfowl to digest foods and repair muscle fibers, thus impacting other necessary life history behaviors.

Waterfowl Sanctuaries

As discussed in the previous section, wintering waterfowl need access to areas that are free from human interruption to complete seasonal and annual life cycle events. These interruptions can be characterized as disturbance, which causes an animal to deviate from behavior patterns that normally transpire without human influence. To explain further, a disturbance stimulus is produced when a human-related presence or object (e.g. birdwatcher, motorized vehicle) or sound (e.g. seismic blast or gunshot) occurs that causes changes to the natural behavioral patterns of animals (Frid and Dill, 2002). Activities such as hiking, photography, jogging, hunting, fishing, boating, research and management activities, bicycling, and driving are among many types of disturbance that can and do occur on any national wildlife refuge. Because a disturbance free sanctuary is critical to waterfowl during the period of September 1 – March 15, it is important to understand that if unimpeded access is allowed, the ability of the refuge sanctuary to meet the needs of waterfowl may be reduced. The following sections discuss the values and functions of waterfowl sanctuaries and illustrate the impacts of disturbance on the ability of waterfowl to utilize habitat.

Disturbance is a primary factor influencing avoidance behaviors in waterfowl (Paulus 1984b, Heitmeyer 1985, Austin 1987) as ducks and geese are highly sensitive to motor traffic and human disturbance (walking, bird viewing, vehicular traffic) along roads during fall and winter (e.g., Bartelt 1987; Belanger and Bedard 1989, 1990; Bowles 1995; Dalhgren and Korschgen 1992; Gabrielson and Smith 1995; Heitmeyer 1985; Klein 1989; Knight and Cole 1991, 1995; Madsen 1985; Van Der Zande et al. 1980; Raasch 1996). Thus, when waterfowl are in areas adjacent to roads, they reduce time spent foraging and spend more time alert and vigilant to disturbance. For instance, a research study examining disturbance effects conducted on Mingo NWR in southeastern Missouri showed that mallards became alert at a

mean distance of 213 m (698 ft) and flew from the site at a mean distance of 173 m (568 ft) in response to vehicle disturbance (Raasch 1996). In another study in Virginia, Pease, et al. (2005) described the responses of seven species of dabbling ducks to six different forms of disturbance and recorded whether the birds had: 1) no response; 2) alert; 3) swam; and 4) flew. Analysis of the data from Virginia showed that 74.2 percent of birds responded (alert, swam, or flew) when birds were within 200 meters (656 feet) of a human caused disturbance. As a result, when birds exhibit avoidance behaviors, swimming and flying activities increase, while resting and feeding activities decrease (Combs 1987), which creates the need for additional foraging effort, which in turn influences seasonal movements and habitat selection. Areas void of regulations can cause increased human-wildlife interactions that can negatively impact the life history behaviors and metabolic processes of migratory waterfowl.

Laskowski et al. (1993) studied behavior of snowy egrets, female mallards, and greater yellowlegs on Back Bay National Wildlife Refuge in Virginia within 91.4 meters of impoundment dikes used by the general public. Behavior of snowy egrets was recorded during August and September. Mallards were monitored during migration in November and January. Greater yellowlegs behavior was observed during the northward shorebird migration. Behavior was monitored during the typical public activities of walking, bicycling, and driving a vehicle past the sample sites.

The study found that snowy egret resting behavior decreased and alert behavior increased in the presence of humans. Preening decreased when humans were present, but this change was not significant. Feeding, walk/swim, and flight behaviors were not related to human presence. Female mallards in November increased feeding, preening and alert behaviors in the presence of humans. Resting, walk/swim, and flight behavior were not influenced by human presence. In January, female mallard resting and preening behavior were not influenced by the presence of humans. However, feeding, alert, walk/swim, and flight behaviors were related to human presence. Greater yellowlegs increased alert behavior in the presence of humans. No other behaviors were affected. Maintenance behavior (combined feeding, resting, and preening) decreased when humans were present for all study species. In addition, this decrease was accompanied by an increase in escape behavior by each species. Maintenance behavior of mallards in January decreased in the presence of vehicles and combined disturbance. Escape behavior increased when vehicles or bicycles were present. Maintenance behavior of greater yellowlegs declined when bicycles and vehicles were present but was not influenced by pedestrian presence. Snowy egrets and female mallards increased movement between subplots and to areas within the study area but further from the disturbance.

Speed of approach by vehicles has also been identified as having detrimental effects to waterfowl, as objects that approach quickly tend to frighten birds more often than objects that approach at lower speeds (Frid and Dill, 2002). Pease (2005), found that vehicles traveling more than 13 miles per hour but less than 30 miles per hour created the least amount of disturbance. As a contrast to speed, Pease noted that humans approaching waterfowl on foot had a greater disturbance impact than passing vehicles. Thus, research suggests that waterfowl are disturbed less by vehicles that pass at a moderate rate of speed, and more distressed by vehicles going very fast, very slow, or by humans on foot.

Non-motorized boating can affect refuge resources in a number of ways. Studies show that canoes and kayaks disturb wildlife (Bouffard 1982; Kaiser and Fritzell 1984; Knight 1984; Kahl 1991). They may affect waterfowl broods, wintering waterfowl, shorebirds, raptors and wading-birds, but their low speed and their use primarily during the warmer months would mitigate those impacts, especially on wintering waterfowl and raptors. Little canoeing/ kayaking occurs in areas frequented by shorebirds. Air thrust boats and jet skis are not permitted.

When birds leave the refuge because of human disturbance, high quality habitat is left unexploited for the duration of time that the birds are displaced. The length of time that a bird is displaced from a feeding site determines how much additional foraging effort will be required to replace lost food resources, which in turn impacts other maintenance activities such as molting, resting and preening. There have been several research studies which examined how long it took waterfowl to return to habitats after being disturbed. For example, the return rate of mallards and Canada geese (*Branta canadensis*) at Mingo NWR following vehicular disturbance indicated that two thirds of the birds were still displaced after 25 minutes. At the Russell Lakes State Wildlife Area in Colorado, mallards flew from a pond during disturbances and did not return within 1 hour (George et al. 1991). In Wisconsin, only 15-56 percent of canvasbacks (*Aythya valisineria*) returned to foraging sites following disturbances (Kahl 1991), and staging snow geese (*Chen caerulescens*) populations in Quebec were found to be lower the day after they have been disturbed at a rate of less than two disturbances per hour, and that vehicular disturbance and unobstructed visual sight planes of approximately 400-500 m (1312 -1640 ft) are detrimental to waterfowl use and subsequent rates of return (Belanger and Bedard 1989). Thus, repeated disturbances (> 2 per hour), which could occur if unregulated access is permitted, can have serious detrimental impacts on the utilization of seasonal wetlands, which may ultimately cause birds to completely abandon a site, disperse to poorer quality habitat, and/or change feeding strategies.

As wildlife professionals, public use and access is recognized as important, but this use must be managed so that disturbance to wildlife is minimized and habitat utilization is not compromised. With these objectives in mind, it becomes necessary to recognize that disturbance to waterfowl early and late in the day can negatively impact biological processes such as feeding, flight, metabolic processes, molting, preening, and resting. For example, birds are feeding early in the morning to obtain food resources, but are beginning to come to roost at sunset to begin a period of rest after returning from evening feeding forays. This period of rest is just as important as feeding as it permits the digestion of food ingested prior to roosting and allows the repair of muscle fibers damaged during flight. Therefore, if measures to minimize or eliminate the cause of disturbance are not considered, the impacts from these activities can negatively affect the potential for wildlife to acquire the necessary resources needed to meet nutritional life history requirements throughout their annual life cycle (Raasch 1996, Fredrickson and Reid, 1988).

Providing waterfowl sanctuaries will minimize some of these impacts and allow waterfowl to have undisturbed access to these areas during biologically critical periods of the day. Havera et al (1992) and Dahlgren (1988) in comprehensive literature reviews of human disturbances to migrating and wintering waterfowl have noted that the use of sanctuaries (non-hunted areas) was the most common and effective solution to mitigating adverse disturbance impacts.

The use of sanctuaries as a management tool is an old concept. Bellrose (1954) wrote of the early 1900's when owners of duck lands found that providing non-hunted areas on their properties was of value in building and holding concentrations of waterfowl. A distinctive degree of sense of security constituted the principal factor governing duck use of areas that were all hunted, half hunted/half unhunted, or no hunting. Waterfowl numbers averaged 16 times more abundant per acre on half hunted/half unhunted areas than on areas that were completely hunted.

Other hunting measures that serve to mitigate adverse impacts to waterfowl:

1. provide adequate buffer areas and large enough sanctuaries to ensure full use by waterfowl;
2. provide "temporal respite" for ducks by limiting hunts to half days and/or use an intermittent hunt program (3-4 hunts/week); and

3. regulate hunter access limiting boat access and traffic to specific areas.

To minimize waterfowl disturbance, the refuge has designated approximately 2,500 acres as waterfowl sanctuaries that will be closed to hunting and other recreational uses on a seasonal or annual basis. Given the dominant role of the refuge in the Atlantic Flyway migration corridor, this closed area system was established to provide waterfowl with a network of resting and feeding areas and to disperse waterfowl hunting opportunities on the refuge. These sanctuaries lie in the Unit II (~1,800 acres) and the southern half of the Unit III (~970 acres) managed impoundments. The northern portion of Unit IV (~230 acres), which contains a proposed trail and observation platform, will be closed from the Monday before Thanksgiving to March 15 to also minimize disturbance to wildlife in this area. Waterfowl hunting will be terminated at noon in all hunting areas on limited hunting days to reduce disturbance to waterfowl feeding patterns, which in turn will result in high quality hunting experiences. Literature reviews of visitor use and its relationship to disturbance to waterbirds support the time restriction and are reflected in the hunting regulations of other refuges, particularly in the Southeast Region of the FWS (DeLong 2002).

Hunting is a priority, wildlife-dependent, consumptive activity with additional direct effects on waterfowl. General adverse impacts of waterfowl hunting are mortality, crippling and disturbance. Belanger and Bedard (1995) concluded that disturbance caused by waterfowl hunting to waterfowl resources can:

1. modify the distribution and use of habitats by waterfowl;
2. affect their activity budget and decrease their foraging time; and
3. disrupt pair and family bonds and contribute to increased hunting mortality.

The U.S. Fish and Wildlife Service annually prescribe frameworks, or outer limits, for dates and times when hunting may occur and the number of birds that may be taken and possessed. These frameworks are necessary to allow State selections of season and limits for recreation and sustenance; aid Federal, State, and tribal governments in the management of migratory game birds; and permit harvests at levels compatible with population status and habitat conditions. Because the Migratory Bird Treaty Act stipulates that all hunting seasons for migratory game birds are closed unless specifically opened by the Secretary of the Interior, the Service annually promulgates regulations (50 CFR Part 20) establishing the frameworks from which States may select season dates, bag limits, shooting hours, and other options for each migratory bird hunting season. The frameworks are essentially permissive in that hunting of migratory birds would not be permitted without them. Thus, in effect, Federal annual regulations both allow and limit the hunting of migratory birds.

Migratory game birds are those bird species so designated in conventions between the United States and several foreign nations for the protection and management of these birds. Under the Migratory Bird Treaty Act (16 U.S.C. 703-712), the Secretary of the Interior is authorized to determine when “hunting, taking, capture, killing, possession, sale, purchase, shipment, transportation, carriage, or export of any bird, or any part, nest, or egg” of migratory game birds can take place, and to adopt regulations for this purpose. These regulations are written after giving due regard to “the zones of temperature and to the distribution, abundance, economic value, breeding habits, and times and lines of migratory flight of such birds, and are updated annually (16 U.S.C. 704(a)). This responsibility has been delegated to the U.S. Fish and Wildlife Service as the lead federal agency for managing and conserving migratory birds in the United States. Acknowledging regional differences in hunting conditions, the Service has administratively divided the nation into four Flyways for the primary purpose of managing migratory game birds. Each Flyway (Atlantic, Mississippi, Central, and Pacific) has a Flyway Council, a formal organization generally composed of one member from each State and Province in that Flyway. The refuge is in the Atlantic Flyway.

The process for adopting migratory game bird hunting regulations, located in 50 CFR part 20, is constrained by three primary factors. Legal and administrative considerations dictate how long the rule making process will last. Most importantly however, the biological cycle of migratory game birds controls the timing of data-gathering activities and thus the dates on which these results are available for consideration and deliberation. The process of adopting migratory game bird hunting regulations includes two separate regulations-development schedules, based on "early" and "late" hunting season regulations. Early hunting seasons pertain to all migratory game bird species in Alaska, Hawaii, Puerto Rico, and the Virgin Islands; migratory game birds other than waterfowl (e.g. dove, woodcock, etc.); and special early waterfowl seasons, such as teal or resident Canada geese. Early hunting seasons generally begin prior to October 1. Late hunting seasons generally start on or after October 1 and include most waterfowl season not already established. There are basically no differences in the processes for establishing either early or late hunting seasons. For each cycle, Service biologists and others gather, analyze, and interpret biological survey data and provide this information to all those involved in the process through a series of published status reports and presentations to Flyway Councils and other interested parties. Though not as detailed as that for waterfowl, relevant data are collected and summarized for migratory bird species such as dove, woodcock, etc. Bird monitoring data are available through the Service's Division of Migratory Bird Management Website (*http://www.fws.gov/migratorybirds/*; accessed February 2012).

Because the Service is required to take abundance of migratory birds and other factors into consideration, the Service undertakes a number of surveys throughout the year in conjunction with the Canadian Wildlife Service, State and Provincial wildlife-management agencies, and others. To determine the appropriate frameworks for each species, factors such as population size and trend, geographical distribution, annual breeding effort, the condition of breeding and wintering habitat, the number of hunters, and the anticipated harvest were considered. After frameworks are established for season lengths, bag limits, and areas for migratory game bird hunting, migratory game bird management becomes a cooperative effort of State and Federal Governments. After Service establishment of final frameworks for hunting seasons, the States may select season dates, bag limits, and other regulatory options for the hunting seasons. States may always be more conservative in their selections than the Federal frameworks but never more liberal. Season dates and bag limits for national wildlife refuges open to hunting are never longer or larger than the State regulations. In fact, based upon the findings of an environmental assessment developed when a national wildlife refuge opens a new hunting activity, season dates and bag limits may be more restrictive than the State allows.

National Environmental Policy Act (NEPA) considerations by the Service for hunted migratory game bird species are addressed by the programmatic document, "Final Supplemental Environmental Impact Statement: Issuance of Annual Regulations Permitting the Sport Hunting of Migratory Birds (FSES 88-14)," filed with the Environmental Protection Agency on June 9, 1988. The Service published Notice of Availability in the *Federal Register* on June 16, 1988 (53 FR 22582), and our Record of Decision on August 18, 1988 (53 FR 31341). Annual NEPA considerations for waterfowl hunting frameworks are covered under a separate environmental assessment, in which the FONSI is published generally in August of that hunt year. Further, in a notice published in the September 8, 2005, *Federal Register* (70 FR 53376), the Service announced its intent to develop a new Supplemental Environmental Impact Statement for the migratory bird hunting program. Public scoping meetings were held in the spring of 2006, as announced in a March 9. 2006, *Federal Register* notice (71 FR 12216). More information may be obtained from: Chief, Division of Migratory Bird Management., US_ Fish and Wildlife Service, Department of the Interior, MS MBSP-4107-ARLSQ, 1849 C Street, NWR, Washington, DC 20240.

At the refuge, the impacts of hunting of waterfowl are negligible when compared to the State's total waterfowl harvest. For example, from 1987 to 2009, the average annual waterfowl harvest at the refuge is 2.6 percent of Delaware's total waterfowl harvest (Table 1.1). Furthermore, in 2009, the refuge's harvest of ducks was only 3.4 percent of Delaware's total duck harvest, 0.96 percent of the Atlantic Flyway's duck harvest, and 0.01 percent of the entire United States' duck harvest (Table 1.2; Raftovich et al. 2011). Also in 2009, the refuge's harvest of geese (Canada and snow geese combined) was only 0.82 percent of Delaware's total goose harvest, 0.04 percent of the Atlantic Flyway's goose harvest, and 0.01 percent of the entire United States' goose harvest. (Table 1.2; Raftovich et al. 2011).

The impacts of waterfowl hunting at the refuge are also negligible when compared to long-term trends in duck and goose populations at the refuge and across the state. Through monthly aerial surveys from October through November, the Delaware Division of Fish and Wildlife is able to evaluate long-term trends in duck and goose populations. The surveys give fairly accurate information about geese, but duck populations such as wood ducks and sea ducks are almost impossible to count. Furthermore, these surveys do not cover the entire state, but only the primary waterfowl habitat in Delaware which is approximately the eastern half of the state. These figures represent the numbers of ducks and geese at the time of the survey, but do not reflect an actual annual estimate for the waterfowl population in Delaware due to the transitory nature of birds migrating through the State during the fall and winter months.

Based on the findings of these monthly surveys from 1987 to 2009, the average annual waterfowl harvest at the refuge is only 1.8 percent of the estimated peak waterfowl survey findings on the refuge (Table 1.1). During an individual season, the percent of the refuge's harvest on statewide and refuge populations may range greatly depending on the timing of refuge hunting activity and peak waterfowl migration. For example, during the 2009-2010 hunting season, the refuge harvested between 0.19 percent and 1.5 percent of the State's estimated monthly duck population and between 0.02 percent and 0.11 percent of the State's estimated monthly goose population (Table 1.3). Refuge hunters harvested between 0.31 percent and 6.15 percent of the refuge's estimated monthly duck population and between 0.09 percent and 1.48 percent of the refuge's estimated monthly goose population (Table 1.3).

Table 1.1. Waterfowl harvest and aerial survey estimates on Prime Hook NWR compared to statewide harvest. Waterfowl includes geese and ducks.

Year	Statewide Waterfowl Harvest*	Refuge Waterfowl Harvest	Refuge Waterfowl Survey**	Refuge Hunter Visits
1987	63,360	1,202	21,243	1,206
1988	62,160	771	21,814	826
1989	61,480	578	64,822	333
1990	59,510	1,241	49,611	1,065
1991	63,410	1,625	55,792	1,178
1992	46,600	1,155	55,238	1,291
1993	46,850	1,421	86,087	962
1994	53,290	2,053	155,096	1,604
1995	45,540	1,572	71,131	1,024
1996	44,170	1,980	104,447	1,630

Year	Statewide Waterfowl Harvest*	Refuge Waterfowl Harvest	Refuge Waterfowl Survey**	Refuge Hunter Visits
1997	71,070	3,116	191,446	1,904
1998	118,560	2,964	193,617	1,530
1999	96,410	1,987	224,693	1,403
2000	94,610	2,047	134,156	1,250
2001	76,210	2,679	107,919	1,683
2002	95,170	1,936	102,690	1,330
2003	88,800	2,546	203,615	1,486
2004	73,190	1,573	69,737	1,422
2005	71,740	1,624	111,544	1,301
2006	64,630	2,389	132,088	1,750
2007	81,620	2,989	44,086	1,850
2008	107,120	1,634	90,875	1,253
2009	86,600	1,934	79,263	1,453

*Statewide waterfowl harvest data from: *http://www.flyways.us/regulations-and-harvest/harvest-trends*

** Waterfowl estimates were derived from peak numbers found during aerial surveys. Zone 7 was used to estimate waterfowl numbers for PHNWR, which covers the area from Big Stone Beach to the Broadkill River and east of Route 1. Only one survey was conducted in 2007 (October 2007) which may not have reflected the peak. (*http://www.fw.delaware.gov/Hunting/Pages/Waterfowl%20 Surveys.aspx*)

Table 1.2. Comparison of waterfowl harvest at Prime Hook NWR to State, Flyway, and United States harvest in the 2009 hunting season.

Waterfowl Harvest Area	Ducks	Geese
Prime Hook NWR	1,609	325
Delaware*	46,800	39,800
Atlantic Flyway*	1,680,100	922,200
United States*	13,139,800	3,327,000

*Harvest estimates from (Raftovich et al. 2011)

Table 1.3. Comparison of duck and goose (Canada & snow geese) harvest at Prime Hook NWR to State waterfowl surveys during the 2009-2010 hunting season.

Month	Refuge Duck Harvest	Refuge Duck Population Estimates*	Statewide Duck Survey Results*	Refuge Goose Harvest	Refuge Goose Population Estimates*	Statewide Goose Survey Results*
October 2009	67	21,457	36,042	9	10,512	44,372
November 2009	406	30,548	63,516	104	18,734	92,604

Month	Refuge Duck Harvest	Refuge Duck Population Estimates*	Statewide Duck Survey Results*	Refuge Goose Harvest	Refuge Goose Population Estimates*	Statewide Goose Survey Results*
December 2009	697	46,675	76,100	115	32,588	247,922
January 2010	439	7,141	28,688	97	6,565	102,229

* Waterfowl estimates were derived from peak numbers found during aerial surveys. Zone 7 was used to estimate waterfowl numbers for PHNWR, which covers the area from Big Stone Beach to the Broadkill River and east of Route 1. (*http://www.fw.delaware.gov/Hunting/Pages/Waterfowl%20Surveys.aspx*)

Impacts of refuge hunting on snow geese and resident Canada geese are negligible. For resident Canada geese, hunters averaged 8.8 birds per year from 2001 to 2006 (Table 1.4). For snow geese in the late season (late January into March), hunters averaged 16.0 birds per year from 2001 to 2006 (Table 1.5). From 2000 to 2009, refuge hunters harvested between 0.04 percent and 0.43 percent of the refuge's estimated monthly snow goose population (Table 1.5).

Table 1.4. Resident Canada Goose Harvest in Prime Hook National Wildlife Refuge.

Year	Resident Canada Goose Harvest	Refuge Hunter Visits
2001	14	33
2002	6	15
2003	10	13
2004	14	10
2005	0	0
2006	9	2

Table 1.5. Snow Goose Harvest and Aerial Survey Estimates at Prime Hook National Wildlife Refuge.

Year	Total Snow Goose Harvest*	Hunted in Late Season**	Snow Goose Harvested in Late Season**	Refuge Hunter Visits in Late Season**	Refuge Snow Goose Survey***
2000	174	No	n/a	n/a	96,112
2001	242	Yes	37	42	67,840
2002	48	Yes	7	9	72,200
2003	118	Yes	33	24	124,500
2004	121	Yes	3	5	55,330
2005	36	Yes	4	8	86,627
2006	73	Yes	12	12	132,088
2007	130	No	n/a	n/a	30,500
2008	56	No	n/a	n/a	84,520
2009	43	No	n/a	n/a	27,000

* Includes snow geese harvested in February / March when applicable
** Late season includes late January to mid-March
*** Snow goose estimates were derived from peak numbers found during aerial. Zone 7 was used to estimate snow goose numbers for PHNWR, which covers the area from Big Stone Beach to the Broadkill River and east of Route 1. Only one survey was conducted in 2007 (October 2007) which may not have reflected the peak. (*http://www.fw.delaware.gov/Hunting/Pages/Waterfowl%20Surveys.aspx*)

Migratory bird hunters may also disturb migratory birds and other wildlife as they travel to and from their hunting sites or when retrieving downed birds. Depending on the location and the number/species of migratory birds in the area, a disturbance can be temporary with displaced birds moving to nearby backwaters, or major in the case of motoring through a large flock of snow geese. For some species like bald eagles and other predators, migratory bird hunting creates a readily available food source due to birds lost or wounded.

Direct disturbance to waterfowl occurs during white-tailed deer hunting seasons, as hunters flush deer through wetlands, creeks, and open water habitats. Dogs running at large during upland game hunting seasons will also flush wintering waterfowl resting and feeding in both wetland and upland areas. The ingestion of lead sinkers or lead shot is another concern; however the impacts are lessened from refuge regulations requiring the use of non-toxic shot for upland hunting, except for slugs for deer hunting.

Expanded hunting opportunities for deer and waterfowl will cause disturbance to waterfowl in refuge impoundments, Prime Hook Creek, and refuge salt marshes. On Prime Hook Creek, deer hunting will occur on Tuesday, Thursday, and Friday during the hunting seasons. On refuge impoundments in Unit III and Prime Hook Creek, waterfowl hunting will occur on Monday, Wednesday, and Saturday during the hunting season. If a duck hunting season opens on a Friday, waterfowl hunting will be open and deer hunting will close. Impacts to waterfowl will be decreased from current management by changing the end of shooting time from 3:00pm to noon. Participating in the early teal, resident Canada goose, and snow goose conservation order will cause direct impacts to increase but will be negligible based on current refuge harvest contributions to statewide and national harvests. Free roam areas for deer and waterfowl hunting (jump shooting) will provide hunters greater access and also increase the potential for waterfowl disturbance. These disturbances are mitigated by creating sanctuary areas where no waterfowl hunting occurs.

Proposed waterfowl hunting in Units I and IV salt marshes have the potential to increase adverse impacts and disturbance on refuge wintering American black ducks. Zoned hunting areas have been established in Unit IV to limit hunter numbers, thereby minimizing wildlife disturbance. Since black ducks are a focal species of conservation concern, monitoring and the evaluation of impacts of increased recreational use of salt marsh habitats will be required to identify and respond to unacceptable impacts.

Impacts to Shorebirds

Disturbance to shorebirds has been well documented. Pfister et al. (1992) investigated human disturbance as a factor that might limit the capacity of appropriate staging areas to support migrating shorebirds. Results indicate that adverse impacts from human disturbance will be greater on shorebird species using the front side of beach habitats and that the local abundance of impacted species may be reduced by 50 percent. Such disturbance is implicated as a potential factor in long-term declines in shorebird abundance during migration periods at disturbed sites.

Disturbance of shorebirds becomes a very crucial issue during incubation or nesting periods. Direct adverse impacts of displacement caused by human disturbance during nesting periods include egg exposure to temperature extremes, predation of eggs when the nest is vacated by the adult, and predation at a later time due to predators following human trail or scent (Korschgen and Dahlgren 1992). Protection of nesting colonial shorebirds is easier than protection of solitary nesters, like the American oystercatcher and piping plover, because much larger beach areas must be protected, managed, and patrolled. Public education, active protection methods (small fences around nests, signs, wardens), legal

measures (beach use regulations, active enforcement patrols), and well-advertised closures of portions of the beach are management actions that often successfully reduce the adverse impacts of human disturbance when shorebirds are most vulnerable. Protection of nesting colonies using fences and wardens has markedly decreased reproductive losses of least tern colonies in New Jersey (Burger 1995).

Based on these findings and past observations of impacts on shorebirds by refuge staff, disturbance by refuge hunters to shorebirds is expected to be negligible since most shorebird species have completely passed through Delaware by peak hunting season in November through January. Some hunting occurs when these species may be migrating before and after this peak hunting time. Shorebirds using refuge marsh habitats that are also open to hunting may be disturbed by hunters traveling in these areas or by their gunshots; however, established sanctuaries provide disturbance-free areas for migrating birds during the hunting season.

A direct beneficial impact for shorebirds is derived from seasonal closures to hunting and other public use. Minimizing human disturbance will increase nesting and foraging opportunities on overwash habitats which will subsequently increase shorebird nesting productivity. Seasonal closures of designated beach dunes and overwash areas from March 1 through September 1 are in place to minimize disturbance to nesting shorebirds such as least terns, American oystercatchers, and, potentially, piping plovers.

Indirect beneficial impacts on shorebirds are obtained by educating hunters about special beach closures with news releases and other outreach mechanisms to engage the public to understand the needs of nesting shorebirds. Public awareness and appreciation of the refuge's efforts to conserve and protect shorebirds could inspire some to volunteer or support refuge needs in the conservation and protection of critical habitats required to protect continental and hemispheric shorebird resources in perpetuity in other ways.

Impacts to Landbirds

Disturbance to landbirds has been well documented. Pedestrian travel can influence normal behavioral activities, including feeding, reproductive, and social behavior and the location of recreational activities impacts species in different ways. Miller et al. (1998) found that nesting success was lower near recreational trails, where human activity was common, than at greater distances from the trails. A number of species have shown greater reactions when pedestrian use occurred off trail (Miller et al. 1998). For songbirds, Gutzwiller et al. (1997) found that singing behavior of some species was altered by low levels of human intrusion.

Some other species, such as wood thrush, will avoid areas frequented by people, such as developed trails and buildings, while other species, particularly highly social species such as tufted titmouse, Carolina chickadee, or Carolina wren, seem unaffected or even drawn to a human presence. When visitors approach too closely to nests, they may cause the adult bird to flush exposing the eggs to weather events or predators.

Disturbance to these non-hunted migratory birds could have regional, local, and flyway effects. Regional and flyway effects would not be applicable to species that do not migrate such as most woodpeckers, and some songbirds including cardinals, titmice, wrens, chickadees, etc. Disturbance is expected to non-hunted landbirds, such as feeding and resting, to increase due to an expected increase in deer hunters

in new free roam hunting areas. However, the direct, indirect, and cumulative impacts of hunting on these non-hunted landbirds are expected to be negligible because the deer, upland game, and waterfowl hunting seasons are during the fall and winter months which do not coincide with the critical nesting periods of most bird species. Turkey hunting, which does occur during the nesting season of many non-hunted landbird species in April and May, is expected to have negligible impacts because hunter numbers are limited to less than five and are scattered over 3,472 acres.

Direct impacts to hunted landbirds such as quail, woodcock, and snipe are expected to remain stable since no increase in upland game hunting is expected. Hunting of resident game species such as quail does not have any regional impact on their respective populations due to their restricted home ranges. Delaware Division of Fish & Wildlife periodically reviews populations of all harvested resident species, and has determined that populations are adequate to support hunting efforts throughout the State. The refuge contributes negligibly to the State's total harvest for resident game species. For example, the number of quail taken per year has been no more than 14 per year on the refuge in recent years (Table 1.6).

Table 1.6. Number of upland game, small game, and webless migratory birds harvested and hunter visits on Prime Hook NWR.

Year	Dove Harvest	Snipe Harvest	Woodcock Harvest	Quail Harvest	Rabbit Harvest	Refuge Hunter Visits*
1996	110	0	0	5	83	126
1997	77	0	0	0	117	169
1998	30	0	0	0	46	112
1999	90	0	0	0	98	123
2000	13	0	0	0	29	81
2001	6	0	0	0	65	128
2002	58	0	0	0	163	114
2003	13	0	0	0	79	81
2004	12	0	0		75	53
2005	6	0	0	0	257	129
2006	20	0	0	14	115	106
2007	22	0	0	11	145	178
2008	0	0	1	10	176	171
2009	0	0	6	1	163	149

*Hunter visits include all species combined; majority are hunting rabbits

For migratory birds such as mourning dove, an estimated 36,300 birds were harvested in Delaware during the 2009 season (Table 1.6; Raftovich et al. 2011) when none were taken on the refuge. (Table 1.7). Similarly, very few snipe and woodcock were harvested (Table 1.7). Direct, indirect, and cumulative impacts on these species on the refuge are negligible. See Impacts to Waterfowl for a description of how the Federal and State migratory bird hunting frameworks are established.

Table 1.7. Comparison of mourning dove, woodcock, and snipe harvest at Prime Hook NWR to State, Flyway, and United States harvest in the 2009 hunting season.

Harvest Area	Dove	Woodcock	Snipe
Prime Hook NWR	0	6	0
Delaware*	36,300	200	0
Eastern Management Unit*	7,639,200	63,300	43,600
United States*	17,354,800	238,400	83,500

*Harvest estimates from (Raftovich et al. 2011); Estimates for snipe are from the Atlantic Flyway

Turkey hunting is proposed only if a huntable population is found to exist on the refuge. This will be determined through coordination with the Delaware Division of Fish & Wildlife. Currently, turkey are hunted in other areas of Delaware.

The hunting of deer can be a beneficial impact to landbirds. The reduction of the vegetation's physical structure and diversity due to overbrowsing by deer also can negatively impact landbirds. Casey and Hein (1983) have found greatly reduced bird species diversity in areas with long term, high density populations of deer. These changes were mainly attributed to habitual landscape alteration with pronounced browse line and sparse cover caused by overbrowsing.

Impacts on Secretive Marsh and Waterbirds

Resident waterbirds tend to be less sensitive to human disturbance than are migrants, and thus will be less impacted by disturbance from public use on the refuge. However, wading birds have been found to be extremely sensitive to disturbance in the northeastern U.S. and may be adversely impacted by disturbance from public use on the refuge (Burger 1981). The impacts of intrusion through public use are generally negligible for this group of birds, but can vary by species and between years (Gutzwiller and Anderson 1999).

Disturbance to secretive marsh birds and waders from hunting would start in September and usually end in January, unless hunting is allowed during the snow goose conservation order into mid-April. This disturbance may have direct effects on migrating and wintering secretive marsh birds and waders. However, these birds would receive added benefits from the establishment of new sanctuary areas or zones, where 3,000 acres would be protected from hunting activities that cause disturbances to secretive marsh and waterbirds.

Impacts on Fisheries

Impacts to fisheries from visitors engaged in hunting are expected to be temporary and negligible. Increased deer and waterfowl hunting on Prime Hook Creek and Unit III impoundments will cause increased suspension of bottom sediments from boat motors. However, since hunting occurs during the fall and winter months, this sediment suspension should not adversely affect biological oxygen demand (BOD) for fisheries resources. Early season hunters may harm submerged or emergent vegetation by accessing small ditches, which may cause negligible adverse impacts to protective cover for fisheries based on past observations of these impacts from refuge staff. Effects on interjurisdictional fishes are expected to be unlikely from hunting because the majority of the refuge will experience minimal, transitory use by hunters.

Impacts on Mammals

In general, the presence of humans will disturb most mammals, which typically results in indirect negligible short-term adverse impacts without long-term effects on individuals and populations.

Adverse impacts on resident game populations from hunting would be negligible. The Delaware Division of Fish and Wildlife periodically reviews populations of all harvested resident species and has determined that populations are adequate to support hunting efforts throughout the State. Hunter visits and harvest of upland and small game such as rabbit on the refuge have been relatively low (Table 1.6) and impacts are expected to be negligible. The refuge does not allow hunting of eastern gray squirrel to minimize conflicts with endangered Delmarva fox squirrel.

Overall impacts from hunting on non-hunted mammals, such as voles, moles, mice, shrews, and bats, are expected to be negligible. Since small mammals are less active during winter when hunting season occurs, and since these species are mostly nocturnal, hunter interactions with small mammals are very rare. Vehicles are restricted to roads and harassment or taking of any wildlife other than legal game species is not permitted. Except for some species of migratory bats, these species have very limited home ranges and hunting would not affect their populations regionally. Impacts of hunting to migratory bat species would be negligible. These species are in torpor or have completely passed through Delaware by peak hunting season in November through January. Some hunting occurs during September-October and March-April when these species are migrating; however, hunter interaction would be commensurate with that of non-consumptive users.

The Delaware Division of Fish and Wildlife recently finalized a new statewide 10-year deer management plan (Rogerson 2010). The plan was created with input from a 22-member advisory group, a public phone attitude survey, a mail survey to hunters, comments solicited from the general public, and technical reviews from deer experts outside the division. The resultant plan identifies population objectives based on habitat capability and societal tolerances.

The refuge is located in the State's deer management zone 9, which encompasses the northeastern coastal portion of Sussex County (Rogerson 2010). The Division of Fish and Wildlife manages deer populations, in part, through recreational hunting. Based on their monitoring programs, the Division of Fish and Wildlife adjusts hunting levels in terms of season length, sex ratio in the harvest, and number of hunters (tag availability) to move population levels toward desired objectives. Of course, other factors such as disease, severe weather, predation, and automobile collisions influence mortality are taken into account by annual monitoring.

Delaware deer herd statistics indicate that the deer density in zone 9 was estimated in 2009 at 22.5 deer per square mile with a variability of plus or minus 20.75 percent (Rogerson 2010). This is a decrease of 58 percent from the 2005 estimated density of 39.2 deer per square mile (Rogerson 2010). The total Statewide post-hunting season deer population in 2005 was estimated at 37,563 deer, while in 2009 it was estimated at 31,071 deer, a 17.3 percent Statewide reduction. Major land use changes over the last 100 years have created a deer herd that exceeds normal deer densities of 10 to 20 deer per square mile.

High deer numbers are associated with crop damage, reduction of some forest understory species, and reduction of reforestation seedling survival, which all impact habitat that is important for a variety of wildlife. White-tailed deer hunting is the single most important public use on the refuge that would impact mammals, including deer, and other forest-dependent wildlife. It serves both as a wildlife-

dependent recreational use and a method to reduce and stabilize deer densities. This benefits other mammals, including the endangered Delmarva fox squirrel.

Based on a nationwide survey of all states (Krausman 1992), deer populations are effectively controlled with hunting and habitat manipulation in many areas where they were overpopulated. In a 10-year study in northwestern Pennsylvania examining the impacts of varying densities of deer on deer health and habitat, starvation mortality resulted when densities reached higher than 25 deer per square kilometer (247 acres). Also, no prevention or control of epizootic hemorrhagic disease exists to date except by keeping populations below the carrying capacity of their habitats. Such breakouts have occurred on the refuge in the past. Based on these considerations, it is anticipated that hunting would have short-term and long-term minor-to-moderate beneficial impacts on deer health and quality and habitat condition.

Hunting resident game species on the refuge, such as deer, will result in negligible impacts on their populations because of their restricted home ranges. The refuge contributes negligibly to the State's total harvest for resident game species (figure 1.1 and tables 1.8 and 1.9). For example, since 1999, deer harvest at the refuge has ranged from 0.8 percent to 1.5 percent of Delaware's total deer harvest each year. The current harvest level of deer on the refuge (107) has a negligible impact on the Statewide deer population of 31,071 deer (Table 1.9). Given the low numbers of animals harvested from the refuge in respect to the total Statewide harvest and deer population, no cumulative impacts to local, regional, or Statewide populations of white-tailed deer are anticipated from allowing hunting of the species on the refuge.

Figure 1.1. Delaware annual deer harvest, 1954 – 2008/09 seasons. ***(Source: Rogerson (2010)***

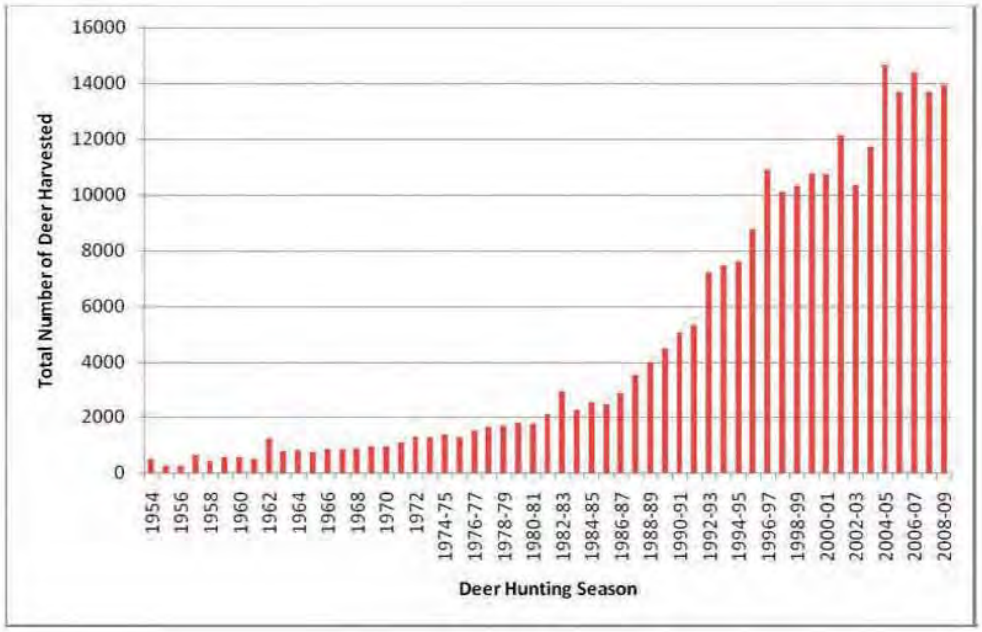

Table 1.8. Number of deer harvested and hunter visits on Prime Hook NWR compared to statewide harvest *(Source: Refuge harvest data; http://www.dnrec.state.de.us/fw/deer.pdf; http://www.fw.delaware.gov/Hunting/Documents/2007-08%20Historical%20Delaware%20White-tailed%20Deer%20Summary.pdf)*

Year	Statewide Deer Harvest	Refuge Deer Harvest	Refuge Hunter Visits
1988	3,998	141	1,289
1989	4,504	155	1,131
1990	5,066	178	1,689
1991	5,336	163	1,703
1992	7,245	257	1,608
1993	7,465	219	1,616
1994	7,615	169	1,568
1995	8,781	217	1,184
1996	10,915	221	1,326
1997	10,091	187	1,510
1998	10,312	138	1,335
1999	10,756	114	870
2000	10,741	125	941
2001	12,133	188	1,003
2002	10,357	160	913
2003	11,712	175	891
2004	14,669	143	841
2005	13,670	133	884
2006	14,401	120	825
2007	13,369	108	790
2008	13,926	106	670
2009	12,400*	107	552

*Data from DNREC (2010b).

Table 1.9. Cumulative impacts of existing deer hunting on Prime Hook NWR/State Deer Management Zone 9 (2009-2010 data) compared to Statewide Harvest.

Hunt Location & Type	Harvest
Prime Hook NWR	107
State Deer Management Zone 9	767
Statewide Harvest (all 17 Deer Management Zones)	12,400

Delaware permits hunting for red fox, which assists State management efforts in reducing the incidence of mange outbreaks to maintain a healthy population and reducing the predatory impact of this species on migrating and breeding birds, particularly State and federally endangered or threatened species. Hunting would be opportunistic in most cases. In other states, the incidental harvest of fox occurs during other open seasons such as deer season and the pelts are often retained for personal use. Though no county-

specific data are available, healthy populations of fox exist in the State and anticipated harvest rates would result in negligible impacts to local or State populations (Reynolds, personal communication 2010).

Impacts to Amphibians and Reptiles

The direct, indirect, and cumulative effects of hunting to amphibians and reptiles such as snakes, skinks, turtles, lizards, salamanders, frogs, and toads are expected to be negligible. Hibernation or torpor by cold-blooded reptiles and amphibians limits their activity during the hunting seasons for deer, waterfowl, and upland game when temperatures are low and hunters would rarely encounter them during most of the hunting season. Turkey season occurs during the warmer months of April and May; however, the impact of turkey hunters is expected to be negligible because hunter numbers are limited to less than five and are scattered over a large area.

Impacts to Invertebrates

Impacts to invertebrates such as butterflies, moths, other insects, and spiders are expected to be negligible. Invertebrates are not active during the majority of the hunting seasons and would have few interactions with hunters during the hunting season.

Impacts on Public Use and Access

Public opportunities to hunt on the Delmarva Peninsula are decreasing with increasing private land development. Refuge lands have become increasingly important in the region as a place to engage in this activity. A recent study found that 78% of hunters in Delaware hunt on private land (U.S. Department of the Interior 2006). When asked the importance of hunting activities in the USGS Visitor and Community Survey (Sexton et. al 2007), a little over half of responses were rated as moderately to very important. Both consumptive and nonconsumptive use visitors reported that being in a natural, undeveloped area and experiencing a serene environment are equally important to their refuge experience as well as the trails that afford this opportunity (Sexton et. al 2007).

Hunters have the opportunity to harvest a renewable resource in a traditional manner, which is culturally important to the local community. Refuge lands allow the public to enjoy hunting at no or little cost in a region where private land is leased for hunting, often costing a person several hundred to several thousand dollars per year for membership. Refuge hunting programs also make special accommodations for mobility-impaired hunters and youth hunters, which provide opportunities to experience a wildlife-dependent recreational activity, instill an appreciation for and understanding of wildlife, the natural world and the environment and promote a land ethic and environmental awareness.

The moderate beneficial impacts of providing the existing level of wildlife-dependent activities, with some modest increases, include helping meet existing and future demands for outdoor recreation and education, as documented in the State Comprehensive Outdoor Recreation Plan (DNREC 2003) and in the Visitor and Community Survey (Sexton et. al 2007). Visitors interested in hunting would find high quality opportunities to engage in their favored pastime. Visitor use is increasing over time as local residents and visitors become increasingly aware of refuge opportunities, and as progress is made in creating new facilities and programs. The economic benefits of increased tourism likely would also benefit local communities.

The refuge would also be promoting a wildlife-oriented recreational opportunity that is compatible with the purpose for which the refuge was established. The public would have an increased awareness of

PHNWR and the National Wildlife Refuge System and public demand for more areas to hunt and learn about wildlife would be met. Over time, it is reasonable to believe that public awareness of the refuge would increase, and, in turn, visitation would increase on the areas open to hunting. The refuge may or may not be capable of meeting the demand as it increases and would depend on staffing levels and the availability of partners and volunteers to assist.

Eventually, the level and means of use resulting from this increase in visitation could change the nature of the experience for many visitors. Some may choose either to forgo hunting due to issues of crowding or behavior, or to go elsewhere. Because the refuge provides opportunities now for only a small portion of the area's hunters, if that shift occurs, it is not imminent and would likely occur outside the 15 year life of the Comprehensive Conservation Plan. If it does occur, it could put additional strains on other public lands, or diminish the refuge contribution to the mission of the Refuge System. Continuing to distribute our programs and facilities minimizes conflicts among users.

The hunting program for deer, waterfowl, upland game and webless migratory birds (dove), and turkey provides an administratively simple program that balances other public use activities. The program supports Presidential Executive Order: Facilitation of Hunting Heritage and Wildlife Conservation, regional directives, and parallels State hunting regulations. In addition, it provides seasonal closures to minimize wildlife disturbance and/or avoid conflicts with other uses, eliminates hunting fees except for lottery hunts, enhances disabled hunting opportunities, further develops an appreciation for fish and wildlife, and expands public hunting opportunities.

Preseason lottery drawings at PHNWR provide hunting opportunities for local, in State, and out-of-State hunters. Knowing in advance of a hunting opportunity allows hunters to prepare, plan, and scout, which ultimately helps to provide a quality hunting experience.

Hunting areas will be closed to other public uses, unless the uses can be safely sequester from the locations of hunting activity. Experience has proven that time and space zoning (e/g., establishment of separate use area, use periods, and restriction on the number of users) is an effective tool in eliminating conflicts between user groups. Seasonal closures apply to non-consumptive users during the hunting season, which is typically a slower period of use due to weather conditions. Short-term, moderate adverse impacts are expected for non-consumptive users due to the seasonal closures that are highlighted below:

1.) Western Prime Hook Creek (from old shop ramp to Waples Pond) (Unit III): Closed every day during the deer and waterfowl hunting seasons, which typically starts on September 1 and ends in early February. Additional seasonal closures may apply through the second Saturday in May for hunting during the snow goose conservation order and/or turkey hunting.
2.) Deep Branch Road Trail (includes Goose & Flaxhole Ponds) and Eastern Prime Hook Creek (from old shop ramp to HQ ramp) (Unit III): Closed every day from September 1 through March 15. Additional seasonal closures may apply through the second Saturday in May for hunting during the snow goose conservation order and/or turkey hunting.
3.) Headquarters Area (includes Turkle & Fleetwood Ponds) (Unit III): Closed only for a maximum of two days for deer hunts.
4.) The northern portion of Unit IV (includes trail overlooking Vergie's Pond): Closed from the Monday before Thanksgiving through March 15. Additional seasonal closures may apply through the second Saturday in May for hunting during the snow goose conservation order and/or turkey hunting.

5.) Hiking trails on Fowler Beach Road (Unit I), Prime Hook Road (Unit III), and Slaughter Beach Road and Slaughter Canal (Unit I): Closed on Sundays from September 1 through the deer and waterfowl hunting seasons, which typically end in early February. Additional seasonal closures may apply through the second Saturday in May for hunting during the snow goose conservation order and/or turkey hunting.

According to the USGS Visitor and Community Survey (Sexton et. al 2007), the overall mean desirability of additional hunting opportunities was not as high as that of other public use activities. However, upon further breakdown between hunters and non-hunters, the additional hunting opportunities listed were very desirable by the hunting community. We detail below the impacts that may result from the different types of hunting: white-tailed deer, waterfowl, upland game and webless migratory birds (dove), and wild turkey.

White-tailed deer hunting: A total of 5,389 acres is open for deer hunting, which includes archery (to include the use of crossbows), muzzleloader, handgun, and shotgun hunting. Seasonal closures would occur to not only protect wildlife, but also to minimize conflicts between different hunting activities and/or other non-consumptive recreational uses (e.g., minimize conflict with anglers on Prime Hook Creek, offset hunting days for deer and waterfowl hunting on Prime Hook Creek and for disabled hunters in the disabled hunt area; close hunting in late November in designated areas to minimize bald eagle and waterfowl disturbance). Disabled hunting areas in Unit III and IV would limit access to individuals who are permanently confined to a wheelchair, which ensures quality opportunities for hunters with limited mobility.

Permanent deer hunting stands will be phased out over a five-year period in all areas except the disabled hunting area. A limited number of permits, approximately 30 in the lottery hunt area, will be issued to minimize hunter conflict in an area historically known to attract large hunter numbers. In the regular hunt area, hunting will be open every day during designated seasons (except the October antlerless and handgun seasons).

The phasing out of all permanent deer hunting stands (except non-ambulatory hunt blinds) will require hunters to find a suitable hunting location within designated hunting areas through effective scouting. Use of portable deer climbing stands is recommended but not required. Hunters have expressed an interest in scouting and choosing their hunting locations to enhance the quality of their hunt. Maintenance mowing will no longer occur to provide trails to facilitate hunting. Minor to moderate short-term adverse impacts are expected among hunters over desired hunting locations and proper hunting ethics is encouraged.

Waterfowl hunting: A total of 3,455 acres is open to migratory bird hunting, which is 40% of the refuge (includes lands purchased with Land and Water Conservation Funds which are excluded from the 40% rule). Seasonal closures would occur to not only protect wildlife, but also to minimize conflicts between different hunting activities and/or other non-consumptive recreational uses (e.g., offset hunting days for deer and waterfowl hunting on Prime Hook Creek and for disabled hunters in the disabled hunt area; close hunting in late November in designated areas to minimize bald eagle and waterfowl disturbance, provide access for non-consumptive users on Sundays during the hunting season). In the lottery hunt area, hunting will occur three days per week and cease at noon. In the regular hunt area, hunting will be open every day during all waterfowl hunting seasons. Although the loss of one hunting day per week and an earlier closure at noon rather than the current 3:00pm will not be well received by the hunting public;

this perceived decrease in hunting is offset by the additional 1,732 acres being proposed to open under this alternative for waterfowl hunting.

Although the permanent waterfowl blinds on the refuge will be phased out over a five-year period, in the lottery hunt area hunters will be required to hunt within a defined area around a designated blind site (marker). This will minimize hunter conflict in an area historically known to attract large hunter numbers. In past years for daily drawings on opening days, it was common to see over 60 to 80 duck hunting parties compete for 27 available hunting opportunities.

The phasing out of all permanent waterfowl hunting blinds (except non-ambulatory blinds) in lieu of blind sites in the lottery hunt area will now require hunters to provide their own means to camouflage themselves (e.g., boat blind, pop up blind, etc.). Hunters would be required to find a suitable hunting location within a specified area around the blind site marker. Hunters have expressed an interest in scouting and having the flexibility to adjust their hunting locations for weather conditions to enhance the quality of their hunt. In free roam areas, hunters may hunt anywhere in the designated area. Minor to moderate short-term adverse impacts are expected among hunters over desired hunting locations and proper hunting ethics will be encouraged.

The creation of sanctuaries in Unit III will result in the elimination of 6 hunting blinds from the 19 available federal blinds; however 9 new blinds sites will be added. These 9 new blinds sites, which include a wheelchair accessible blind, brings the total number of federal blind sites to 22 and does not include the 8 blinds on the state owned Prime Hook Wildlife Area. The addition of new free-roam waterfowl hunting areas in salt marsh habitats in Unit I and IV will also provide quality opportunities.

Upland game and webless migratory bird hunting: A total of 1,957 acres are available for hunting of upland game and webless migratory birds. Dove hunting will not be open on 105 of these acres, which should affect few hunters.

Wild turkey hunting: A total of 3,472 acres are open for hunting wild turkey until noon on selected hunt days. In recent years, hunter and staff observations indicate that a huntable population of turkeys may exist on the refuge. Limited opportunities exist on public lands to hunt turkey and the refuge may contribute to providing additional quality opportunities for hunters.

The Service will collaborate with the Delaware Division of Fish & Wildlife to evaluate the status of the wild turkey population on the refuge. Hunting will be permitted if State and refuge personnel determine that the turkey population in the area is sufficient to support hunting on the refuge. It is anticipated only limited number of permits (less than five per year) will be available. Permits would be issued through preseason lottery drawing.

The elimination of nearly all hunting permit fees (except for lottery hunts) should be well received by hunters. An administratively simplified hunting program minimizes the amount of staffing resources needed to conduct the hunt by as much as 54 staff days and by $17,890 from the previous program and thereby reduces the administrative burden and minimizes the amount of staffing resources needed to conduct the hunt. The minor beneficial impact to the hunter is a reduction in the cost to hunt.

Fees are required to manage the lottery hunts for deer, waterfowl, and turkey. The refuge Recreation Act requires that funds are available for the development, operation, and maintenance of the permitted

forms of recreation. The permit fee ($10 for deer & turkey; $15 for waterfowl), preseason application fee ($5/hunter), and processing fee for permits acquired after the preseason drawing ($2-3 per hunt) are the minimal amounts needed to offset the cost of facilitating the preseason drawings and manage the lottery hunts. Due to the uncertainty in the level of hunter participation in future years, permit fees may need to be adjusted (increased or decreased) and therefore will be evaluated. Preseason lottery drawings will be administered by a contracted company which will collect information and required fees, conduct the drawing, and issue the permits. This may reduce our costs by over $3,000 and application and processing fees will be paid to the contractors for administering this permitting process. Refuge staff will work with the contractor to provide the highest level of customer support to refuge users. New fees for preseason application for waterfowl and turkey hunting, new processing fees for standby permits, and charging a flat blind fee for waterfowl rather than an individual fee are anticipated to be unpopular with the hunting public.

Expanding hunting opportunities is expected to have moderate adverse impacts on a certain segment of the public that does not desire any change in public use programs and regulations, or that may hold differing views on the course of action. In addition, while new visitors become familiar with those changes, violations could increase. Some conflict between wildlife observers, photographers, students, and other refuge users is expected to result in short-term moderate adverse impacts and will be managed through seasonal closures. Negative reactions by some visitors may be caused by the closure of the western end of Prime Hook Creek to all uses (mainly fishing, canoeing, and kayaking) other than hunters from September 1 through the end of the deer and waterfowl hunting seasons; the closure of the eastern end of Prime Hook Creek from September 1 through March 15; and the temporary closure of the general public use area near the Refuge Headquarters to conduct deer hunts. Seasonal closures for hunting occur during the fall and winter months, which is typically a slower period of use due to weather conditions. Refuge officers would enforce these and other current refuge regulations, where appropriate, and would seek the assistance and cooperation of Delaware Division of Fish & Wildlife in enforcing common regulations, to provide a safe environment for refuge visitors and promote activities that are compatible with protecting the resources.

Some conflicts between concurrent hunting programs (e.g., waterfowl, deer, and upland game hunting seasons overlapping) are anticipated. For the majority of the hunting seasons, the Delaware Division of Fish & Wildlife has made efforts to avoid these overlaps in the various hunting programs. As public use levels expand across time, unanticipated conflicts between user groups may occur. The refuge's visitor use programs would be adjusted as needed to eliminate or minimize each conflict and provide quality wildlife-dependent recreational opportunities. The Service's law enforcement efforts will be increased.

The refuge would work closely with State, Federal, and private partners to minimize impacts to adjacent lands and its associated natural resources. Due to an increase in new hunting areas and by allowing hunters to free roam, an increase in violations may occur until hunters become familiar with the refuge boundaries and regulations. As a result some landowner conflicts may erupt due to hunter trespassing. These minor short-term adverse impacts will be minimized through enhanced law enforcement efforts. For example, waterfowl hunting zones in Unit IV along the Broadkill River have the potential to conflict with nearby existing blinds on private lands. We will evaluate this activity and adjust these zones accordingly. Hunters will most likely opt to hunt within the marsh areas of these zones and not along the Broadkill River, which would lessen any direct conflicts with hunters on these nearby private lands.

Refuge Facilities - Minimal infrastructure, which includes the addition of two to three parking areas, enhancement of existing boat ramps, and placement of informational signs, is anticipated in support of

this priority public use. There would be some costs associated with these programs in the form of road maintenance, law enforcement, and boat ramp maintenance. These costs should be minimal relative to total refuge operations and maintenance costs and would not diminish resources dedicated to other refuge management programs. Impacts to refuge resources are expected to be negligible.

Cumulative Impact Analysis of Hunting

"Cumulative impact" is the term that refers to impacts on the environment that result from the incremental impact of the proposed action when added to other past, present and reasonably foreseeable future actions, regardless of what agency (federal or nonfederal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time. Cumulative impacts of hunting on resident wildlife, migratory birds, non-hunted wildlife, endangered species, refuge environment, and other wildlife recreation were analyzed. Because of the regulatory process of harvest management of migratory birds in place within the Service, the setting of the hunting seasons largely outside the breeding seasons of resident and migratory wildlife, and the ability of individual refuge hunt programs to adapt refuge-specific hunting regulations to changing local conditions, no direct or indirect cumulative effects on resident wildlife, migratory birds, non-hunted wildlife, endangered species, refuge environment, and other wildlife recreation of hunting on the refuge are anticipated.

Anticipated Cumulative Impacts on Wildlife Species

1.1 Resident Big Game

White-tailed Deer

The Delaware Division of Fish and Wildlife (DFW) recently finalized a new statewide ten-year deer management plan (Rogerson 2010). The plan was created with input from a 22-member advisory group, a public phone attitude survey, a mail survey to hunters, from comments solicited from the general public, and technical reviews from deer experts outside of the DFW. The resultant plan identifies population objectives based on habitat capability and societal tolerances.

The refuge is located in DFW Deer Management Zone 9 (Figure 1.3; Rogerson 2010). The DFW has the ability to manage deer populations, in part, through recreational hunting because these animals have a "k-selection population strategy." This means that reproductive rates are low, adults invest a tremendous amount of energy bringing young to maturity, and survival rates are relatively high compared to more prolific breeders (e.g. rabbits). Based on their monitoring programs, the DFW adjusts hunting levels in terms of season length, sex ratio in the harvest, and number of hunters (tag availability) to move population levels toward desired objectives. Of course, other factors such as disease, severe weather, predation, and automobile collisions influence mortality, but these are taken into account by the annual monitoring. Their analysis of populations and hunting on populations, habitat and communities is cumulative.

Figure 1.2. White-tailed Deer Management Zones in Delaware (Source: Rogerson 2010)

Delaware deer herd statistics indicate that the deer density in Zone 9 is estimated in 2009 at 22.5 deer per square mile with a variability of ±20.75% (Rogerson 2010). This is a decrease of 42.6 percent from the 2005 estimated density of 39.2 deer per square mile (Table 1.10; Rogerson 2010). The total statewide post-hunting season deer population in 2005 was estimated at 37,563 deer, while in 2009 it was estimated at 31,071 deer, a 17.3% statewide reduction. Major land use changes over the last 100 years have created a deer herd that exceeds normal deer densities of 10 to 20 deer per square mile. High deer numbers are recognized as a problem causing crop damage, reducing some forest understory species, and reducing reforestation seedling survival. Hunting is the only viable solution to keep the deer herd and other resident wildlife in balance, resulting in long-term impacts on wildlife habitat.

Table 1.10. Estimated Deer Density in 2005 and 2009 within each of Delaware's 17 Deer Management Zones. Deer densities were estimated via aerial infrared surveys. (Source: Rogerson 2010)

Deer Management Zone	2005 Deer Density*	2009 Deer Density*
1	134.8**	46.7**
2	59.7	85.4
3	33.2	22.0
4	42.1	34.8
5	42.1	14.5
6	15.2	37.6
7	72.4	65.4
8	57.9	59.4
9	39.2	22.5
10	37.7	108.7
11	43.5	21.1
12	36.0	16.8
13	16.3	53.6
14	73.2	114.4
15	70.8	29.8
16	74.6	51.8
17	11.3	53.8
Statewide Average	52.2	**44.3 (-15.1%)**

White-tailed deer hunting is the single most important public use that would affect mammals and other forest-dependent wildlife. It serves both a wildlife-dependent recreational use and a method to reduce and stabilize deer densities that not only benefits other mammals, but also benefits endangered species management for Delmarva fox squirrels, conserves migratory landbird habitats, and lessen impacts to adjacent agricultural lands. Reducing deer densities is best accomplished by means of the refuge deer hunting program.

Deer overabundance can affect native vegetation and natural ecosystems and have been well studied (Tilghman 1989, Nudds 1980, Hunter 1990; Behrend et al. 1970). White-tailed deer selectively forage on vegetation (Strole and Anderson 1992), and thus can have substantial impacts on certain herbaceous and woody species and on overall plant community structure (Waller and Alverson 1997). These changes can lead to adverse impacts on other wildlife species which depend on this vegetation for food and/or shelter. Several studies have shown that over browsing by deer can decrease tree reproduction, understory vegetation cover, plant density, and plant diversity (Warren 1991). Heavy deer populations in the Great Smokey Mountains National Park in Tennessee caused a reduction in the number of plant species, a loss of hardwood species, and a predominance of conifer species compared to an ecologically similar control area with fewer deer (Bratton 1979).

The alteration and degradation of habitat from over-browsing deer can have a detrimental effect on deer herd health and may displace other wildlife communities (e.g., neotropical migrant songbirds and small mammals such as the endangered Delmarva fox squirrel) that depend on the understory vegetation habitat destroyed by deer browsing (VDGIF 1999). Deer browsing also affects vegetation that songbirds need for foraging surfaces, escape cover, and nesting (DeCalesta 1997). DeCalesta (1997) also found that species richness and abundance of intermediate canopy nesting songbirds was reduced in areas with higher deer densities. Intermediate canopy-nesting birds declined 37 percent in abundance and

27 percent in species diversity at higher deer densities. Five species of birds were found to disappear at densities of 38.1 deer per square mile and another two disappeared at 63.7 deer per square mile. Casey and Hein (1983) found that three species of birds were lost in a research preserve stocked with high densities of ungulates and that the densities of several other species of birds were lower than in an adjacent areas with lower deer density. Waller and Alverson (1997) hypothesize that by competing with squirrels and other fruit-eating animals for oak mast, deer may further affect many other species of animals and insects.

Based on a nationwide survey of all states (Krausman 1992), deer were effectively controlled with hunting and habitat manipulation in many areas where they were overpopulated. The remaining overpopulated herds were either not hunted, had an inadequate doe harvest, or an inadequate general harvest. Because the refuge boundary area is open, with numerous tracts and corridors for movement and contact with other herds, it is unlikely that hunting will reduce the population to such low levels as to place it at risk of becoming genetically bottlenecked. Also, no prevention or control of epizootic hemorrhagic disease exists to date except by keeping populations below the carrying capacity of their habitats. In a 10-year study in northwestern Pennsylvania examining the impacts of varying densities of deer on deer health and habitat, starvation mortality resulted when densities reached higher than 25 deer per square kilometer (247 acres). Species richness and abundance of shrubs and herbaceous vegetation also has been shown to decline when deer densities reach between 4-8 deer/km2 (deCalesta and Stout 1997). At high densities, deer may act as a host reservoir for Lyme-disease bearing ticks (Jones et al. 1998). Reducing the deer population will reduce the potential for Lyme disease transmission. Based on these considerations, it is anticipated that hunting would have a positive impact on deer health and quality and habitat condition.

High densities of deer have also been recognized as vectors for spreading invasive species like Japanese stiltgrass. Deer consumed the seed and fruits of many plant species and when excreted, a large percentage of seeds remain viable. In some areas over 50% of seeds eaten represent highly invasive plant species (Williams and Ward 2006). Stiltgrass invasions serve to prevent the shrub layer from returning which decreases and/or eliminates these forest structural components used by songbirds and also interferes with native plant successional dynamics.

Reducing the deer population will also benefit the surrounding human community by reducing damage on agricultural crops and residential landscape vegetation and by reducing deer-vehicle collisions. The average estimated economic impact from deer depredation to high-value agricultural crops from 1994 to 2000 in Delaware was $375,966 (Drake et al. 2005). High-value agricultural crops included fresh market and processed vegetables including but not limited to snap beans, sweet corn, leafy vegetables, tomatoes, and peppers. Fruits such as apples and peaches were also included as high-value crops (Drake et al. 2005). The average estimated economic impact from deer depredation to grain crops from 1994-2000 in Delaware was $867,937 (Drake et al. 2005). Grain crops included corn (silage and grain), soybeans, wheat, and oats. The average annual vehicle damage from deer-vehicle collisions in Delaware from 1986 to 2000 is estimated at $592,000. This does not include costs of human fatalities associated with deer collisions or costs associated with disposal of deer carcasses.

Hunting of resident game species such as deer does not have any regional impact on their respective populations due to their restricted home ranges. The refuge contributes negligibly to the State's total harvest for deer (Figure 1.3 and Tables 1.11-1.12). For example, since 1999, deer harvest at the refuge has ranged from 0.8 percent to 1.5 percent of Delaware's total deer harvest each year.

Figure 1.3. Delaware annual deer harvest, 1954 – 2008/09 seasons. (Source: Rogerson (2010)

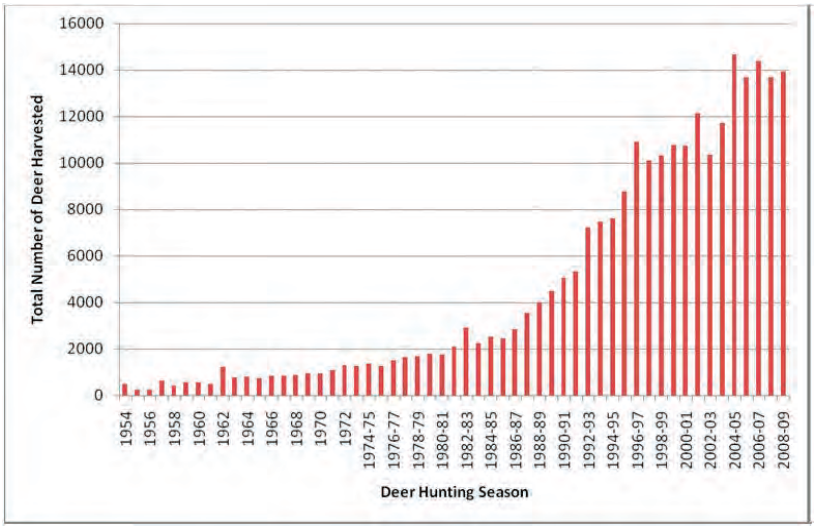

Table 1.11. Number of deer harvested and hunter visits on Prime Hook NWR compared to statewide harvest *(Source: Refuge harvest data; http://www.dnrec.state.de.us/fw/deer.pdf; http://www.fw.delaware.gov/Hunting/Documents/2007-08%20Historical%20Delaware%20White-tailed%20Deer%20Summary.pdf)*

Year	Statewide Deer Harvest	Refuge Deer Harvest	Refuge Hunter Visits
1988	3,998	141	1,289
1989	4,504	155	1,131
1990	5,066	178	1,689
1991	5,336	163	1,703
1992	7,245	257	1,608
1993	7,465	219	1,616
1994	7,615	169	1,568
1995	8,781	217	1,184
1996	10,915	221	1,326
1997	10,091	187	1,510
1998	10,312	138	1,335
1999	10,756	114	870
2000	10,741	125	941
2001	12,133	188	1,003
2002	10,357	160	913
2003	11,712	175	891
2004	14,669	143	841
2005	13,670	133	884
2006	14,401	120	825
2007	13,369	108	790
2008	13,926	106	670
2009	12,400*	107	552

*Data from DNREC (2010b).

Table 1.12. Cumulative impacts of existing deer hunting on Prime Hook NWR/State Deer Management Zone 9 (2009-2010 data) compared to Statewide Harvest.

Hunt Location & Type	Harvest
Prime Hook NWR	107
State Deer Management Zone 9	767
Statewide Harvest (all 17 Deer Management Zones)	12,400

The refuge proposes to open 1,513 additional acres for deer hunting for a total of 5,389 acres. This additional acreage includes: an area located north of Prime Hook Road commonly referred to as Oak Island, an area of red maple swamp along Prime Hook Creek and west of the existing Headquarters Area, an area north of Route 16 referred to as the Millman Tract, and an expansion of the Headquarters Area. Of these "new areas," Oak Island was previously hunted up until 1995 and the Millman Tract was hunted under private ownership up until the Service purchased it in 2001. Prime Hook Creek and its associated red maple swamp will provide additional opportunities and will be limited by access. Hunter numbers are expected to initially increase based on the opening of these areas and the opportunity for hunters to free-roam; however, cumulative impacts are expected to be negligible.

The current harvest of deer on the refuge (107) has a negligible impact on the statewide deer population of 31,071 deer (Table 1.12). Furthermore, hunting license sales in Delaware have declined from 29,994 in 1975 to 18,746 in 2007 (Rogerson 2010). Based on the decline in the number of hunters and the relatively few numbers of animals harvested from the refuge in respect to the total statewide harvest and deer population, no cumulative impacts to local, regional or statewide populations of white-tailed deer are anticipated from allowing hunting of the species on the refuge.

Wild Turkey

The refuge proposes to open 3,472 acres for wild turkey hunting. This additional acreage includes many of the areas for deer hunting. Turkey hunting was permitted on the refuge in Unit I west of Slaughter Canal from 1993 up until 1998. Turkey hunting is proposed only if a huntable population is found to exist. This will be determined through coordination with the Delaware Division of Fish & Wildlife. Impacts from turkey hunting, which occurs in April and May, is expected to be negligible since only a very small number of hunters (≤5) will be permitted to hunt.

1.2 Upland Game or "Small Game"

Cottontail rabbit is the primary small game species sought on the refuge and to a much lesser extent northern bobwhite quail, mourning dove, woodcock, snipe, and ring-necked pheasant. Mourning dove, woodcock, and snipe have been addressed in the migratory bird section of this analysis.

Hunting of resident game species such as quail, rabbit, red fox, and pheasant does not have any regional impact on their respective populations due to their restricted home ranges. Delaware Division of Fish & Wildlife periodically reviews populations of all harvested resident species, and has determined that populations are adequate to support hunting efforts throughout the state.

Hunter visits and harvest of upland and small game such as rabbit have been relatively low and the number of quail taken per year has been non-existent to no more than 14 per year on the refuge in recent years (Table 1.13). The refuge does not allow hunting of the eastern gray squirrel to minimize conflicts with the endangered Delmarva fox squirrel.

Table 1.13. Number of upland game, small game, and webless migratory birds harvested and hunter visits on Prime Hook NWR.

Year	Dove Harvest	Snipe Harvest	Woodcock Harvest	Quail Harvest	Rabbit Harvest	Refuge Hunter Visits*
1996	110	0	0	5	83	126
1997	77	0	0	0	117	169
1998	30	0	0	0	46	112
1999	90	0	0	0	98	123
2000	13	0	0	0	29	81
2001	6	0	0	0	65	128
2002	58	0	0	0	163	114
2003	13	0	0	0	79	81
2004	12	0	0		75	53
2005	6	0	0	0	257	129
2006	20	0	0	14	115	106
2007	22	0	0	11	145	178
2008	0	0	1	10	176	171
2009	0	0	6	1	163	149

*Hunter visits include all species combined; majority are hunting rabbits

Given the relatively few numbers of animals harvested from the refuge, no cumulative impacts to local, regional or statewide populations of small game are anticipated from allowing hunting of these species on the refuge.

1.3 Migratory Birds

Migratory birds are managed on a flyway basis by the U.S. Fish and Wildlife Service. The process of surveying populations and setting regulations is, inherently, a cumulative impact analysis. The following paragraphs describe this process.

The U.S. Fish and Wildlife Service annually prescribe frameworks, or outer limits, for dates and times when hunting may occur and the number of birds that may be taken and possessed. These frameworks are necessary to allow State selections of season and limits for recreation and sustenance; aid Federal, State, and tribal governments in the management of migratory game birds; and permit harvests at levels compatible with population status and habitat conditions. Because the Migratory Bird Treaty Act stipulates that all hunting seasons for migratory game birds are closed unless specifically opened by the Secretary of the Interior, the Service annually promulgates regulations (50 CFR Part 20) establishing the frameworks from which States may select season dates, bag limits, shooting hours, and other options for each migratory bird hunting season. The frameworks are essentially permissive in that hunting of migratory birds would not be permitted without them. Thus, in effect, Federal annual regulations both allow and limit the hunting of migratory birds.

Migratory game birds are those bird species so designated in conventions between the United States and several foreign nations for the protection and management of these birds. Under the Migratory Bird Treaty Act (16 U.S.C. 703-712), the Secretary of the Interior is authorized to determine when “hunting,

taking, capture, killing, possession, sale, purchase, shipment, transportation, carriage, or export of any bird, or any part, nest, or egg" of migratory game birds can take place, and to adopt regulations for this purpose. These regulations are written after giving due regard to "the zones of temperature and to the distribution, abundance, economic value, breeding habits, and times and lines of migratory flight of such birds, and are updated annually (16 U.S.C. 704(a)). This responsibility has been delegated to the U.S. Fish and Wildlife Service as the lead federal agency for managing and conserving migratory birds in the United States. Acknowledging regional differences in hunting conditions, the Service has administratively divided the nation into four Flyways for the primary purpose of managing migratory game birds. Each Flyway (Atlantic, Mississippi, Central, and Pacific) has a Flyway Council, a formal organization generally composed of one member from each State and Province in that Flyway. The refuge is in the Atlantic Flyway.

The process for adopting migratory game bird hunting regulations, located in 50 CFR part 20, is constrained by three primary factors. Legal and administrative considerations dictate how long the rule making process will last. Most importantly however, the biological cycle of migratory game birds controls the timing of data-gathering activities and thus the dates on which these results are available for consideration and deliberation. The process of adopting migratory game bird hunting regulations includes two separate regulations-development schedules, based on "early" and "late" hunting season regulations. Early hunting seasons pertain to all migratory game bird species in Alaska, Hawaii, Puerto Rico, and the Virgin Islands; migratory game birds other than waterfowl (e.g. dove, woodcock, etc.); and special early waterfowl seasons, such as teal or resident Canada geese. Early hunting seasons generally begin prior to October 1. Late hunting seasons generally start on or after October 1 and include most waterfowl season not already established. There are basically no differences in the processes for establishing either early or late hunting seasons. For each cycle, Service biologists and others gather, analyze, and interpret biological survey data and provide this information to all those involved in the process through a series of published status reports and presentations to Flyway Councils and other interested parties. Though not as detailed as that for waterfowl, relevant data are collected and summarized for migratory bird species such as dove, woodcock, etc. Bird monitoring data are available through the Service's Division of Migratory Bird Management Website (*http://www.fws.gov/migratorybirds/*; accessed February 2012).

Because the Service is required to take abundance of migratory birds and other factors into consideration, the Service undertakes a number of surveys throughout the year in conjunction with the Canadian Wildlife Service, State and Provincial wildlife-management agencies, and others. To determine the appropriate frameworks for each species, the Service considers factors such as population size and trend, geographical distribution, annual breeding effort, the condition of breeding and wintering habitat, the number of hunters, and the anticipated harvest. After frameworks are established for season lengths, bag limits, and areas for migratory game bird hunting, migratory game bird management becomes a cooperative effort of State and Federal Governments. After Service establishment of final frameworks for hunting seasons, the States may select season dates, bag limits, and other regulatory options for the hunting seasons. States may always be more conservative in their selections than the Federal frameworks but never more liberal. Season dates and bag limits for national wildlife refuges open to hunting are never longer or larger than the State regulations. In fact, based upon the findings of an environmental assessment developed when a national wildlife refuge opens a new hunting activity, season dates and bag limits may be more restrictive than the State allows.

National Environmental Policy Act (NEPA) considerations by the Service for hunted migratory game bird species are addressed by the programmatic document, "Final Supplemental Environmental Impact Statement: Issuance of Annual Regulations Permitting the Sport Hunting of Migratory Birds (FSES 88-

14)," filed with the Environmental Protection Agency on June 9, 1988. The Service published Notice of Availability in the *Federal Register* on June 16, 1988 (53 FR 22582), and our Record of Decision on August 18, 1988 (53 FR 31341). Annual NEPA considerations for waterfowl hunting frameworks are covered under a separate environmental assessment, in which the FONSI is published generally in August of that hunt year. Further, in a notice published in the September 8, 2005, *Federal Register* (70 FR 53376), the Service announced its intent to develop a new Supplemental Environmental Impact Statement for the migratory bird hunting program. Public scoping meetings were held in the spring of 2006, as announced in a March 9. 2006, *Federal Register* notice (71 FR 12216). More information may be obtained from: Chief, Division of Migratory Bird Management., US_ Fish and Wildlife Service, Department of the Interior, MS MBSP-4107-ARLSQ, 1849 C Street, NWR, Washington, DC 20240.

Waterfowl at Prime Hook NWR

Impacts to hunting waterfowl are further minimized from State and Federal frameworks by limiting hunting to three days per week during the hunting season with a noon closure.

At the refuge, the impacts of hunting of waterfowl are negligible when compared to the State's total waterfowl harvest. For example, from 1987 to 2009, the average annual waterfowl harvest at the refuge is 2.6 percent of Delaware's total waterfowl harvest (Table 1.14). Furthermore, in 2009, the refuge's harvest of ducks was only 3.4 percent of Delaware's total duck harvest, 0.96 percent of the Atlantic Flyway's duck harvest, and 0.01 percent of the entire United States' duck harvest (Table 1.15; Raftovich et al. 2011). Also in 2009, the refuge's harvest of geese (Canada and snow geese combined) was only 0.82 percent of Delaware's total goose harvest, 0.04 percent of the Atlantic Flyway's goose harvest, and 0.01 percent of the entire United States' goose harvest. (Table 1.15; Raftovich et al. 2011).

The impacts of waterfowl hunting at the refuge are also negligible when compared to long-term trends in duck and goose populations at the refuge and across the state. Through monthly aerial surveys from October through November, the Delaware Division of Fish and Wildlife is able to evaluate long-term trends in duck and goose populations. The surveys give fairly accurate information about geese, but duck populations such as wood ducks and sea ducks are almost impossible to count. Furthermore, these surveys do not cover the entire state, but only the primary waterfowl habitat in Delaware which is approximately the eastern half of the state. These figures represent the numbers of ducks and geese at the time of the survey, but do not reflect an actual annual estimate for the waterfowl population in Delaware due to the transitory nature of birds migrating through the State during the fall and winter months.

Based on the findings of these monthly surveys from 1987 to 2009, the average annual waterfowl harvest at the refuge is only 1.8 percent of the estimated peak waterfowl survey findings on the refuge (Table 1.14). During an individual season, the percent of the refuge's harvest on statewide and refuge populations may range greatly depending on the timing of refuge hunting activity and peak waterfowl migration. For example, during the 2009-2010 hunting season, the refuge harvested between 0.19 percent and 1.5 percent of the State's estimated monthly duck population and between 0.02 percent and 0.11 percent of the State's estimated monthly goose population (Table 1.16). Refuge hunters harvested between 0.31 percent and 6.15 percent of the refuge's estimated monthly duck population and between 0.09 percent and 1.48 percent of the refuge's estimated monthly goose population (Table 1.16).

Table 1.14. Waterfowl harvest and aerial survey estimates on Prime Hook NWR compared to statewide harvest. Waterfowl includes geese and ducks.

Year	Statewide Waterfowl Harvest*	Refuge Waterfowl Harvest	Refuge Waterfowl Survey**	Refuge Hunter Visits
1987	63,360	1,202	21,243	1,206
1988	62,160	771	21,814	826
1989	61,480	578	64,822	333
1990	59,510	1,241	49,611	1,065
1991	63,410	1,625	55,792	1,178
1992	46,600	1,155	55,238	1,291
1993	46,850	1,421	86,087	962
1994	53,290	2,053	155,096	1,604
1995	45,540	1,572	71,131	1,024
1996	44,170	1,980	104,447	1,630
1997	71,070	3,116	191,446	1,904
1998	118,560	2,964	193,617	1,530
1999	96,410	1,987	224,693	1,403
2000	94,610	2,047	134,156	1,250
2001	76,210	2,679	107,919	1,683
2002	95,170	1,936	102,690	1,330
2003	88,800	2,546	203,615	1,486
2004	73,190	1,573	69,737	1,422
2005	71,740	1,624	111,544	1,301
2006	64,630	2,389	132,088	1,750
2007	81,620	2,989	44,086	1,850
2008	107,120	1,634	90,875	1,253
2009	86,600	1,934	79,263	1,453

*Statewide waterfowl harvest data from: *http://www.flyways.us/regulations-and-harvest/harvest-trends*

** Waterfowl estimates were derived from peak numbers found during aerial surveys. Zone 7 was used to estimate waterfowl numbers for PHNWR, which covers the area from Big Stone Beach to the Broadkill River and east of Route 1. Only one survey was conducted in 2007 (October 2007) which may not have reflected the peak. (*http://www.fw.delaware.gov/Hunting/Pages/Waterfowl%20Surveys.aspx*)

Table 1.15. Comparison of waterfowl harvest at Prime Hook NWR to State, Flyway, and United States harvest in the 2009 hunting season.

Waterfowl Harvest Area	Ducks	Geese
Prime Hook NWR	1,609	325
Delaware*	46,800	39,800
Atlantic Flyway*	1,680,100	922,200
United States*	13,139,800	3,327,000

*Harvest estimates from (Raftovich et al. 2011)

Table 1.16. Comparison of duck and goose (Canada & snow geese) harvest at Prime Hook NWR to State waterfowl surveys during the 2009-2010 hunting season.

Month	Refuge Duck Harvest	Refuge Duck Population Estimates*	Statewide Duck Survey Results*	Refuge Goose Harvest	Refuge Goose Population Estimates*	Statewide Goose Survey Results*
October 2009	67	21,457	36,042	9	10,512	44,372
November 2009	406	30,548	63,516	104	18,734	92,604
December 2009	697	46,675	76,100	115	32,588	247,922
January 2010	439	7,141	28,688	97	6,565	102,229

* Waterfowl estimates were derived from peak numbers found during aerial surveys. Zone 7 was used to estimate waterfowl numbers for PHNWR, which covers the area from Big Stone Beach to the Broadkill River and east of Route 1. (*http://www.fw.delaware.gov/Hunting/Pages/Waterfowl%20Surveys.aspx*)

Managing Resident Canada Geese

Canada goose herbivory during the growing season is a relatively new impact upon wetlands. In 2002, a research study conducted at neighboring refuges, Bombay Hook and Chincoteague NWRs, suggested that higher levels of goose-use may cause a long-term change in wetland community structure (Laskoswki et al, 2002). The study measured the impact of foraging by resident Canada geese on biomass and species composition of wetland vegetation at Bombay Hook and Chincoteague National Wildlife Refuges in Delaware and Virginia, respectively. Resident geese reduced the amount of plant biomass that would be available to migrant birds at the end of the growing season. Biomass of several species of vegetation was significantly impacted by feeding resident Canada geese at both refuges.

Direct damage to agricultural resources by resident geese includes grain crops, trampling and spring seedlings. Heavy grazing by geese can result in reduced yields and in some instances a total loss of the grain crop. A single heavy grazing event by Canada geese in the fall, winter, or spring can reduce the yield of winter wheat by 13-30 percent (Allen et al. 1985, Flegler et al. 1987). In the mid-Atlantic, the Maryland Department of Natural Resources reported that 23 percent of all complaints were related to agricultural damage and estimated agricultural damage exceeds $200,000 per year (USFWS, FEIS, 2005).

To address well-documented concerns regarding the impacts of resident Canada geese on habitats as well as public property, the USFWS issued new regulations for control of resident geese [VOL#71 Fed. Reg. PAGE#45964-45993 (2006)]. We expect that the use of resident Canada goose control and management activities; particularly lethal control methods would increase significantly. Such lethal and nonlethal activities would be expected to significantly decrease the number of injurious resident Canada geese in specific localized areas, thus reducing adverse impacts on vegetation. The long term viability of goose populations would not be affected, however. Over time, we expect the cumulative impacts to become less evident and significant as the goose populations are reduced.

The impact of refuge hunting on resident Canada geese is negligible. For resident Canada geese, hunters averaged 8.8 birds per year from 2001 to 2006 (Table 1.17).

Table 1.17. Resident Canada Goose Harvest in Prime Hook National Wildlife Refuge.

Year	Resident Canada Goose Harvest	Refuge Hunter Visits
2001	14	33
2002	6	15
2003	10	13
2004	14	10
2005	0	0
2006	9	2

Managing Snow Geese

In the nearly three decades since the original snow goose management plan of 1981, the greater snow goose population, as indexed by the spring survey, has undergone a five-fold increase to over one million birds. Various light goose populations in North America have experienced rapid population growth, and have reached levels such that they are damaging habitats on their Arctic and subarctic breeding areas (Abraham and Jefferies 1997, Alisauskas 1998, Jano et al. 1998, Didiuk et al. 2001). Habitat degradation in arctic and sub-arctic areas may be irreversible, and has negatively impacted light goose populations (Abraham and Jefferies 1997), and other bird populations dependent on such habitats (Gratto-Trevor 1994, Rockwell 1999, Rockwell et al. 1997). Natural marsh habitats on some migration and wintering areas have been impacted by light geese (Giroux and Bedard 1987, Giroux et al. 1998, Widjeskog 1977, Smith and Odum 1981, Young 1985). In addition, goose damage to agricultural crops has become a problem (Bedard and Lapointe 1991, Filion et al. 1998, Giroux et al. 1998, Delaware Div. of Fish and Wildlife 2000).

The increasing numbers of light-geese are viewed as a continental problem, but with real local consequences. A common feeding strategy of snow geese on refuge wetlands is to grub for underground roots and tubers. Primary marsh vegetation species exploited in this fashion are; salt marsh cordgrass (*Spartina alterniflora*), salt meadow cordgrass (*S. patens*),Olney's bulrush (*Scirpus americanus*), black needlerush (*Juncus romerianus*), and cattail (*Typha sp*). Grubbing for rhizomes of these species, especially in salt marshes, results in areas denuded of vegetation, typically referred to as "eat-outs". Presently, eat-outs occur on four NWRs within R5; Forsythe, Bombay Hook, Prime Hook, and Blackwater.

Snow goose eat-outs in salt marshes tend to re-vegetate during the subsequent growing season, however at a reduced vegetative density. Vegetation density at these eat-outs may increase after several years to pre-eat-out levels, if left alone. However, at most NWRs where eat-outs occur within salt marsh habitats, snow geese return each winter to the same areas to feed. This may be a result of the vegetative growth being at an earlier stage of development, being more nutritious, or having a less dense root mat and

therefore easier to grub. It is also speculated that during the time snow geese are feeding in a salt marsh, much of the soil and sediment may be loosened and placed into suspension. This material may then be washed away during high or flood tide periods. After several years of successive eat-outs at the same location, a lowering of ground elevation may occur causing a more permanent impact to the site.

Most agree that salt marsh eat-outs are detrimental to habitat integrity and other wildlife species. This is a result of the radical change of habitat structure from dense vegetation to mudflat. Undoubtedly, this conversion negatively impacts invertebrate communities as well as species such as rails, and waterfowl that feed on these invertebrates and rely on the dense vegetative structure for cover. However, some refuge staff report increased use of snow goose eat-outs by numerous shorebirds during migration, as well as, some species of waterfowl. This is particularly the case at the refuge, Forsythe NWR, and Bombay Hook NWR.

Reducing the acreage in cropland habitats in favor of more native vegetation also supports the preferred alternative for snow goose management on refuge lands identified in the final environmental impact statement for snow goose management along the Atlantic Flyway. Reducing the use by snow geese of these upland habitats will also benefit a variety of wildlife species that tend to be absent from agricultural habitats, and will also reduce the numbers of snow geese staying on the refuge. Reducing snow goose numbers on the refuge will also diminish adverse impacts of snow goose herbivory on salt marsh habitats.

The impact of refuge hunting on snow geese is negligible. From 2000 to 2009, refuge hunters harvested between 0.04 percent and 0.43 percent of the refuge's estimated monthly snow goose population (Table 1.18). For snow geese in the late season (late January into March), hunters averaged 16.0 birds per year from 2001 to 2006 (Table 1.18).

Table 1.18. Snow Goose Harvest and Aerial Survey Estimates at Prime Hook National Wildlife Refuge.

Year	Total Snow Goose Harvest*	Hunted in Late Season**	Snow Goose Harvested in Late Season**	Refuge Hunter Visits in Late Season**	Refuge Snow Goose Survey***
2000	174	No	n/a	n/a	96,112
2001	242	Yes	37	42	67,840
2002	48	Yes	7	9	72,200
2003	118	Yes	33	24	124,500
2004	121	Yes	3	5	55,330
2005	36	Yes	4	8	86,627
2006	73	Yes	12	12	132,088
2007	130	No	n/a	n/a	30,500
2008	56	No	n/a	n/a	84,520
2009	43	No	n/a	n/a	27,000

* Includes snow geese harvested in February / March when applicable
** Late season includes late January to mid-March
*** Snow goose estimates were derived from peak numbers found during aerial. Zone 7 was used to estimate snow goose numbers for PHNWR, which covers the area from Big Stone Beach to the Broadkill River and east of Route 1. Only one survey was conducted in 2007 (October 2007) which may not have reflected the peak. *(http://www.fw.delaware.gov/Hunting/Pages/Waterfowl%20Surveys.aspx)*

Managing Non-Native Mute Swans

Mute swans are highly invasive of wetland habitats, impact native species of fish and wildlife, damage commercial agricultural crops, and pose a threat to human health and safety. As such, they cause serious nuisance problems and property damage, including economic loss. Because of their consumption of large quantities of submerged aquatic vegetation and their aggressive behavior, mute swans compete directly with many other water birds and fisheries for critical habitats. Due to their strong territorial defense, some pairs will vigorously defend nest and brood sites from intrusion by other wildlife and have attacked humans, causing serious harm. They do provide some aesthetic value for public enjoyment. But, as populations of mute swans have grown in various states and expanded into new areas, there is a need to coordinate management actions among state/provincial and Federal wildlife agencies to reduce numbers to desirable levels (AFC 2003).

Consequently, the Atlantic Flyway Council has adopted the Atlantic Flyway Mute Swan Management Plan 2003-2013. The mute swan is not federally protected under the Migratory Bird Treaty Act, and is listed as an unprotected-invasive species by the State of Delaware. As such, mute swans, their nests, and eggs have been routinely removed from national wildlife refuges, State wildlife management areas and (with landowner permission) from private lands since the early 1970s, in Delaware (AFC 2003).

Minimizing Hunting Disturbance

The refuge proposes to open 1,732 additional acres for waterfowl hunting for a total of 3,455 acres. This additional acreage includes: an area between Slaughter Beach Road and Fowler Beach Road referred to as Unit I, an area located south of Prime Hook Road, Prime Hook Creek, an area along the Broadkill River in Unit IV, and a reconfiguration of the existing waterfowl hunt area in Unit III. Of these “new areas,” Unit I was already open to dove hunting and Prime Hook Creek was hunted up until 1991.

To minimize waterfowl disturbance, the refuge has designated approximately 3,000 acres as waterfowl sanctuaries that will be closed to hunting and other recreational uses on a seasonal or annual basis. Given the dominant role of the refuge in the Atlantic Flyway migration corridor, this closed area system was established to provide waterfowl with a network of resting and feeding areas and to disperse waterfowl hunting opportunities on the refuge. These sanctuaries lie in the Unit II (~1,800 acres) and the southern half of the Unit III (~970 acres) managed impoundments. The northern portion of Unit IV (~230 acres), which contains a proposed trail and observation platform, will be closed from the Monday before Thanksgiving to March 15 to also minimize disturbance to wildlife in this area.

Furthermore, on refuge impoundments in Unit III and Prime Hook Creek, waterfowl hunting will occur three days per week during the hunting season, which is one less day per week than current management. Impacts to waterfowl will also be decreased from current management by changing the end of shooting time from 3:00pm to noon. These restrictions also apply to the early teal and resident Canada goose seasons, which will be further limited by lower water levels during that time of year due to drawdown practices.

Hunter numbers are expected to initially increase based on the opening of these areas and the opportunity for hunters to free-roam in the regular waterfowl areas; however, cumulative impacts are expected to be negligible. Hunting license sales in Delaware have declined from 29,994 in 1975 to 18,746 in 2007 (Rogerson 2010). Based on the decline in the number of hunters and the relatively low numbers of waterfowl harvested from the refuge in respect to the total statewide, flyway, and national harvests, no cumulative impacts to local, regional or flyway waterfowl populations are anticipated from allowing

hunting of waterfowl on the refuge. Impacts to waterfowl using the refuge would be localized to the area being hunted (which can be no more than 40 percent of the refuge) and due to the short temporal nature of these types of disturbance (from day restrictions to hunting at noon), no cumulative indirect impacts from shooting, walking, boats, or vehicles are anticipated.

Other Migratory Birds at Prime Hook NWR

Other migratory birds hunted at the refuge include mourning dove, woodcock, and snipe. For mourning dove, an estimated 36,300 birds were harvested in Delaware during the 2009 season (Table 1.19; Raftovich et al. 2011) when none were taken on the refuge. Similarly, very few snipe and woodcock were harvested (Tables 1.13 & 1.19).

Table 1.19. Comparison of mourning dove, woodcock, and snipe harvest at Prime Hook NWR to State, Flyway, and United States harvest in the 2009 hunting season.

Harvest Area	Dove	Woodcock	Snipe
Prime Hook NWR	0	6	0
Delaware*	36,300	200	0
Eastern Management Unit*	7,639,200	63,300	43,600
United States*	17,354,800	238,400	83,500

*Harvest estimates from (Raftovich et al. 2011); Estimates for snipe are from the Atlantic Flyway

Given the low numbers of birds harvested from the refuge, no cumulative impacts to local, regional/flyway, or nationwide populations of other migratory birds are anticipated from allowing hunting of these species on the refuge.

1.4 Non-Hunted Wildlife

Non-hunted wildlife would include resident and migratory birds (songbirds, wading birds, shorebirds, etc.); small mammals such as voles, moles, mice, shrews, and bats; reptiles and amphibians such as snakes, turtles, salamanders, frogs and toads; and invertebrates such as butterflies, moths, insects, and spiders). Except for migratory birds and some species of butterflies, moths, and bats, these species have very limited home ranges and hunting could not affect their populations regionally; thus, only local effects will be discussed.

Disturbance to non-hunted migratory birds could have regional, local, and flyway effects. Regional and flyway effects would not be applicable to species that do not migrate such as most woodpeckers, and some songbirds including cardinals, titmice, wrens, chickadees, etc. The continual effects of disturbance to non-hunted migratory birds under this plan are expected to be negligible for the following reasons. The hunting season would not coincide with the nesting season except for the spring turkey hunt. Turkey hunting will negligibly affect non-target wildlife since only a very small number of hunters (no more than five) will be permitted to hunt on the 3,472 designated acres of the refuge. Long-term future impacts that could occur if reproduction was reduced by hunting are not relevant for this reason. Disturbance to the daily wintering activities of birds might occur, such as feeding and resting.

Disturbance of resident birds would increase slightly, but displacement is usually brief, infrequent, and short distance. Disturbance would be unlikely for many small mammals, such as bats, which are inactive during fall and winter when hunting season occurs, and/or are nocturnal. Hibernation or torpor by cold-blood reptiles and amphibians also limits their activity during the hunting season when temperatures low, making encounters with reptiles and amphibians infrequent and inconsequential to local populations.

Invertebrates are also not active during cold weather and will have few interactions with hunters during the hunting season. The Service anticipates no measurable negative cumulative impacts to resident non-hunted wildlife populations locally, regionally, or globally. The cumulative impact of wildlife and habitat management when considered at the flyway scale may in fact, benefit the health of migratory birds by maintaining the diversity and native components of the habitats they use. In summary, hunting has little or no impact on non-hunted wildlife due to temporal and spatial separation due to timing of the season and migration.

1.5 Threatened and Endangered Species

Disturbance factors resulting from public use are always considered for all listed species. The Delmarva fox squirrel (*Sciurus niger cinereus*) and piping plover (*Charadrius melodus*) are listed as endangered and threatened by the U.S. Fish and Wildlife Service and the red knot was designated as a candidate species in 2006 for possible listing. Several other species listed as endangered by the Delaware Division of Fish & Wildlife include American oystercatcher (*Haematopus palliates*), common tern (*Sterna hirundo*), Forster's tern (*Sterna forsteri*), least tern (*Sterna antillarum*), and bald eagle (*Haliaeetus leucocephalus*). Of these, the piping plover, red knot, American oystercatcher, common tern, Forster's tern, and least tern will not be impacted by hunting because they would be unlikely to use the refuge's forested habitats and/or their occurrence on the refuge is outside of the hunting season for deer, upland game, and waterfowl. Impacts on the piping plover, American oystercatcher, common tern, Forster's tern, and least tern will be minimized through the seasonal closure of designated beach dunes and overwash areas from March 1 through September 1 to all visitors. A Section 7 Evaluation has been conducted as part of this review and it was determined that proposed activities would not likely affect the Delmarva fox squirrel or piping plover. Furthermore, the hunting of any squirrel species is prohibited on the refuge to further minimize impacts to this endangered species.

While the bald eagle is no longer a federally listed species, the refuge uses the National Bald Eagle Management Guidelines for bald eagle management to implement time-of-year restrictions for nesting eagles. The guidelines do not permit any activity within 330 feet of an active nest during the breeding season, particularly where eagles are unaccustomed to such activity (U.S. Fish and Wildlife Service 2007).

Fishing, hunting, and wildlife observation/photography on or near Turkle Pond was an existing activity prior to nesting by bald eagles on the adjacent Horse Island. When bald eagles were listed as endangered, the Section 7 Evaluation conducted on the refuge concluded that these activities in Turkle Pond would not likely affect this species and the uses were permitted.

1.6 Anticipated Direct and Indirect Impacts of Proposed Action on Refuge Programs, Facilities, and Cultural Resources

1.6.1 Other Wildlife-Dependent Recreation

The opportunities for recreational sport hunting, a wildlife-dependent priority public use, would be available to the hunters, meeting a demand. Hunting on the refuge would contribute to the State's wildlife management objectives and allow a traditional use to continue.

Expanded hunting opportunities is expected to have moderate adverse impacts on a certain segment of the public that does not desire any change in public use programs and regulations, or that may hold differing views on the course of action. In addition, while new visitors become familiar with those changes, violations could increase. Some conflict between wildlife observers, photographers, students, and other refuge users is expected to result in short-term, moderate adverse impacts, which will be managed through seasonal closures. Negative reactions by some visitors may be caused by the closure

of the western end of Prime Hook Creek to all uses (mainly fishing, canoeing, and kayaking) other than hunters from September 1 through the end of the deer and waterfowl hunting seasons; the closure of the eastern end of Prime Hook Creek from September 1 through March 15; and the temporary closure of the general public use area near the Refuge Headquarters to conduct deer hunts. Under current management, the westernmost four miles of Prime Hook Creek was open year-round to the non-hunting public. Refuge officers would enforce these and other current refuge regulations, where appropriate, and would seek the assistance and cooperation of Delaware Division of Fish & Wildlife in enforcing common regulations, to provide a safe environment for refuge visitors and promote activities that are compatible with protecting the resources.

Some conflicts between concurrent hunting programs (e.g., waterfowl, deer, and upland game hunting seasons overlapping) are anticipated. For the majority of the hunting seasons, the Delaware Division of Fish & Wildlife has made efforts to avoid these overlaps in the various hunting programs. As public use levels expand across time, unanticipated conflicts between user groups may occur. The refuge's visitor use programs would be adjusted as needed to eliminate or minimize each conflict and provide quality wildlife-dependent recreational opportunities. The Service's law enforcement efforts will be increased. Also, conflicts among hunters over desired hunting locations is expected and we will continue to encourage proper hunting ethics.

1.6.2 Refuge Facilities

Minimal infrastructure, which includes the addition of two to three parking areas, enhancement of existing boat ramps, and placement of informational signs, is anticipated in support of this priority public use. There would be some costs associated with these programs in the form of road maintenance, law enforcement, and boat ramp maintenance. These costs should be minimal relative to total refuge operations and maintenance costs and would not diminish resources dedicated to other refuge management programs. Impacts to refuge resources are expected to be negligible.

1.6.3 Cultural Resources

With a relatively small number of hunters dispersed across the refuge during the hunting season, direct or indirect cumulative impacts would be negligible on the refuge's cultural resources based on our observations of past hunting impacts. Refuge lands are vulnerable to looting, despite our best efforts at outreach, education, and law enforcement. Upland areas adjacent to wetland areas have been identified for high potential for cultural resources. In addition, refuge visitors may inadvertently or even intentionally damage or disturb known or undiscovered cultural artifacts or historic properties. Law enforcement and outreach will be utilized to minimize this problem.

For compliance with section 106 of the National Historic Preservation Act, the refuge staff will provide the regional historic preservation officer a description and location of all projects, activities, routine maintenance and operations that affect ground and structures, details on requests for compatible uses, and the range of alternatives considered. That office will analyze those undertakings for their potential to affect historic and prehistoric sites, and consult with the State Historic Preservation Officer and other parties as appropriate. The State and local government officials will be notified to identify concerns about the impacts of those undertakings.

1.7 Anticipated Impacts of Proposed Hunt on Refuge Environment and Community

The refuge expects no sizeable adverse impacts of the proposed action on the refuge environment which consists of soils, vegetation, air quality, water quality and solitude. Some disturbance to surface soils and vegetation would occur in areas used by hunters; however impacts would be negligible. Hunting would

benefit vegetation as it is used to keep many resident wildlife populations in balance with the habitat's carrying capacity.

The refuge expects impacts to air and water quality to be negligible. The effect of these refuge-related activities, as well as other management activities, on overall air and water quality in the region are anticipated to be relatively negligible, compared to the contributions of industrial centers, power plants, and non-refuge vehicle traffic on nearby public roads.

The refuge would work closely with State, Federal, and private partners to minimize impacts to adjacent lands and its associated natural resources. The hunts result in a net gain of public hunting opportunities positively affecting the general public, nearby residents, and refuge visitors. However, hunt zones in the proposed waterfowl hunt area in Unit IV along the Broadkill River has the potential to conflict with nearby existing blinds on private lands. This activity will be evaluated and zones adjusted accordingly. Hunters will most likely opt to hunt within the marsh areas of these zones and not along the Broadkill River, which would lessen any direct conflicts with hunters on these nearby private lands. Also, due to an increase in new hunting areas and by allowing hunters to free roam, an increase in violations may occur until hunters become familiar with the refuge boundaries and regulations. As a result some landowner conflicts may erupt due to hunter trespassing. These impacts will be minimized through enhanced law enforcement efforts.

The refuge expects a minimal increase in visitation, but any additional use will add some revenue to local communities. The elimination of nearly all hunting permit fees (except for lottery hunts) should be well received by hunters and changes to the hunting program reduces the administrative burden and minimizes the amount of staffing resources needed to conduct the hunt by 54 staff days and by $17,890 from current management. The beneficial impact to the hunter is a reduction in their cost to hunt.

1.8 Other Past, Present, Proposed, and Reasonably Foreseeable Actions and Anticipated Impacts

Cumulative effects on the environment result from incremental effects of a proposed action when these are added to other past, present, and reasonably foreseeable future actions. While cumulative effects may result from individually minor actions, they may, viewed as a whole, become substantial over time. The proposed hunt plan has been designed to be sustainable through time given relatively stable conditions.

Due to hunting history of low hunter use and harvest for resident geese and late season snow geese, the refuge has been closed during these seasons but will consider reopening if demand and opportunity exist and conflicts are minimized.

Greater snow geese (*Chen caerulescens atlantica*) have undergone a dramatic increase in recent decades, to current population estimates of over 1 million birds. Natural marsh habitats on some migration and wintering areas have been impacted by the destructive feeding strategies of overabundant light geese (Giroux and Bedard 1987, Giroux et al. 1998, Widjeskog 1977, Smith and Odum 1981, Young 1985). In addition, goose damage to agricultural crops has become a problem (Bedard and Lapointe 1991, Filion et al. 1998, Giroux et al. 1998, Delaware Div. of Fish and Wildlife 2000). Snow geese use the refuge wetland habitats extensively, and are not subjected to any hunting disturbance or mortality on the refuge. Impacts to refuge wetlands and impacts to wetland-dependent wildlife compound over time as long as the population is not adequately controlled at the flyway level, through the coordinated efforts of individual agencies.

Similarly, resident Canada geese have been shown to cause changes in wetland community structure (Laskoswki et al. 2002). Resident geese can reduce the amount of plant biomass that would be available to migrant birds at the end of the growing season. Direct damage to agricultural resources by resident geese includes grain crops, trampling and spring seedlings. Heavy grazing by geese can result in reduced yields and in some instances a total loss of the grain crop (Allen et al. 1985, Flegler et al. 1987). Thus uncontrolled Canada goose populations on the refuge can impact migratory bird populations utilizing the refuge as well as contribute to agricultural losses on lands surrounding the refuge.

The refuge will consider participating in additional deer hunting seasons if an overabundance of deer arises, as determined the Delaware Division of Fish & Wildlife and concurrence by the refuge (Refer to Resident Wildlife Section for impacts of deer overabundance).

If visitation levels expand in the unforeseen future, unanticipated conflicts between user groups may occur. Service experience has proven that time and space zoning (e.g., establishment of separate use areas, use periods, and restrictions on the number of users) and limiting visitations are effective tools in eliminating conflicts between user groups.

1.9 Anticipate Impacts if Individual Actions are Allowed to Accumulate

National wildlife refuges, including the refuge, conduct hunting programs within the framework of State and Federal regulations. Hunting at the refuge is at least as restrictive as the State of Delaware and in some cases more restrictive. By maintaining hunting regulations that are as, or more, restrictive than the State, individual refuges ensure that they are maintaining seasons which are supportive of management on a more regional basis. Additionally, the refuge coordinates with the DFW annually to maintain regulations and programs that are consistent with the states' management programs.

The cumulative impact of hunting on migratory and resident wildlife populations at the refuge is negligible. As described in the previous sections, the proportion of the refuge's harvest of waterfowl, deer, and small game is negligible when compared to local, regional, and flyway populations and harvest.

Because of the regulatory process for harvest management of migratory birds in place within the Service, the setting of hunting seasons largely outside the breeding seasons of resident and migratory wildlife, the ability of individual refuge hunt programs to adapt refuge-specific hunting regulations to changing local conditions, and the wide geographic separation of individual refuges, no direct or indirect cumulative effects on resident wildlife, migratory birds, and non-hunted wildlife of hunting on the refuge are anticipated.

AUDIENCES

Based on visitor and community surveys conducted by the U.S. Geological Survey in 2004 and 2005 (Sexton et al. 2007), most refuge visitors are local to the area (72 percent). Of those local visitors, about half (56 percent) are considered consumptive users (participating in hunting, fishing, or crabbing). About 35 percent of visitors indicated that they had hunted on the refuge, with an average of 11 years spent hunting at the refuge. The estimated percentage of non-local visits for big game hunting was higher (83%) than for migratory birds (25%) and upland game (10%) (Sexton et al. 2007). The average consumptive visitor to the refuge is male, 47 years old, works full-time, has attended two years of college or technical school, and makes $50,000 to $74,999 per year.

Just over half of the visitors rated hunting activities as moderately to very important and 85 percent felt that the refuge provides a quality hunting experience. Hunting ducks, hunting deer with muzzleloaders, and hunting deer with a shotgun were rated the most important hunting activities among hunters. Hunting rabbit, squirrel, and trapping were rated least important among hunters. For all surveyed visitors and community residents, hunting deer, waterfowl, and upland game were rated the least three important activities at the refuge. The most important activities among all surveyed visitors and community residents were being in a natural, undeveloped area, experiencing a serene environment, and hiking (Sexton et al. 2007).

Hunting activities directly related to refuge operations would generate an estimated $93.8 thousand in local output, 0.8 jobs, and $26.9 thousand in labor income in the local economy (USGS. Including direct, indirect, and induced effects, overall refuge hunting activities would generate total economic impacts of $132.1 thousand in local output, 1.2 jobs and $38.5 thousand in labor income. A further breakdown of hunting activities on the refuge, including direct, indirect, and induced effects, reveals that big game hunting on the refuge would generate total economic impacts of $47.8 thousand in local output, 0.4 jobs, and $13.7 thousand in labor income. Waterfowl hunting on the refuge would generate total economic impacts of $82.3 thousand in local output, 0.8 jobs, and $24.3 thousand in labor income. Small game hunting on the refuge would generate total economic impacts of $2.0 thousand in local output, 0.02 jobs, and $500 in labor income.

The refuge will provide hunting opportunities for local and non-local hunters. Preseason drawings using online technology will provide hunters greater flexibility and efficiency in choosing their hunts in advance of the hunt date. Programs encouraging youth hunting will continue and new opportunities will be explored to enhance their experience. Hunting areas with wheelchair accessible ground blinds will be established specifically for non-ambulatory disabled hunters with limited mobility. Hunting opportunities for hunters with other disabilities abound in areas open to free-roam hunting where the hunter has the option to hunt anywhere in the designated hunt area.

DESCRIPTION OF THE HUNTING PROGRAM

Guidelines for Hunt Program

The following guiding principles for the Refuge System's hunting programs can be found in Part 605 FW 2 of the U.S. Fish & Wildlife Service Manual:

(1) Manage wildlife populations consistent with Refuge System-specific management plans approved after 1997 and, to the extent practicable, State fish and wildlife conservation plans;

(2) Promote visitor understanding of and increase visitor appreciation for America's natural resources;

(3) Provide opportunities for quality recreational and educational experiences consistent with criteria describing quality found in 605 FW 1.6;

(4) Encourage participation in this tradition deeply rooted in America's natural heritage and conservation history; and

(5) Minimize conflicts with visitors participating in other compatible wildlife-dependent recreational activities.

Areas Open to Hunting & Support Populations of Target Species

The following designated areas (Maps 4-16, 4-17, 4-18, and 4-19) will be open to hunting on the refuge for the following game species:

Area	Species	Acres	Seasons***
Regular Deer Hunt Area	Deer	3,939	Sept-Feb
Regular Waterfowl Hunt Area	Waterfowl & Dove	2,100*	Sept- Feb
Lottery Waterfowl Hunt Area	Waterfowl	1,338*	Sept-Feb
Lottery Deer Hunt Area	Deer	751	Nov & Jan
Non-Ambulatory Hunt Area	Deer & Waterfowl	16**	Sept-Feb
Lottery Non-Ambulatory Deer Hunt Area	Deer	682	Oct & Nov
Upland Game Hunt Area	Upland game & webless migratory birds (1,847 acres) except where designated as closed (110 acres)	1,957	Sept-Feb
Lottery Turkey Hunt Area Snow Goose Conservation Order	Turkey Snow Geese	3,471 Refuge-wide****	Apr-May Late Jan - April

* A total of 3,454 acres is open to migratory bird hunting. This is the maximum amount of land allowed by law (40% rule). Lands purchased with Land and Water Conservation Funds do not apply.
**Acres included as part of Lottery Waterfowl Hunt Area
***Follow State hunting seasons that include seasonal closures and time restrictions (see hunting objectives and strategies in this section for more information)
****40% rule does not apply because taking of snow geese in the conservation order has been determined to be beneficial to the species.

Future land acquisitions will be evaluated and if appropriate will be included in the refuge's hunting program.

Species to be Taken & Other Hunting Information

The refuge offers a wide diversity of hunting opportunity. Programs will include big game (white-tailed deer), upland game (rabbit, quail, pheasant, and red fox), waterfowl (including coot), wild-turkey, and other migratory game birds (mourning dove, snipe, & woodcock). Below are specific goals and objectives and their complementing strategies for the hunting program these species. These goals, objectives, and strategies can also be found under Goal 5 in the CCP.

Detail Information of Hunting Program Objectives

Visitor Services

Provide visitors with a place to safely take part in the six priority wildlife-dependent recreational uses established by the Refuge Improvement Act, as well as such other public uses as may be allowed without interfering with refuge purposes and objectives for wildlife.

The National Wildlife Refuge System Improvement Act was passed in 1997 that established hunting, fishing, wildlife observation and photography, and environmental education and interpretation as "priority public uses" when compatible with the System mission and purpose of an individual refuge. Refuge managers use sound professional judgment in determining compatible public uses, and the Refuge System Improvement Act established a formal process for determining what a compatible use on the refuge is.

Prime Hook National Wildlife Refuge provides opportunities for all six of these priority recreational uses. We believe we are offering quality programs that meet public demand and our wildlife population and habitat goals. In chapter 3 (affected environment), we describe in detail the facilities and programs we offer to support hunting and wildlife observation and photography. As always, we look to our partners, Friends Group, and volunteers to assist with our public use programs. We will provide these opportunities in ways that do not adversely impact wildlife resources.

Objective 5.1 Hunting

Provide a high quality hunting program that is administratively efficient and is used to maintain healthy habitats through the management of wildlife populations, where appropriate.

Rationale

Hunting on the Delmarva Peninsula is a traditional outdoor past time and is deeply rooted in our American and Delaware heritage. Opportunities for public hunting are decreasing with increasing private land development. Refuge lands thus become increasingly important in the region as a place to engage in this activity. Hunting has and will continue to be an integral component of the public use program at the refuge.

Section 605 (FW 2) of the Fish & Wildlife Service Manual states that hunting programs will be compatible, provide quality experiences, and to the extent practicable, be consistent with State fish and wildlife laws and regulations. After careful review and consideration, we have determined that the previous hunting program was inefficient, overly complex, and required a significant amount of staff resources. A recently conducted Regional Visitor Services Review found our hunt program to be "out of balance with other priority refuge needs and services," such as habitat management, maintenance, and public use programs such as environmental education. Another finding from the review identified that "the amount of station resources going into this activity (hunting) seem to far exceed what is necessary to provide for a quality hunting program." The Review also mentioned that the "care and maintenance of refuge blinds and tree stands….seems to put an undue burden on staffing resources."

The opinions by the visiting public and community landowners were surveyed in 2004 and 2005 by the United States Geological Survey (USGS) on behalf of the refuge (Sexton et al. 2007). About 35 percent of visitor respondents indicated that they hunted on the refuge and had been hunting there an average of 11 years. When asked about the importance of hunting activities, more than half of the responses were rated as moderately to very important and most hunters (85 percent) feel the refuge provides a quality hunting experience. Dove hunting and upland game hunting appear much less important than other

hunting activities according to hunters surveyed. Hunting ducks and hunting deer with a muzzleloader and shotgun were more important than other hunting activities.

In the USGS survey, hunters were also asked about the desirability of changing some hunting services or regulations, but did not appear to be very interested in making changes. The most desirable of the suggested changes was the provision of more areas where portable deer stands could be used as well as areas where individuals could set up their own waterfowl blinds. Some were only slightly interested in adding a preseason drawing for waterfowl hunting. Consumptive use visitors also asked to see increases in hunting and fishing areas and access.

To improve the refuge's program, we evaluated hunting on the refuge, incorporated the opinions of hunters, and developed this plan in collaboration with our State partners in the Delaware Division of Fish and Wildlife. These program changes, which reflect a diversity of hunting preferences and opportunities, strive to meet the guiding principles for a quality refuge hunting program identified in Service policy 605 FW 2. They also support Presidential Executive Order 13443: Facilitation of Hunting Heritage and Wildlife Conservation.

The hunting program has been adjusted, both expanded and reduced, to allow for more effective consumptive recreation opportunities along with an increase in opportunities for non-consumptive users to appreciate the refuge while avoiding conflicts with hunters. Hunting opportunities would be increased, where possible, to include additional days and acres throughout the hunting seasons established by the State Delaware Division of Fish and Wildlife. We propose to expand hunting on refuge lands to enhance quality opportunities for hunting deer, waterfowl, upland game, webless migratory birds (dove), and turkey. Deer hunting would increase from 3,876 to 5,389 acres, waterfowl hunting from 1,723 to 3,455 acres, upland game & migratory bird hunting remains at 1,957 acres, and turkey hunting from zero to 3,472 acres.

Other changes to the hunting program would lower administrative burdens to staff resources and improve hunting quality. More specifically, these changes include eliminating permanent hunting structures and allowing hunters to free roam in most areas on a first-come, first-serve basis following State regulations, adopting one-time seasonal permits for all hunting areas except lottery hunts, enhancing disabled hunting opportunities, establishing seasonal closures to minimize wildlife disturbance and/or avoid conflicts with other uses, establishing preseason lottery drawings for high demand deer, waterfowl, and turkey hunt areas, eliminating daily standby permit drawings, and eliminating permit fees except for lottery hunts.

All persons hunting on the refuge would be required to obtain the necessary state licenses, tags and stamps. Waterfowl hunters would be required to have a Federal Migratory Bird Hunting and Conservation Stamp ("Duck Stamp"). Each hunter would also be required to have a signed copy of the current PHNWR Hunting Regulations Leaflet, which would serve as the refuge hunting permit. In addition, hunters participating in the lottery hunts for deer, waterfowl, and turkey would also be required to have a daily permit issued in advance of the hunt date through a contractor. Hunters would not be required to check-in or check-out on the day of any hunt (except for non-ambulatory deer/waterfowl hunters in the Non-Ambulatory Hunt Areas).

For most areas, hunter numbers would not be limited to a specific hunt location. Hunters would have the ability to free roam for deer, waterfowl, and upland game in designated areas on a first-come, first-serve basis. Non-ambulatory hunters would be required to hunt from a designated hunt blind and waterfowl hunters in the Waterfowl Lottery Hunt Area (the Unit III impoundment and Prime Hook Creek) would be

required to hunt within a defined area around a designated blind site. For the Statewide youth hunts, all designated hunt areas would be open for waterfowl, deer, or turkey hunting on a first-come, first-serve basis. We don't know the number of hunters that will participate in refuge hunting opportunities; however, we do anticipate a slight increase from current levels.

Preseason lottery drawings are proposed for high demand areas, including the Lottery Deer Hunt Area (headquarters area), Lottery Non-Ambulatory Deer Hunt Area, Lottery Waterfowl Hunting Area (described previously in this section), and Lottery Turkey Area to reduce hunter conflicts, lessen administration, and provide equal opportunity for all hunters. For daily drawings on opening days under current management, it is common to see over 100 deer hunters show up for 34 available shotgun hunting opportunities and for 80 waterfowl hunting parties (with up to three people per party) show up for 27 available hunt blinds. This illustrates how inefficient and frustrating it is for a group of hunters to get up early in the morning when they have less than a chance of one in three of getting a hunting spot. As a national wildlife refuge, PHNWR will provide hunting opportunities through these preseason drawings for local, in-state, and out-of-state hunters. Knowing in advance of a hunting opportunity allows hunters to prepare, plan, and scout, which ultimately improves their quality hunting experience.

Preseason lottery drawings would be administered by a contracted company which will feature online and telephone services to collect hunter information, required fees (covered later in this section), and issue permits. These services would provide hunters with the ability to apply, pay for, and receive hunting permits in advance of the hunting dates. All fees must be paid prior to the issuance of a permit. Refuge staff would work with the contractor to provide the highest level of customer support.

For the preseason drawing for the Lottery Deer Hunt Area, hunters will be selected for a hunt date based on their date preferences. If selected, a limited number of hunters (25-30 hunters) would have access to the hunt area and may choose their hunting location on a first-come, first-serve basis on the day of the hunt. For the Lottery Waterfowl Hunt Area and Lottery Non-Ambulatory Deer Hunt Area, hunters would be selected for a hunt date and hunting blind site based on their date preferences during the preseason drawing. Hunters could be picked for multiple dates. For the lottery waterfowl hunts, the selected hunter may take two additional people on that hunt day. A total of 22 federal blind sites (plus 8 state blinds) will be available each day. Everyone in the lottery drawing has an equal chance of being selected multiple times. The Lottery Turkey Hunt will be administered by the Delaware Division of Fish and Wildlife.

For any vacant hunting opportunities not selected during the preseason lottery drawing, hunters would have the flexibility to go to the contractor's Web site at any time (24 hours a day) during the hunting season, view available hunt dates, and select and pay for these permits at any time. For those individuals who do not have computer access, customer representatives would be available by telephone during business hours on weekdays to assist. Hunters will be allowed to claim only one permit per day to avoid someone from claiming all available vacancies at one time. The licensing contractor would supply refuge staff of a list of permitted applicants. No daily standby lottery drawings would be conducted.

Permanent hunting structures (i.e. deer hunting stands and duck hunting blinds) would be phased out over a five year period in all areas except the disabled hunting areas. We will limit the number of permits in the lottery hunt areas to minimize hunter conflict in areas historically known to attract large hunter numbers. In the case of deer hunting, the phasing out of permanent deer stands would now require hunters to find a suitable hunting location within designated hunting areas through effective scouting. Use of portable deer climbing stands is recommended. In the case of waterfowl hunting, the phasing

out of permanent waterfowl hunting blinds in the lottery hunt area will now require hunters to provide their own means to camouflage themselves (boat blind, pop up blind, etc.). Waterfowl hunters would be required to hunt within a defined area around a designated blind site (marker) in the lottery waterfowl hunt area. For any type of hunting, we feel that allowing hunters to scout and have the flexibility to adjust their hunting locations for weather conditions enhances the quality of their hunt. Maintenance mowing will no longer occur to provide trails to facilitate deer hunting. Some conflict among hunters over desired hunting locations is expected and we will continue to encourage proper hunting ethics.

Season dates, bag limits, and harvest methods for the hunting program at the refuge will be consistent with State and Federal hunting frameworks and regulations. However, restrictions to these frameworks are listed below in the strategies and refuge-specific regulations to minimize user conflicts, address natural resource impacts, reduce the administrative complexity, and ensure a quality hunting experience. The refuge manager will evaluate and make necessary adaptations to the hunting program to ensure that the refuge is meeting resource management objectives and continuing to offer quality experiences. Therefore, the refuge manager may extend or close hunting opportunities on the refuge within the established hunting seasons of the Delaware Division of Fish and Wildlife. The hunt program would apply to lands now a part of the refuge and lands added to the refuge in the future.

Strategies

- Expand hunting opportunities for deer, waterfowl (including snow geese), upland game, webless migratory bird, and turkey hunting (For details, refer to Objectives 5.1a through 5.1d)
    - Supports Presidential Executive Order: Facilitation of Hunting Heritage and Wildlife Conservation
    - Adopt all State of Delaware hunting seasons and regulations, except as restricted in refuge-specific regulations
    - Provide additional hunting days and areas over the current program
    - Seasonal closures in effect for some areas to minimize wildlife disturbance and/or avoid conflicts with other public recreational programs
    - Provide high quality hunting opportunities for turkey

- Adopt a one-time issued seasonal permit except for lottery hunts
    - Permit must be signed and in possession of hunter
    - Permits are non-transferable

- Remove all permit fees except for lottery hunts
    - Adjust the fee schedule for Lottery Deer Hunt Area, Lottery Waterfowl Hunt Area, Lottery Non-Ambulatory Deer Hunt Area, and Lottery Turkey Hunt Area
        a. Increase the application fee for preseason lottery drawing ($5/hunter)
        b. Require a processing fee of $2-3 per hunt for vacancies remaining after the preseason lottery drawing
        c. Adjusted permit fees are as follows:
            i. Deer & Turkey - $10 per daily permit (per blind for non-ambulatory hunters)
            ii. Waterfowl - $15 per daily permit per blind site
            iii. The 50 percent discount on permit fees to Interagency Senior & Access passholders does not apply
            iv. Youth hunters age 15 years and younger must obtain a free seasonal permit. Only hunters aged 16 years and older can apply or obtain lottery hunt area permit.

The refuge collects boat ramp launching fees and hunting permit fees under the guidance of the Federal Lands Recreation Enhancement Act (REA), 16 U.S.C. 6803©, Consolidated Appropriations Act (PL 108-447). This law grants the Secretary authority to collect recreation fee revenues for public recreation. REA provides for a nationally consistent interagency program, additional on-the-ground improvements to visitor services sites across the nation, a new national pass for use across interagency federal recreational sites and services, and more public involvement in the program. REA replaces the Recreation Fee Demonstration Program and authorizes the Recreation Fee Program for 10 years through 2014. At least 80% of the funds raised from user fees on a particular refuge in this region stay at the refuge and are used to enhance visitor services and reduce the backlog of maintenance needs for recreation facilities. Recreation fees may not be used to pay for biological monitoring on Federal recreational lands and waters under the Endangered Species Act of 1973 for listed or candidate species or to pay for employee bonuses. The other 20 percent is sent to the region to be distributed to other refuges. In previous years, PHNWR has received money from these regional funds for visitor services (Refer to Appendix I).

Due to reduced staffing, this plan reduces the administrative burden and minimizes the amount of staffing resources needed to conduct the hunt by 54 staff days and $17,890. The benefit to the hunter is a reduction in their cost to hunt. Therefore, the refuge proposes to eliminate permit fees to hunt on the refuge (except for lottery hunts).

Fees will be required to manage the lottery hunts for deer, waterfowl, and turkey. The Refuge Recreation Act requires that funds are available for the development, operation, and maintenance of the permitted forms of recreation. The proposed permit fee ($10 for deer & turkey; $15 for waterfowl), preseason application fee ($5/hunter), and processing fee for permits acquired after the preseason drawing ($2-3 per hunt) are the minimal amounts needed to offset the cost of facilitating the preseason drawings and manage the lottery hunts. Due to the uncertainty in the level of hunter participation with these new program changes, permit fees may need to be adjusted (increased or decreased), and therefore will be evaluated during the first five years of the CCP plan. Preseason lottery drawings will be administered by a contracted company which will collect information and required fees, conduct the drawing, and issue the permits. This may reduce our costs by over $3,000 and application and processing fees will be paid to the contractors for administering this permitting process. Refuge staff will work with the contractor to provide the highest level of customer support. Signs for posting hunting areas, trails, etc., will have an initial, one-time cost.

- Provide lottery hunts in the Lottery Waterfowl Hunt Area, Lottery Deer Hunt Area, Lottery Non-Ambulatory Deer Hunt Area, and Lottery Turkey Hunt Area.
    - Permits are non-transferable.
    - Conduct a preseason drawing to issue permits and collect fees for all available hunting dates.
      Drawings will be administered by a contracted company which will collect information and required fees, conduct the drawing, and issue the permits. Hunting opportunities for these lottery hunts will be available to hunters through the preseason drawing and throughout the season by going to the contractor's Web site or calling a customer service representative. For vacant hunting opportunities after the preseason drawing, hunters will be allowed to claim only one permit per day to avoid someone from claiming all available vacancies at one time.
    - No daily standby drawings will be conducted; however, permits would be available from the contractor online or by telephone throughout the hunting season.

  - Permit and application fees apply.
  - Preseason drawings for turkey hunting will be conducted by the Delaware Division of Fish and Wildlife.
  - See discussion earlier in this section or Objectives 5.1a, 5.1b, or 5.1d for more info.

- Enhance disabled hunting opportunities, particularly for those permanently confined to wheelchairs (See Objectives 5.1a and 5.1b for more information).

- Seasonal closures apply to non-consumptive users during the hunting season, which is typically a slower period of use due to weather conditions, and are highlighted below:
  - Western Prime Hook Creek (from old shop ramp to Waples Pond) (Unit III): Closed every day during the deer and waterfowl hunting seasons, which typically starts on September 1 and ends in early February. Additional seasonal closures may apply through the second Saturday in May for hunting during the snow goose conservation order and/or turkey hunting.
  - Deep Branch Road Trail (includes Goose & Flaxhole Ponds) and Eastern Prime Hook Creek (from old shop ramp to HQ ramp) (Unit III): Closed every day from September 1 through March 15. Additional seasonal closures may apply through the second Saturday in May for hunting during the snow goose conservation order and/or turkey hunting.
  - Headquarters Area (includes Turkle & Fleetwood Ponds) (Unit III): Closed only for a maximum of two days for deer hunts.
  - The northern portion of Unit IV (includes trail overlooking Vergie's Pond): Closed from the Monday before Thanksgiving through March 15. Additional seasonal closures may apply through the second Saturday in May for hunting during the snow goose conservation order and/or turkey hunting.
  - Hiking trails on Fowler Beach Road (Unit I), Prime Hook Road (Unit III), and Slaughter Beach Road and Slaughter Canal (Unit I): Closed on Sundays from September 1 through the deer and waterfowl hunting seasons, which typically end in early February. Additional seasonal closures may apply through the second Saturday in May for hunting during the snow goose conservation order and/or turkey hunting.

- Evaluate newly acquired refuge lands for potential quality hunting opportunities if deemed compatible.

- Provide effective outreach and communication for and about the refuge's hunting program
  - Coordinate with state and other partners to develop and/or participate in host programs that encourage new user groups, e.g., Becoming an Outdoors Woman, youth hunts.
  - Monitor and evaluate the hunting program through staff observation and hunter contact.
  - Continue yearly review of refuge hunting regulations with staff and State partners to ensure clarity and to address any emerging issues or concerns.
  - Develop one brochure that contains all refuge hunting regulations to inform the public of hunting opportunities and refuge-specific regulations.
  - Ensure public notification of hunting program changes through news releases and other means well before the hunting season.

- Add a new law enforcement officer to enforce regulations and continue to collaborate with enforcement officers from the Delaware Division of Fish & Wildlife.

- Clearly sign all areas closed to hunting.

- Evaluate the future management of the Prime Hook Wildlife Area with the Delaware Division of Fish & Wildlife.

Refuge staff has issued hunting permits and collected fees for the eight waterfowl hunting blinds on the Prime Hook Wildlife Area, which is managed and owned by the Delaware Division of Fish and Wildlife, through the refuge's permitting system. State and Federal personnel maintain the facilities (duck blind construction & grassing) every year. No formal agreement such as a MOU exists. An evaluation of the cooperative management of the State area should occur and if necessary, a formal agreement should be developed. For more information about the partnership between the refuge and the Delaware Division of Fish and Wildlife as it relates to the Prime Hook Wildlife Area, refer to "Hunting Opportunities" in the "Refuge Visitor Services Program" section in chapter 3 of the refuge's CCP.

- Improve access at boat launching areas.
    - Enhance boat ramp access on Fowler Beach Road for access to Slaughter Canal.
    - Work with private landowners to improve access to western end of Prime Hook Creek.
    - Within 5 years of the plan, open a boat ramp at the old maintenance area for access to Prime Hook Creek.

- General Regulations for All Hunting Programs.
    - Hunters may not be on the refuge any earlier than two hours before shooting time.
    - Areas may be closed on the refuge without prior warning.
    - The maximum permitted motor on refuge waterways is 30 horsepower.
    - The refuge will follow all state youth hunting requirements.
    - No vegetation may be cut on the refuge for shooting lanes, camouflaging, etc.
    - The use of natural vegetation for camouflaging your blind is prohibited.
    - Practice or target shooting on the refuge is prohibited.
    - Overnight camping and open fires are prohibited.
    - Hunting blinds/stands/steps must be portable and removed at the end of each day.
    - No hunting is permitted in designated safety zones.
    - Non-toxic shot is required for all hunting except for lead slugs for deer/fox hunting.
    - Individuals assisting non-ambulatory deer hunters are not permitted to hunt; however, up to two individuals may hunt while assisting a non-ambulatory waterfowl hunter.
    - The refuge manager will monitor, evaluate, and make necessary adaptations to the hunting program to ensure that the refuge is meeting resource management objectives and continuing to offer quality experiences. The refuge manager has the authority to extend or close hunting opportunities on the refuge within the established hunting seasons of the Delaware Division of Fish and Wildlife, while ensuring compatibility.

Objective 5.1a White-Tailed Deer Hunting

Provide high quality hunting opportunities for white-tailed deer.

Rationale

In addition to the information presented under Objective 5.1, deer hunting would be increased to include an additional 1,513 acres beyond current management for a total of 5,389 acres. We would open these acres for archery (to include the use of crossbows), muzzleloader, or shotgun hunting, where appropriate,

and would phase out permanent deer stands. Seasonal closures would occur to not only protect wildlife, but also to minimize conflicts between different hunting activities and/or other non-consumptive recreational uses (e.g., minimize conflict with anglers on Prime Hook Creek, offset hunting days for deer and waterfowl hunting on Prime Hook Creek and for disabled hunters in the disabled hunt area; close hunting in late November in designated areas to minimize bald eagle and waterfowl disturbance). Disabled hunting areas in Unit III and IV would limit access to individuals who are permanently confined to a wheelchair for movement.

In addition to being a traditional outdoor pastime, deer hunting aids statewide efforts to control deer populations and complements habitat management on the refuge. We would continue to consult with the Delaware Division of Fish & Wildlife to maintain the deer population at a level commensurate with available habitat, to maintain the health of the herd, and prevent the habitat degradation that accompanies overpopulation. Map 4-16 depicts deer hunting opportunities and infrastructure.

Strategies

In addition to objective 5.1 strategies:

- Hunting will be on a first-come, first-serve basis except for lottery hunts.

- Check in and check out by hunters would not be required for any deer hunt except for use of the non-ambulatory blinds in the Non-Ambulatory Hunt Area.

- Expand deer hunting opportunities from 3,876 acres to 5,389 acres (See Map 4-16).
    - The refuge has adopted State hunting regulations and seasons for the Regular Deer Hunt Area with the following restrictions:
        a. No access by canoe from Slaughter Creek on Cods Road
            i. There is no infrastructure to support boat launching.
    - Seasonal closures to deer hunting from the Monday before Thanksgiving through March 15 will occur on the designated area north of Prime Hook Road (Oak Island), and south of Fowler Beach Road to minimize disturbance to waterfowl and/or nesting bald eagles.
    - In the designated area along Prime Hook Creek, hunting is permitted during designated State deer hunting seasons on Tuesday, Thursday, and Friday.
        a. Deer hunting will be closed on Fridays when it coincides with the opening days of a duck season.

- Phase out permanent deer hunting stands over a five year period or when they become unsafe; whichever comes first.
    - Hunters may free roam in hunting areas except in the Lottery Non-Ambulatory Deer Hunt Area.
    - Portable stands are permitted.
    - Eliminate maintenance mowing except for non-ambulatory hunts.

- Hunters will not be required to report their harvest data to the refuge. Refuge staff will collect harvest information from the existing reporting system administered by the State Delaware Division of Fish & Wildlife.

- Enhance hunting opportunities for individuals with disabilities, particularly for those permanently confined to wheelchairs.
    - Reestablish areas for disabled hunters permanently confined to wheelchairs in designated areas in Unit III and Unit IV.
    - Provide a limited number of hunting days in designated areas to minimize deer disturbance and maximize quality hunting experience.
        a. In the Non-Ambulatory Hunt Area, permit deer hunting on Tuesday, Thursday, and Friday following State regulations. A total of three ground blinds are available and required. Deer hunting will be closed on Fridays when it coincides with the opening days of a duck season.
        b. In the Lottery Non-Ambulatory Deer Hunt Area, permit deer hunting for limited days during early muzzleloader, the statewide non-ambulatory hunt in November, and the early shotgun hunting seasons. A total of 11 ground blinds are available and required.
    - The refuge will also evaluate the regular deer hunting area for the potential to incorporate hunting opportunities for non-ambulatory hunters.

- Provide lottery hunts in the Lottery Deer Hunt Area and the Lottery Non-Ambulatory Deer Hunt Area for a limited number of days during the firearms deer hunting seasons
    - Conduct a preseason lottery drawing. No daily standby drawings will be conducted.
        a. Drawings will be administered by a contracted company which will collect information and required fees, conduct the drawing, and issue the permits. Hunting opportunities for these lottery hunts will be available to hunters through the preseason drawing and throughout the season by going to the contractor's Web site or calling a customer service representative. For vacant hunting opportunities after the preseason drawing, hunters will be allowed to claim only one permit per day to avoid someone from claiming all available vacancies at one time.
    - A limited number of permits will be issued for each hunt day to reduce conflict and maintain quality hunting experiences.
    - Hunters may hunt anywhere within the Lottery Deer Hunt Area on a first-come, first-serve basis. Hunters in the Lottery Non-Ambulatory Deer Hunt Area must hunt from one of 11 ground blinds in the area.
        a. The areas will be gated to minimize conflict with the general public and times will be designated for ingress and egress to the area

- The refuge will continue to participate in all State hunting seasons and bag limits except the October Antlerless Deer Season and January Handgun Season. State hunting seasons and harvest limits for deer are based on guidelines found in the Delaware Deer Management Plan 2010-2019 (Rogerson 2010), written by the Delaware Division of Fish and Wildlife.
    - The refuge will consider participating in the October Antlerless Season if the refuge can provide a quality hunting experience, if an overabundance of deer arises as determined by the Delaware Division of Fish and Wildlife and concurrence by the refuge, and conflicts are minimized with other user groups.

- The refuge will participate in the statewide youth deer hunt.

- General Regulations for Deer Hunting.
    - Enhanced opportunities for scouting will be allowed two weeks before the start of archery season and throughout the deer hunting season.
    - Hunters must be out of the hunting areas one and one-half hours after the evening shooting time.

Objective 5.1b Waterfowl Hunting

Provide high quality hunting opportunities for waterfowl.

Rationale

In addition to the information presented under Objective 5.1, waterfowl hunting would be increased to include an additional 1,732 acres from current management for a total of 3,455 acres. Seasonal closures would occur to not only protect wildlife, but also to minimize conflicts between different hunting activities and/or other non-consumptive recreational uses (e.g., offset hunting days for deer and waterfowl hunting on Prime Hook Creek and for disabled hunters in the disabled hunt area; close hunting in late November in designated areas to minimize bald eagle and waterfowl disturbance). We would phase out permanent waterfowl hunting blinds. In the lottery hunt area, hunting is open for three days per week to minimize wildlife disturbance. In all hunt areas, hunting will cease at noon to also minimize disturbance. In the regular hunt area, hunting will be open every day. A new blind would be added to Unit III near Prime Hook Beach for individuals who are permanently confined to a wheelchair for movement and would replace the blind in Unit IV.

The creation of sanctuaries in Unit III will result in the elimination of 6 hunting blinds from the 19 available federal blinds; however 9 new blinds sites will be added. These 9 new blinds sites, which include a wheelchair accessible blind, brings the total number of federal blind sites to 22 and does not include the 8 blinds on the state owned Prime Hook Wildlife Area. The addition of new free-roam waterfowl hunting areas in salt marsh habitats in Unit I and IV will provide quality opportunities, particularly when refuge impoundments freeze.

Like deer hunting, waterfowl hunting is an established, traditional use on the Delmarva Peninsula. CCP Map 4-17 depicts waterfowl hunting opportunities and infrastructure.

Strategies

In addition to objective 5.1 strategies:

- Create waterfowl sanctuaries (no hunting) in Unit II (1,800 acres), Unit III (970 acres), and Unit IV (230 acres)
    - Southside of Unit III impoundment will be closed September 1 through March 15 to all public use
    - The Unit II impoundment will be closed annually to all public use
    - The northern portion of Unit IV will be closed from the Monday before Thanksgiving through March 15 to all public use.
    - Additional seasonal closures may apply through the second Saturday in May for hunting during the snow goose conservation order and/or for wild turkey.

To support waterfowl conservation efforts, the refuge has designated 3,000 acres as waterfowl sanctuaries that will be closed to hunting and other recreational use on a seasonal or annual basis. These sanctuaries lie in the managed impoundments of Unit II (1,800 acres), the southern half of Unit III (970 acres), and the northern portion of Unit IV (230 acres). Managed impoundments provide a higher diversity and abundance of vegetation types that are consumed by waterfowl, which better meet their biological needs. Waterfowl concentrate in these impounded areas rather than being dispersed throughout the refuge. These sanctuaries function to

1) Provide migrating waterfowl a more balanced and effective network of feeding and resting areas:
    - Align closed areas over existing preferred food sources.
    - Continue to promote growth of aquatic vegetation using water level drawdowns.
2) Minimize disturbance to feeding and resting waterfowl.
3) Provide waterfowl hunters with more equitable hunting opportunities throughout the refuge:
    - Establish hunter spacing limits.
4) Reduce hunter competition and improve hunting quality
    - Managed hunts in the Lottery Waterfowl Hunt Area will provide opportunities for a limited number of hunters and allow them to choose their hunting location
    - Expanded hunting areas interspersed among sanctuaries will provide greater opportunity for hunters

- Hunting will be on a first-come, first-serve basis except for lottery hunts.

- Check in and check out by hunters would not be required for any waterfowl hunt except for use of the non-ambulatory blind in the Non-Ambulatory Hunt Area.

- Expand hunting opportunities from 1,723 acres to 3,455 acres or 40% of the refuge to include 11 new blind sites in Unit III and new hunting opportunities in Unit I and IV. We must follow the guidelines of the 40% rule: All areas approved for purchase by the Migratory Bird Conservation Commission prior to 1978 are inviolate sanctuaries and thus subject to the 40% limitation, meaning only 40% of the area or areas can be open to migratory bird hunting. In 1978, the Fish and Wildlife Improvement Act amended Section 6 of the Refuge Administration Act of 1966 to provide the opening of all or any portion of an inviolate sanctuary to the taking of migratory birds if the taking is determined to be beneficial to the species. In addition, the Act amended Section 5 of the Migratory Bird Conservation Act to include the provision that areas could be acquired for other management purposes.
    - The refuge has adopted State hunting regulations and seasons for the Regular Waterfowl Hunt Area with the following restrictions:
        a. Hunters are permitted to hunt until noon on a first-come, first-serve basis that includes jump shooting. Boat access is permitted in designated areas.
        b. Four to five blind sites will be established in areas along the Broadkill River and one to two blind sites along Petersfield ditch.
            i. Access is from Oyster Rocks Boat Ramp
            ii. Jump shooting is permitted in designated zone behind blind stakes
        c. The refuge will participate in all State waterfowl hunting seasons.

- Phase out permanent waterfowl hunting blinds over a five year period or when they become unsafe; whichever comes first.
    - Hunters may free roam in the regular waterfowl hunting areas (except the Lottery Waterfowl Hunt Area).

- Hunters would be required to hunt from hunting blind site areas in the Lottery Waterfowl Hunt Area.
- Blind site areas are subject to change due to changing habitat conditions, to improve the quality of hunting, or for safety considerations.

- Hunters will not be required to report their harvest data to the refuge. Harvest information will be collected through the Harvest Information Program (HIP) system.

- Enhance hunting opportunities for individuals with disabilities, particularly for those permanently confined to wheelchairs.
  - Reestablish areas for disabled hunter permanently confined to wheelchairs in designated areas in Unit III.
  - Provide a limited number of hunting days in the Non-Ambulatory Hunt Area to minimize deer disturbance and maximize quality hunting experience
    a. Permit hunting on Monday, Wednesday, and Saturday until noon following State regulations. Hunting will be open on Friday when it coincides with the opening day of duck season.
    b. One disabled, camouflaged waterfowl hunting blind is available.

- Provide lottery hunts in the Lottery Waterfowl Hunt Area.
  - Conduct a preseason lottery drawing. No daily standby drawings will be conducted.
    a. These drawings will be administered by a contracted company which will collect information and required fees, conduct the drawing, and issue the permits. Hunting opportunities for these lottery hunts will be available to hunters through the preseason drawing and throughout the season by going to the contractor's Web site or calling a customer service representative. For vacant hunting opportunities after the preseason drawing, hunters will be allowed to claim only one permit per day to avoid someone from claiming all available vacancies at one time.
    b. Hunters must choose their hunt dates and blind site locations from among the designated blind locations.
  - The refuge must establish a cooperative management program to include state hunting blinds.
  - Hunting is permitted on Monday, Wednesday, and Saturday until noon during the State's waterfowl hunting seasons, which is a decrease from 4 days (M, W, F, S) until 3:00pm under current management. Hunting will be open on Fridays when it coincides with the opening day of duck season.
  - Within 5 years of CCP signing, we will open boat ramp access at the old shop area for all public recreational access.

- The refuge will participate in all State of Delaware waterfowl hunting seasons unless otherwise restricted. This includes the duck seasons, early teal season, youth waterfowl hunt, resident Canada goose season, and snow goose season (early & snow goose conservation order).
  - Provide hunting opportunities during the resident Canada goose season and the early teal season in all areas designated as open to waterfowl hunting. In the Lottery Waterfowl Hunt Area, all regulations apply as stated in earlier strategies of this objective except hunting will be on a first-come, first-serve basis and no preseason drawing will occur. In the Regular Waterfowl Area, all regulations apply as stated in earlier strategies of this objective.

- Provide hunting opportunities during the State of Delaware's Snow Goose Conservation Order season in all four management units throughout the refuge on a first-come, first-serve basis.
    a. Light Geese Conservation Order – The light goose conservation order is an action implemented under the Final Environmental Impact Statement on the Management of Light Geese (USFWS 2007) to help reduce overabundant greater snow goose populations. Although the refuge has been closed recently to late snow goose hunting, the conservation order presents an opportunity to reopen to snow goose hunting during the late season in coordination with the State Delaware Division of Fish and Wildlife. This will be pursued as an option whenever the conservation order is in effect. All special harvest methods permitted by the conservation order apply.
- The refuge will participate in the statewide youth waterfowl hunt in all designated hunting areas on a first-come, first-serve basis.
- Snow geese may only be taken in the Lottery Hunt Area when already open for duck hunting or during the snow goose conservation order.

- General Information for Waterfowl Hunting
    - Enhanced opportunities for scouting will be allowed on Sundays immediately prior to each of the duck season splits.
    - Hunters must be out of the hunting areas by 1:00pm.

Objective 5.1c Upland Game & Webless Migratory Bird Hunting

Provide high quality hunting opportunities for upland game (rabbit, quail, pheasant, and red fox) and webless migratory birds (mourning dove, snipe, & woodcock).

Rationale

In addition to the information presented under Objective 5.1, upland game and webless migratory bird hunting will remain the same at 1,957 acres. However, the dove hunting acres will be decrease by 105 acres. The hunting of red fox will assist State management efforts in reducing the incidence of mange outbreaks to maintain a healthy population and reduce the predatory impact of this species on migrating and breeding birds, particularly State and federally endangered or threatened species. Map 4-18 depicts upland game and webless migratory bird hunting opportunities and infrastructure.

Strategies

In addition to objective 5.1 strategies:

- Hunting will be on a first-come, first-serve basis.

- Check in and check out by hunters would not be required for any upland game and webless migratory bird hunt.

- Continue upland game and webless migratory bird hunting opportunities on 1,957 acres (105 of the total acres would not be open to dove hunting). See Objective 5.1b for explanation of 40% migratory bird hunting rule.

- The refuge has adopted State hunting regulations and seasons for the Upland Game Hunting Area with the following restrictions:
    - a Provide new hunting opportunities for red fox
    - b The hunting of squirrel is prohibited due to the presence of the endangered Delmarva Peninsula fox squirrel on the refuge
    - c Dove hunting is open in the Upland Game Hunting Area except the designated area north of Prime Hook Road.
    - d Hunters will not be required to report their harvest data to the refuge.

Objective 5.1d Wild Turkey Hunting

Provide high quality hunting opportunities for turkey

Rationale

We would provide new opportunities for hunting wild turkey on 3,472 acres. We recognize turkey hunting as a traditional outdoor pastime. When managed responsibly, it can instill a unique appreciation of wildlife, their behavior, and their habitat needs. Turkey hunting was initiated on the refuge in 1993. After two seasons of hunting and only one harvested turkey, this opportunity was discontinued. In recent years, hunter and staff observations indicate that a huntable population of turkeys may exist on the refuge, particularly in the Headquarters Area and in areas near Deep Branch Road. Limited opportunities exist on public lands to hunt turkey and the refuge may contribute to providing additional opportunities. Seasonal closures and time and space zoning among user groups may change on an annual basis to adapt to changing State of Delaware hunting seasons, federal or state regulations, user conflicts, and/or impacts to natural resources. Map 4-19 depicts turkey hunting opportunities and infrastructure.

Strategies

In addition to objective 5.1 strategies:

- Collaborate with the Delaware Division of Fish & Wildlife to evaluate the status of the wild turkey population on the refuge. Hunting will be permitted if State and refuge personnel determine that the turkey population in the area is sufficient to support hunting on the refuge.
    - Consult with the Delaware Division of Fish and Wildlife on an annual basis to determine the status of the turkey population and whether to allow turkey hunting on the refuge.

- Hunting of turkey will be permitted in the designated Lottery Turkey Hunt Area in accordance with State hunting regulations and seasons.
    - Provide lottery hunts in the Lottery Turkey Hunt Area, which will be administered by the Delaware Division of Fish and Wildlife.
    - Conduct a preseason lottery drawing. No daily standby drawings will be conducted.
    - During hunts, all public access will be closed in designated hunt areas until noon.
    - Non-toxic shot is required.
    - Enhanced opportunities for scouting will be allowed during designated dates and times.

Justification for Requiring Permits

When hunting on Prime Hook National Wildlife Refuge, hunters will be required to have in their possession a copy of the current Prime Hook National Wildlife Refuge Hunting Regulations brochure which they have signed, and if applicable, a lottery hunt permit. The leaflet will serve as a refuge hunting

permit and will be updated each year. It will inform hunters of current refuge regulations, safety zones, and other pertinent information for the current year's hunt. It will be available in the information boxes at the refuge entrance, from the refuge office, or on the refuge's Web site.

Except for the lottery hunts, permits will be free and not limited in number. For the lottery deer, turkey, and waterfowl hunts, permit, application, and processing fees will be charged and the number of permits will be limited to reduce potential hunter conflict, ensure a high-quality hunt, and/or achieve a management objective.

Staffing and Funds

Administrative changes reflected in the hunt plan were developed to ease the administrative burden on staff resources. These changes reflect a decrease in estimated staff time to conduct the hunt by 54 staff days or approximately $17,890 (see cost analysis below). The majority of the cost savings is a result of phasing out the use of permanent hunting structures and eliminating the need to have staff conduct daily lottery drawings for permits. The benefit of these changes to the hunter is a reduction in their cost to hunt. Therefore, the refuge proposes to eliminate permit fees to hunt on the refuge (except for lottery hunts). Immediately after the approval of the CCP, and in accordance with Service policies and regulations, the proposed fee structure will be implemented.

Fees will be required to manage the lottery hunts for deer, waterfowl, and turkey. The Refuge Recreation Act requires that funds are available for the development, operation, and maintenance of the permitted forms of recreation. The permit fee ($10 for deer & turkey; $15 for waterfowl), preseason application fee ($5/hunter), and processing fee for permits acquired after the preseason drawing ($2-3 per hunt) are the minimal amounts needed to offset the cost of facilitating the preseason drawings and manage the lottery hunts. Due to the uncertainty in the level of hunter participation with these new program changes, permit fees may need to be adjusted (increased or decreased) and therefore will be evaluated annually. Preseason lottery drawings will be administered by a contracted company which will collect information and required fees, conduct the drawing, and issue the permits. This may reduce our costs by over $3,000 and application and processing fees will be paid to the contractors for administering this permitting process. Refuge staff will work with the contractor to provide the highest level of customer support. Signs for posting hunting areas, trails, etc. will have an initial, one-time cost. Maintenance of facilities used by hunters (roads, parking lots, trails, and boat launching ramps) will be addressed with the refuge's deferred maintenance budget.

Refuge staff will prepare and edit the refuge hunting regulations leaflet annually, make changes to the hunt plan and regulations as needed, prepare annual output reports, and respond to public inquiries about the hunt program.

Law enforcement staffing is essential. Currently, the refuge has no authorized law enforcement staff, but is scheduled to receive a full time officer. The law enforcement position currently at Bombay Hook NWR covers Prime Hook. Additional Service law enforcement staff may have to be brought in from other field stations or rely more on personnel from the Delaware Division of Fish and Wildlife Law Enforcement, who are already working with an undersized staff.

Below is a cost analysis and breakdown of the funding required to administer and manage each hunting program.

Big Game Hunting - Deer

Item	Staff Days	Cost
Planning	3	$1,000
Processing applications	1	$400
Printing costs-handouts	0.5	$800
Law Enforcement	7.5	$1,350
Inquiries	5	$1,190
Facilities maintenance supplies	1	$600
Hunt operations	-	$0
Fuel, electricity	-	$60
Toilet rental	-	$0
Total	**18**	**$5,400.00**

Cost Breakdown for Deer Hunting Program:
Staff Time ($4,235) & Actual Expenditures ($1,165) = $5,400

Volunteer Contributions for Deer Hunting Program ($20.25 per hour):
(mowing of non-ambulatory hunt areas, HQ hunt operations): 32 hrs = $648

Upland Game Hunting

Item	Staff Days	Cost
Planning	0.5	$150
Law Enforcement	0.75	$200
Inquiries	1	$250
Hunt operations	-	$0
Fuel, electricity	-	$60
Printing Costs	0.25	$220
Total	**2.50**	**$880.00**

Cost Breakdown for Upland Game Hunting Program:
Staff Time ($600) & Actual Expenditures ($280) = $880

Waterfowl Hunting

Item	Staff Days	Cost
Planning	3	$1,000
Processing Applications	1	$400
Printing costs-handouts	1	$1,250
Law Enforcement	3.5	$650
Inquiries	5	$1,200
Hunt operations	-	$0
Facilities maintenance (incl. supplies)	1	$800
Fuel, electricity	-	$60
Toilet Rental	-	$0
Total	**14.5**	**$5,360.00**

Cost Breakdown for Waterfowl Hunting Program:
Staff Time ($3,385) & Actual Expenditures ($1,975) = $5,360

Volunteer Contributions for Waterfowl Hunting Program ($20.25 per hour):
(blind stake placement and maintenance): 16 hrs = $324

Hunting - Other Migratory Game Birds

Item	Staff Days	Cost
Planning	0.5	$150.00
Law Enforcement	0.75	$200.00
Inquiries	1	$250.00
Printing Costs	-	$0
Total	**2.25**	**$600.00**

Cost Breakdown for Other Migratory Game Bird Hunting Program:
Staff Time ($600) & Actual Expenditures ($0) = $600

Turkey Hunting

Item	Staff Days	Cost
Planning	0.50	$150.00
Processing applications	0.5	$150.00
Printing costs-handouts	0.50	$150.00
Law Enforcement	0.5	$125.00
Inquiries	1	$250.00
Facilities maintenance supplies	-	$0
Hunt operations	-	$0
Total	**3**	**$825.00**

Cost Breakdown for Turkey Hunting Program:
Staff Time ($675) & Actual Expenditures ($150) = $825

Hunter Visit Estimates

	Deer	Non-Ambulatory Deer	Waterfowl	Turkey	Upland Game
# Preseason Applicants	200*	10	250	50	n/a
Total # Visits	1,000	50	2,000	4	200

* Preseason drawing only applies to Lottery Deer Hunt Area (HQ)

HUNTING PROGRAM COST SUMMARY

Program	Staff Days	Cost	Recovery*
Big Game - Deer	18	$5,400	$1,790
Big Game - Turkey	3	$825	$300
Upland Game**	2.5	$880	$0
Waterfowl	14.5	$5,360	$5,570
Other Migratory Birds**	2.25	$600	$0
Total	**40.25**	**$13,065**	**$7,660***

***$** Returned to Refuge (80 percent)
Of $7,660, $2,870 is for contractor for application fees; 80 percent of remainder ($4,790) is $3,832 (Refuge's share)
** Total revenue for upland game and other migratory birds combined.

Cost Breakdown for All Hunting Programs Combined:
Staff Time ($9,495) & Actual Expenditures ($3,570) = $13,065

Volunteer Contributions for All Hunting Programs Combined ($20.25 per hour):
48 hrs = $972

Recovery is the revenue generated by permit and application fees from hunters participating in refuge hunting activities. Regulations for the fee program allow the refuge to retain 80 percent of the total fees collected. Of the total recovery, the contractor administering the preseason lottery drawing will collect $2,870 in application fees. Of the remaining balance of $4,790, 80 percent or $3,832, is the refuge's share.

Description of Facilities and Infrastructure

Minimal infrastructure, which includes the addition of two to three parking areas, enhancement of existing boat ramps, and placement of informational signs, is anticipated in support of hunting on the refuge. There would be some costs associated with a hunting program in the form of road maintenance, law enforcement, and boat ramp maintenance. These costs should be minimal relative to total refuge operations and maintenance costs and would not diminish resources dedicated to other refuge management programs. Approximately one dozen ground blinds for non-ambulatory hunters and waterfowl blind stakes for the lottery hunt area will need to be maintained.

CONDUCT OF THE HUNT

Federal Regulations

Hunting on the refuge would be contingent on general federal regulations for all refuges and specific regulations for the refuge. These are in addition to state regulations and would take precedence where they are more restrictive than the state regulations. General stipulations for refuge hunting as contained in the Code of Federal Regulations (50 CFR Part 32) state that hunters must have a valid state license, valid Migratory Bird Hunting and Conservation Stamp ("Duck Stamp") while hunting migratory waterfowl, comply with all current federal hunting regulations including the migratory bird regulations (50 CFR Part 20), and comply with all state hunting and safety regulations. Additionally, hunters must comply with the terms and conditions established by the refuge for access to the refuge itself and for its hunting program. Some, not all, of the more pertinent federal regulations for hunting on refuge lands are as follows:

1) The use or possession of lead shot while hunting migratory birds or small upland game (including turkey) is prohibited.

2) The use of all terrain vehicles (ATVs) or other vehicles on refuge lands is prohibited.

3) The use of nails, wire, screws, or bolts to attach a stand to a tree, or hunting from a tree into which a metal object has been driven to support a hunter is prohibited.

4) The unauthorized distribution of bait and the hunting over bait is prohibited.

5) The use or possession of alcoholic beverages while hunting is prohibited.

State Regulations

All state regulations will apply to hunting on the refuge, and all state licenses, tags and stamps will be required.

Refuge-Specific Hunting Regulations

In addition to the foregoing state and federal regulations, the refuge-specific hunting regulations listed below will govern the hunting program on the refuge. These will be enforced by both Service law enforcement agents and designated Delaware Division of Fish and Wildlife conservations officers.

General Regulations for All Hunting Programs

1. All hunters must have in their possession a signed and current refuge hunting permit. Except for lottery hunt areas, permits are available beginning in July through the hunting season. Permits are available at the refuge check station, refuge office, refuge Web site, or upon request from the refuge manager. For lottery hunts, a preseason lottery drawing will be conducted to issue permits and collect fees.
2. No permit fees are required except for lottery hunts for deer, turkey, and waterfowl. For these hunts, a $5.00 application fee for the preseason lottery drawing is required. In addition, a daily permit fee of $10.00 for turkey and deer hunting, and a $15.00 fee for waterfowl hunting are required. Everyone in the lottery drawing has an equal chance of being selected multiple times.
3. Vacancies remaining after the preseason lottery drawing is complete will be available throughout the hunting season. For these vacancies, the daily permit fees plus a processing fee of $2-3 per hunt apply. Hunters will be allowed to claim only one permit per day to avoid someone from claiming all available vacancies at one time. The 50 percent discount on permit fees to Interagency Senior and Access passholders does not apply.
4. Non-ambulatory hunters (those hunters permanently confined to a wheelchair) must obtain an Interagency Access Passport, which provides a record of certified disability, to be eligible to receive a hunting permit for the designated non-ambulatory hunting areas.
5. Youth hunters aged 15 years and younger must obtain a free seasonal permit. Only hunters aged 16 years and older can apply or obtain a lottery hunt area permit.
6. The refuge will not provide permanent hunting structures except for non-ambulatory hunting activities. Hunting blinds/stands/steps must be portable and removed at the end of each day.
7. Hunters may not be on the refuge any earlier than two hours before the morning shooting time.
8. Areas may be closed on the refuge without prior warning.
9. The maximum permitted motor on refuge waterways is 30 horsepower.
10. No vegetation may be cut on the refuge (e.g., for shooting lanes, camouflaging, etc.).
11. The use of natural vegetation for camouflaging your blind is prohibited.
12. Practice or target shooting on the refuge is prohibited.
13. Overnight camping and open fires are prohibited.
14. No hunting is permitted in designated safety zones.
15. When requested by federal and State enforcement officers, hunters must display all game, hunting equipment, and ammunition for inspection.
16. Permits are non-transferable.
17. Individuals assisting non-ambulatory deer hunters are not permitted to hunt; however, up to two individuals may hunt while assisting a non-ambulatory waterfowl hunter.
18. Submission of harvest information to refuge staff is not required.

19. For the Statewide youth hunts, all designated hunt areas will be open for waterfowl and deer hunting on a first-come, first-serve basis.
20. All boaters would be required to operate their craft and possess all safety equipment in accordance with Delaware State and U.S. Coast Guard regulations.
21. Non-toxic shot is required for all hunting except for lead slugs for deer/fox hunting.
22. The refuge manager will monitor, evaluate, and make necessary adaptations to the hunting program to ensure that the refuge is meeting resource management objectives and continuing to offer quality experiences. The refuge manager has the authority to extend or close hunting opportunities on the refuge within the established hunting seasons of the Delaware Division of Fish and Wildlife, while ensuring compatibility.

Regulations for Deer Hunting

1. Free-roam hunting is available on a first-come, first-serve basis everyday during the State hunting seasons in the Regular Deer Hunting Area with the following restrictions:
    a. No access by canoe from Slaughter Creek on Cods Road
    b. The designated area north of Prime Hook Road, Oak Island, and south of Fowler Beach Road will be seasonally closed to deer hunting from the Monday before Thanksgiving through March 15.
    c. In the designated area along Prime Hook Creek, hunting is permitted during designated State deer hunting seasons on Tuesday, Thursday, and Friday.
        i. Deer hunting will be closed on Fridays when it coincides with the opening days of a duck season.
2. For the lottery hunts in the Lottery Deer Hunt Areas, a limited number of permits will be issued through a preseason drawing and hunters may choose their own hunting location anywhere within the hunt area on a first-come, first-serve basis. Vacancies will be filled throughout the season. A contractor will administer the issuance of permits and collection of fees for the preseason drawing and vacant hunting opportunities. Firearms hunting will be during the November and January shotgun seasons. For the lottery hunts in the Lottery Non-Ambulatory Deer Hunt Area, hunters must choose from among several ground blinds during designated dates in October and November.
3. The refuge will participate in all State hunting seasons and bag limits except the October Antlerless deer season and the late handgun season. The refuge will consider participating in the October Antlerless Season only if an overabundance of deer arises, as determined by the Delaware Division of Fish & Wildlife and concurrence by the refuge, and conflicts are minimized with other user groups.
4. No check-in or check-out is required except for the Non-Ambulatory Hunt Area.
5. Hunters must be out of the hunting areas one and one-half hours after the evening shooting time.
6. Wheelchair accessible blinds in the Non-Ambulatory Hunt Area are available for non-ambulatory hunters who possess an Interagency Access Passport on Tuesday, Thursday, and Friday on a first-come, first-serve basis. Hunters must flip over a tag at the parking area to indicate blind use. Deer hunting will be closed on Fridays when it coincides with the opening days of a duck season.
7. Enhanced opportunities for scouting will be allowed two weeks before the start of archery season and throughout the deer hunting season.

Regulations for Waterfowl Hunting

1. Free-roam hunting is available in the Regular Waterfowl Hunting Area on a first-come, first-serve basis everyday during the hunting season until noon. No check-in or check-out is required except for the Non-Ambulatory Area. Zoned areas along the Broadkill River and Petersfield Ditch are also open to hunting.
2. For the lottery hunts (except early teal and resident Canada goose season) in the Lottery Waterfowl Hunt Area, a limited number of hunting parties for each day will be selected from a preseason drawing and required to hunt within a defined area around designated blind stakes. Hunting is permitted on Monday, Wednesday, and Saturday until noon during the hunting season. Hunting will be open on Fridays when it coincides with the opening days of duck season. Vacancies will be filled throughout the season. A contractor will administer the issuance of permits and collection of fees for both the preseason drawing and vacant hunting opportunities.
3. The refuge will participate in all State hunting seasons unless otherwise restricted. This includes the duck seasons, early teal season, youth waterfowl hunt, resident Canada goose season, and snow goose season (early & snow goose conservation order).
    a. Hunting during the early teal, resident Canada goose, and snow goose conservation order will be first-come, first-serve in all designated areas, including the Lottery Hunt Area.
4. Snow geese may only be taken in the Lottery Hunt Area when already open for duck hunting or during the snow goose conservation order.
5. A maximum of three people are permitted for each blind stake in the lottery hunt areas.
6. Hunters must be out of the hunting areas by 1:00pm.
7. No check-in or check-out is required except for the Non-Ambulatory Hunt Area.
8. Only enrollees who complete the Young Waterfowler Training Program may participate in the mentored hunt in the Lottery Waterfowl Hunt Area. Only young waterfowlers may possess or discharge a weapon.
9. A wheelchair accessible blind in the Non-Ambulatory Hunt Area is available for disabled hunters who possess an Interagency Access Passport on Monday, Wednesday, and Saturday until noon on a first-come, first-serve basis. Hunters must flip over a tag at the parking area to indicate blind use. Hunting will be open on Fridays when it coincides with the opening days of duck season.
10. Hunting dogs are permitted.
11. Enhanced opportunities for scouting will be allowed on Sundays immediately prior to each of the duck season splits.

To minimize waterfowl disturbance, the refuge has designated approximately 3,000 acres as waterfowl sanctuaries that will be closed to hunting and other recreational use on a seasonal or annual basis. Given the dominant role of the refuge in the Atlantic Flyway migration corridor, this closed area system was established to provide waterfowl with a network of resting and feeding areas and to disperse waterfowl hunting opportunities on the refuge. These sanctuaries lie in the Unit II (~1,800 acres) and the southern half of the Unit III (~970 acres) managed impoundments. The northern portion of Unit IV (~230 acres), which contains a proposed trail and observation platform, will be closed from the Monday before Thanksgiving to March 15 to also minimize disturbance to wildlife in this area. These managed impoundments provide a higher diversity and abundance of vegetation types that are consumed by waterfowl, which better meet their biological needs. Waterfowl concentrate in these impounded areas rather than being dispersed throughout the refuge.

Regulations for Upland Game & Webless Migratory Bird Hunting

1. The refuge has adopted State hunting regulations and seasons for the Upland Game Hunting Area with the following restrictions:
    a. The hunting of squirrel is prohibited due to the presence of the endangered Delmarva fox squirrel on the refuge.
    b. Hunters must be out of the hunting areas one half hour after legal shooting hours.
    c. Dove hunting is open in the Upland Game Hunting Area except the designated area north of Prime Hook Road.
2. No check-in or check-out is required.
3. Hunting dogs are permitted.
4. Scouting is allowed during designated dates and times.

Regulations for Turkey Hunting

1. Hunting of turkey will be permitted in the designated Lottery Turkey Hunt Area in accordance with State hunting regulations and seasons. A limited number of hunters will be selected through a preseason lottery drawing and required to hunt in designated areas.
2. The refuge will collaborate with the Delaware Division of Fish & Wildlife to evaluate the status of the wild turkey population on the refuge and determine if it is sufficient to support hunting on the refuge.
3. Scouting is allowed during designated dates and times.

Anticipated Public Reaction

The Service conducted public scoping meetings as part of the refuge's CCP. The public voiced support for hunting on the refuge, since hunting is a traditional activity in Sussex County. Service staff has assured the public that hunting would be considered on the refuge where and when it was compatible with refuge objectives.

To improve the refuge's program, we evaluated hunting on the refuge, incorporated the opinions of hunters, and developed this plan in collaboration with our State partners in the Delaware Division of Fish and Wildlife. These program changes, which reflect a diversity of hunting preferences and opportunities, strive to meet the guiding principles for a quality refuge hunting program identified in Service policy 605 FW 2. They also support Presidential Executive Order: Facilitation of Hunting Heritage and Wildlife Conservation. Additional opportunities included increased days, expanded and new hunt areas, and flexibility of the hunter to adapt to changing hunting conditions. Changes that will most likely draw criticism initially from refuge veteran hunters will include: 1.) the implementation of a preseason lottery drawing for waterfowl; 2.) the implementation of an online/telephone permitting process through a contractor for deer and waterfowl hunts; 3.) the elimination of daily standby drawings for deer and waterfowl hunts; 4.) the phasing out and elimination of permanent hunting structures; and 4.) conflicts with adjacent landowners. However, some of these changes were requested by hunters participating in the surveys conducted the U.S. Geological Survey (Sexton et al. 2007). The elimination of permit fees (except for lottery hunts) and the expanded hunting areas should be well received. Ultimately, any change to the existing program will draw skepticism and unfavorable comments as reported by the visitor surveys (Sexton et al 2007). In these surveys, hunters did not appear to be very interested in making changes when asked about the desirability of changing some hunting services or regulations. A well thought outreach plan is essential in explaining to the hunting public the rationale for the changes to the hunting program.

There may be reaction to the refuge hunts by anti-hunter groups. Response to any demonstrations or protests will be coordinated through the Northeast Regional Office of the Service, and may require assistance from refuges who have dealt with these situations in the past. If necessary, state and local law enforcement officials may be asked to assist.

For more information about anticipated public reaction, see the "Impacts on Public Use and Access" section of this document.

Hunter Application and Registration Procedures

All persons hunting on the refuge will be required to obtain the necessary state licenses, tags and stamps. Waterfowl hunters will be required to have a Federal Migratory Bird Hunting and Conservation Stamp ("Duck Stamp"). Each hunter is also required to have a signed copy of the current refuge Hunting Regulations Leaflet, which will serve as the refuge Hunting permit. In addition, hunters participating in the lottery hunts for deer, waterfowl, and turkey will be required to also have a daily permit. Hunters would not be required to check-in or check-out on the day of any hunt except for non-ambulatory deer and waterfowl hunters in the Non-Ambulatory Hunt Areas.

Description of Hunter Selection Process

For most areas, hunter numbers would not be limited to a specific hunt location. Hunting regulation brochures will be available in brochure boxes at the refuge check station, refuge office, refuge Web site, or upon request from the refuge manager. Hunters will be required to have in their possession a signed copy of the hunting regulations. Hunters would have the ability to free roam for deer, waterfowl, and upland game in designated areas on a first-come, first-serve basis. Non-ambulatory deer and waterfowl hunters would be required to hunt from a designated hunt blind. Waterfowl hunters in the Waterfowl Lottery Hunt Area (the Unit III impoundment and Prime Hook Creek) would be required to hunt within a defined area around a designated blind site. For the Statewide youth hunts, all designated hunt areas would be open for waterfowl and deer hunting on a first-come, first-serve basis.

Preseason lottery drawings are proposed for high demand areas, including the Lottery Deer Hunt Area (headquarters area), Lottery Non-Ambulatory Deer Hunt Area, Lottery Waterfowl Hunting Area, and Lottery Turkey Area to reduce hunter conflicts, lessen administration, and provide equal opportunity for all hunters. For daily drawings on opening days under current management, it is common to see over 100 deer hunters show up for 34 available hunting opportunities and for 80 waterfowl hunting parties (with up to three people per party) show up for 27 available hunt blinds. As a national wildlife refuge, the refuge will provide hunting opportunities through these preseason drawings for local, in-state, and out-of-state hunters. Knowing in advance of a hunting opportunity allows hunters to prepare, plan, and scout, which ultimately improves their quality hunting experience.

Preseason lottery drawings would be administered by a contracted company which will feature online and telephone services to collect hunter information, required fees, and issue permits. These services would provide hunters with the ability to apply, pay for, and receive hunting permits in advance of the hunting dates. Contracting the administration of the permitting process may reduce our costs by over $3,000 and the application and processing fees will be paid to the contractors for performing this service. The proposed permit fee ($10 for deer & turkey; $15 for waterfowl), preseason application fee ($5/hunter), and processing fee for permits acquired after the preseason drawing (a minimum of $2-3 per hunt) are the minimal amounts needed to offset the cost of facilitating the preseason drawings and

manage the lottery hunts. All fees must be paid prior to the issuance of a permit. Due to the uncertainty in the level of hunter participation with these new program changes, permit fees may need to be adjusted (increased or decreased) and therefore will be evaluated annually. Refuge staff will work with the contractor to provide the highest level of customer support.

For the preseason drawing for the Lottery Deer Hunt Area, hunters will be selected for a hunt date based on their date preferences. If selected, a limited number of hunters would have access to the hunt area and may choose their hunting location on a first-come, first-serve basis on the day of the hunt. For the Lottery Waterfowl Hunt Area and Lottery Non-Ambulatory Deer Hunt Area, hunters would be selected for a hunt date and hunting blind site based on their date preferences during the preseason drawing. Hunters could be picked for multiple dates. For the lottery waterfowl hunts, the selected hunter may take two additional people on that hunt day. Everyone in the lottery drawing has an equal chance of being selected multiple times. The Lottery Turkey Hunt will be administered by the Delaware Division of Fish and Wildlife.

For any vacant hunting opportunities not selected during the preseason lottery drawing, hunters would have the flexibility to go to the contractor's Web site at any time (24 hours a day) during the hunting season, view available hunt dates, and select and pay for these permits at any time. For those individuals who do not have computer access, customer representatives would be available by telephone during business hours on weekdays to assist. Hunters will be allowed to claim only one permit per day to avoid someone from claiming all available vacancies at one time. The licensing contractor would supply refuge staff of a list of permitted applicants. No daily standby lottery drawings would be conducted.

Procedure for Proper Storage and Disposal of Paper & Electronic Hunter Records

For the preseason lottery drawings for deer, turkey, and waterfowl, hunters will be required to complete the appropriate OMB approved applications. If selected, accepting hunters will be issued a refuge hunting permit. All information collected from hunters either by refuge staff or a licensed contractor will be destroyed at the end of the hunting season. The licensing contractor will assume responsibility for confidentiality and privacy related issues. Lists of selected applications given to refuge staff will be destroyed at the end of the hunting season.

For hunting areas that do not require a preseason lottery drawing, hunters will be required to sign the permit on the cover of the hunting regulation booklet.

Harvest Data Requirements

Harvest data will not be collected through refuge staff. Deer harvest data will be available through the State Division of Fish and Wildlife's harvest reporting system. Migratory bird harvest data will be available through the Harvest Information Program, or HIP. Other harvest related information will be obtained through informal hunter feedback throughout the hunting season.

Media Selection for Announcing and Publicizing Hunts

The public will be informed of refuge hunting regulations through news releases and refuge hunting regulation brochures. Contact information for the refuge will be included in the Delaware Hunting and Trapping Guide for interested hunters. An annual program update will be filed each year as required,

outlining any changes in the current hunt program. Rules and regulations will be published in the *Federal Register* as required.

FUTURE ACTIONS

Long term plans for administering and maintaining the hunting program are to follow the guidelines outlined in this plan and to make future adaptations only in an effort to maintain or increase program efficiency, provide quality experiences to hunters, and maintain healthy wildlife habitats.

EVALUATION

The refuge will evaluate the hunting program on a regular basis along with the Delaware Division of Fish and Wildlife to ensure that we are meeting resource management objectives and continuing to offer quality experiences. In cooperation with our State partners, we will evaluate the hunting program based on hunter harvest, hunter participation and feedback, state and federal wildlife surveys, and staff observations. In addition, the refuge plans to evaluate the following areas:

Fee Structure – Refuge staff will ensure that permit and application/processing fees are adequate to cover expenses to administer the hunting program. Due to the uncertainty in the level of hunter participation with these new program changes, permit fees may need to be adjusted (increased or decreased).

Lottery Waterfowl Hunt & Waterfowl Sanctuaries– Through staff observations and informal feedback from hunters, the refuge will evaluate waterfowl behavior in and adjacent to designated waterfowl sanctuaries and evaluate hunter success in lottery hunt areas to determine impacts of hunting on wildlife populations and on hunter success. OMB approved harvest information surveys may be used if needed to adequately assess hunter harvest rates.

Disturbance to Sensitive Areas & Wildlife – Through staff observations and occasional site visits, the refuge will evaluate public use patterns for short and long-term disturbance to sensitive habitat areas.

Turkey Hunting – The refuge will collaborate with the Delaware Division of Fish & Wildlife to evaluate the status of the wild turkey population on the refuge. Hunting will be permitted if State and refuge personnel determine that the turkey population in the area is sufficient to support hunting on the refuge. The refuge will consult with the State on an annual basis to determine the status of the turkey population and whether to continue to allow turkey hunting on the refuge.

Conflicts Among Hunters and Other Refuge Visitors – The refuge will evaluate the concurrent hunting opportunities of deer, waterfowl, and upland game in hunting areas for conflicts between different hunter user groups. Seasonal restrictions (days of week) or spacing may be required to minimize these conflicts. The refuge will also evaluate the closure of Prime Hook Creek to all users except permitted hunters during the hunting season, which starts on September 1 and may end as late as early May.

Appendix D

©Kevin Fleming

Hibiscus bee

Refuge Resources of Concern

Table D-1. Summary of Biological Integrity, Diversity, and Environmental Health (BIDEH) Elements for Prime Hook National Wildlife Refuge
I. BARRIER ISLAND BEACH HABITATS – 439 ACRES 4/3/2012

Habitats and Plant Communities that Represent Existing BIDEH	Population/Habitat Attributes (Age Class, Structure, Serial Stage, Species Composition	Natural Processes responsible for these conditions	Limiting Factors
Overwash Grassland Dunes: 50 A	A series of small dune "fingers" developed at regular intervals, oriented @ 90^0 to the bay shoreline and protruding into the salt marsh. These overwash and blow-out areas are both recently deposited and devoid of vegetation, or may be older w/ well-established vegetation. *Cakile edentula,* and *Spartina patens* are dominants, in early successional expressions of dune overwash. As vegetation develops, other associates found on the refuge include *Schoenoplectus pungens*, *Cenchrus tribuloides, Triplasis purpurea* and scattered *Baccharis halimifolia* seedlings. ***Potential Focal Species:*** **Piping Plover, Red Knot, American Oystercatcher, Sanderling, Least Tern, Black Skimmer, American Black Duck, Willet, Forster's Tern, Coastal Plain Swamp Sparrow, Common Night Hawk; Horseshoe Crab, Beach-Dune Tiger Beetle, Northern Diamondback Terrapin**	Forms a drier, later successional phase beginning from water-deposited sands from storm overwash. Sand movement, plant burial, and dune formation rates differ from dune grasslands dominated by American Beachgrass (*Ammophilia breviligulata)* to other areas with salt meadow cordgrass (*Spartina* patens) and seaside goldenrod (*Solidago sempervirens).* Storm overwash and dune blowouts from surf surges and wind erosion are the prevalent natural disturbances of this community.	Overwash dunes of mid-Atlantic barrier island habitats are G2-G3 ranked and DE S2/S3. This community is restricted to overwash dunes developed on coastal beach habitats of DE, MD VA & NC. Restricted to specialized habitat it is threatened by a number of human activities especially artificial dune stabilization.
Beachgrass and Panic-grass Dune Grassland Association: 35 A	Community is a maritime dune grassland dominated by *Ammophila breviligulata* or *Panicum amarum.* Other associated plant species include *Solidago sempervirens, Triplasis purpurea, Cenchrus tribuloides, Chamaesyce polygonifolia, Cakile edentula, Nuttallanthus canadensis* and, *Cyperus grayi,* where overwashed by sand. ***Potential Focal Species:*** **Beach-Dune Tiger Beetle.**	Eolian processes cause active sand deposition and erosion. This community generally occurs on foredunes that receive the force of wind and salt spray, but is beyond the influence of spring tides and most storm surges. Diagonostic plant species are *A. breviligulata, S. sempervirens Panicum amarum,* and *O puntia humifusa.*	Community is globally ranked as G2, found on maritime dunes from Long Island, south to NC. Over this range less than 3,000 acres currently exist. Limiting factors include trampling by people and ATV traffic. This association is highly fragile and does not recover well from these types of human uses and impacts.

Habitats and Plant Communities that Represent Existing BIDEH	Population/Habitat Attributes (Age Class, Structure, Serial Stage, Species Composition	Natural Processes responsible for these conditions	Limiting Factors
Atlantic Coast Interdune Swale: 67 A	This association occurs on maritime barrier islands' protected backdunes, barrier flats & interdunal swales. Substrate is sand to loamy sand w/ thin layer of organic matter. Vegetation is characterized by moderately open to densely closed canopy of *Morella cerifera* and short stems of *Prunus serotina.* Other canopy associates include *Baccaris halimifolia* and *Juniperus virginiana* and *Rhus copallinum.* Herbaceous layer characterized by *Spartina patens, Panicum virgatum, Andropogon virginicus, A. virginicus* var. *hirsutior* (S1), *Juncus effuses, Polygonum hydropiperoides, & Distichlis spicata.* ***Potential Focal Species: Catocala muliercula* & other invertebrate fauna dependent on this habitat type & heavily utilized by migratory songbirds.**	This community is not tidally flooded and occurs beyond the reach of most storm tides, but it is impacted by salt spray, wind erosion and sand movements. (**Note:**) Reference sites in Delaware = Great Marsh in Lewes & Prime Hook NWR in Milton.	Habitat Loss and Fragmentation; Most occurrences near refuge have been destroyed by coastal development of Slaughter, Prime Hook & Broadkill Beach communities., These soils are sandy and dry enough that they are not classified as "jurisdictional wetlands." Remaining occurrences are highly fragmented, represented by very small and isolated patches.
Irregularly Flooded Eastern Tidal Salt Shrub: ~ 60 Acres	Dominated by *Iva frutescens* or *Baccharis halimifolia* or both growing in association with salt marshes. Other associated shrubs include *Morella cerifera. Spartina patens* is the characteristic dominant grass with other herbaceous associates: *Panicum virgatum, Distichlis spicata, Hibiscus moscheutos, Tercrium canadenses, Cuscuta gronovii, & Solidago sempervirens.* ***Conservation Target Catocala muliercula* (State Record)**	The tidal shrublands are characteristic of diurnal to irregularly flooded mesohaline (5-18 ppt) systems. Soils are layers of accumulated peat of variable depths overlying sands. Communities occur in estuarine margins and form an ecotone between salt marsh & upland vegetation.	Storm surges can cause shrub die-back. Heavy salt spray & tidal flooding often causes die-back of shrub layer bayward. This association grades into high salt marsh dominated by herbaceous vegetation. Landward, shrub cover becomes denser. Invasive species encroachment problematic. Invertebrate communities susceptible to negative impacts from adulticides (Naled).

Habitats and Plant Communities that Represent Existing BIDEH	Population/Habitat Attributes (Age Class, Structure, Serial Stage, Species Composition	Natural Processes responsible for these conditions	Limiting Factors
Maritime Red Cedar Woodland 76 A	Community dominated by red cedars (*Juniperus virginiana)* of variable heights but trees are generally shorter than 4 meters tall. Trees start to colonize areas behind sand dunes and upper edges of salt marshes. Red cedar either forms pure stands and/or grows in association with *Quercus stellata, Prunus serotina, Amelanchier canadensis & Ilex opaca. Piuns taeda, Q. phellos & Diospyros virginiana* infrequent canopy associates. In Delaware this NVCS community is one of the best remaining examples of this cover-type. This community supports the state rare plant golden heather (*Hudsonia ericoides* – S1) and its population size is significant as the only other known occurrence on the Delmarva Peninsula was Cape Henlopen State Park. A close relative to golden-heather also occurs here, beach heather (*Hudsonia tomentosa*). Vegetation community supports unique and uncommon invertebrate fauna listed below: ***Potential Focal Species: Wallengrenia otho (S1),* Southern Broken Dash, *Drasteria graphica (S1S3)* = Good indicator species of high quality Maritime Red Cedar Woodland Habitat; *Pompeius verna,* Little glassy wing (tier 2) and *Anatrytone logan,* Delaware skipper (tier 2).**	The dominance of red cedar and its maritime location defines this community. Maritime Red Cedar Woodland is influenced by onshore winds and salt spray, sand deposition, and tidal overwash from severe storms. Golden heather grows where soils are hot, sandy and nutrient poor. Plant species diversity is low in these areas due to stressful environmental conditions.	This Coastal Dune community is very rare in DE (S1) and also Globally Rare (G2). Artificial dune stabilization, commercial & residential development as its greatest threats. The invertebrate fauna associated with this community is threatened from annual adulticides applications that occur in and around community locations.

Habitats and Plant Communities that Represent Existing BIDEH	Population/Habitat Attributes (Age Class, Structure, Serial Stage, Species Composition	Natural Processes responsible for these conditions	Limiting Factors
Successional Maritime Forest (184 A)	This community is found on the leeward side of secondary dunes with substrate varying from pure sand directly adjacent to Delaware Bay to well-drained loamy sands in more sheltered areas. Community is a stunted forest of blackcherry, sweetgum, and red maple with a shrub layer dominated by bayberry shrubs (*Morella cerifera* and *pensylvanica)* plus *Smilax rotundifolia* the are dominant shrub species. Other associates include *Diospyros virginiana* and *Pinus taeda* in varying portions.Where trees from an open canopy the herbaceous layers are diverse and characterized by slender spikegrass (*Chasmanthium laxum),* stout wood reedgrass *(Cinna arundinacea),* switchgrass (*Panicum virgatum), panic beachgrass (P. amarum* var. *amarulum),* little bluestem (*Schizachyrium scoparium [Andropogon scoparius],* eastern jointweed (*Polygonella articulate),* rattlesnake hawkweed (*Hieracium venosum*), and seaside goldenrod (*Solidago sempervirens)* . Where trees form a closed canopy herbaceous plants are sparse or lacking. **Potential Focal Species and identified state species of great conservation need (SGCN): *Catolcala muliercula.***	This is a tall deciduous shrub-scrub forest. The physiognomy varies dramatically, ranging from open woodland to stunted forest to dense impenetrable thicket. Individual trees are wind-pruned and multi-stemmed, and are subjected to wind erosion and salt spray to varying degrees. This association occupies a transitional zone between maritime forest and the low maritime shrublands connected to dune associations.	Limited range in mid-Atlantic from VA to north of Cape May, NJ. In Delaware this community is known from the Mispillion River, south into the Inland Bays Region. Historic habitat has been eliminated by human development.

Table D-2. Summary of Biological Integrity, Diversity, and Environmental Health (BIDEH) Elements for Prime Hook National Wildlife Refuge
II. FORESTED HABITATS – UPLAND SITES ~ 775 Acres 4/3/2012

Habitat and Plant Communities that Represent Existing BIDEH	Population/Habitat Attributes (Structure, Species Composition)	Natural Processes responsible for these conditions	Limiting Factors
Southern Red Oak: Heath Forest 289 A	Oak forest of unglaciated NE coastal plain. On refuge occurs on well-drained acidic soils, primarily loamy sands, sandy loams and silty/clay loams. Canopy dominated by a mixture of oaks (*Quercus alba, Q. falcata & Q. velutina).* Characteristic understory species of this association are *Gaylussacia frondosa & Pteridium aquilinum.* Other tree associates include *Sassafras albidum, Q. coccinea, Q .stellata, Liquidambar styraciflua, Nyssa sylvatica, Carya spp & Pinus taeda, w. Acer rubrum, Ilex opaca & Cornus florida* forming the subcanopy. The shrub layer is well-developed and dominated by members of heath family (*Gaylussacia [baccata & pallidum], Vaccinum spp)* and *Aralia spinosa.* The herbaceous layer is sparse with some *Cypripedium acaule, Chimaphila maculate & Gaultheria procumbens.* **Potential Focal Species: DFS, breeding Forest Interior Dwelling Birds, migrating and wintering landbirds.** ***Prionus laticollis* (County Record = Long-Horned Beetles or Cerambycids not ranked in Delaware but species is considered an indicator species of mature healthy forest; 2 rare moths, *Catocala lacrymosa & Papaipema aralia* (Host plant = Hercules Club).**	Distribution in mid-Atlantic Coastal Plain is mainly 2nd growth successional forests following logging or agricultural cropping. Periodic fire is an important natural disturbance in this forest type & encourages oak regeneration. The relative cover of *Pinus taeda* is related to disturbance history, w/ higher pine cover suggesting more recent disturbance from farming or logging.	Status: **G4G5** DE: SNR. This type of oak forest is uncommon in Delaware's state landscape & mature examples are rare. All stands are vulnerable to fire suppression & logging disturbances. State Reference Sites are Milford Neck and Prime Hook NWR; Protect invertebrate fauna from exposure to Naled and Dimilin applications when possible as these chemicals have adverse impacts on invertebrate communities.

Habitat and Plant Communities that Represent Existing BIDEH	Population/Habitat Attributes (Structure, Species Composition)	Natural Processes responsible for these conditions	Limiting Factors
Mesic Coastal Plain Oak Forest (193 A)	This community is a mesic oak forest of the central Atlantic Coastal. On refuge, this community borders wetland habitats that have sandy soils w/ a high water table (wetter than previous community). Refuge areas have mesic to poorly drained soils & the presence of willow Oak and Swamp Chestnut Oak distinguish this community from Southern Red Oak/Heath Forest community. Canopy dominants include *Quercus falcata, Q. phellos, Q. alba & Acer rubrum. Pinus taeda, Q. michauxii, P. serotina, Q. nigra, Q.palustris & Liquidambar styraciflua.* Subcanopy dominated by *Ilex opaca, Vaccinium corymbosum & Amelanchier canadensis. Gaylussacia frondosa,* and *Leucothoe racemosa forms* a patchy shrub layer draped w/ *Smilax rotundifolia*. Herb layer is sparse w/ slender spikegrasss (*Chasmanthium laxum),* royal fern (*Osmunda regalis),* patridge berry (*Mitchella repens)* ,Virginia cutgrass (*Leersia virginica),* stout wood weedgrass (*Cinna arundinacea),* and teaberry (*Gaultheria procumbens).* This forest community on the refuge is also known to support exceptionally large trees in "Gum Woods," First and Second Hills and Oak Island sites that include the following examples: southern red oak (39 bdh), willow oak (53 dbh), pin oak (45 dbh), water oak (29 dbh), black walnut (24 dbh), and pond pine (30 dbh).	Poorly drained sand generally makes up the soil substrates for this community and a high water table is often present. This association grades into drier upland oak forests. State Reference Sites in Delaware include Milford Neck and Prime Hook NWR. Unique features on refuge of these forest patch-types support exceptionally large trees found in the County/State averaging 35 dbh inches (1st & 2nd Hills) w/ largest tree 53 inch dbh (Willow Oak) on Oak Island.	This community typically occurs in a fragmented setting, so it is more prone to exotic species encroachment. On refuge, invasive species that out-compete native species include Japanese Stiltgrass, Multiflora Rose and M-A-M; High density of deer over-browsing understory, reducing diversity and hampering natural oak regeneration.

Habitat and Plant Communities that Represent Existing BIDEH	Population/Habitat Attributes (Structure, Species Composition)	Natural Processes responsible for these conditions	Limiting Factors
Mid-Atlantic Coastal Plain Loblolly Pine Forest 51A	The physiognomy of this association varies from dense tall shrub thickets dominated by Wax-myrtle to salt-pruned loblolly trees. Canopy is dominated by *Pinus taeda,* w/ scattered *Q. falcata, Q. alba, Carya alba & P. virginiana.* Shrub layer is well-developed where canopy is more open, dominated by *Ilex opaca, Cornus florida, Aralia spinosa Sassafra albidum & Magnolia virginiana.* Vines are always present, dominated by *Vitis aestivalis.* Herbaceous layer dominants include *Chasmanthium laxum, Panicum virgatum, Eupatorium hyssopifolium, Cypripedium acaule, Mitchella repens,* and *Parthenocissus quinquefolia.* **Potential Focal Species: DFS, breeding and migrating landbird species and *Photuris frontalis, Zale metatoides, and Z. metata;* use rare invertebrate fauna as possible indicators of environmental health.**	Maritime community occurs on sand dunes, upper edges of coastal marsh areas. The substrate is rapidly moist sands or sandy loams which are nutrient poor.	This coastal community is limited to the mid-Atlantic states of DE, MD, VA & NC. These forests are restricted to a narrow geographic range and are very vulnerable to development pressure, degradation from intensive ag practices, and recreational use demands. Ranked **G3** mostly because of bayberry shrub component (*Morella spp)*, this community is under represented across state and regional landscapes.
Northern Coastal Plain Basic Mesic Hardwood Forest 35 A	Tuliptree rich woods are associated with loamy soils dominated by *Liriodendron tulipifera,* plus *Carya glabra. Liquidambar styraciflua, Circaea lutetiana & Cornus florida* are co-dominants in the subcanopy. Shrub layer dominated by *Viburnum prunifolium, Lindera benzoin.* Herb layer is diverse and includes a number of species restricted to this forest type on the Coastal Plain. Indicator species include *Botrychium biternatum* and *B. dissectum.* Unique herbaceous vine (Canada Moonseed) *Menispermum canadense* is found here plus rare climbing vine *Passiflora lutea* (S3-yellow passion flower) Herbaceous species include *Asplenum platyneuron, Circaea lutetiana, Senecio tomentosus* and the rare (S3- green fringe orchis) *Platanthera lacera.*	Development of this community type is associated with rich loamy soils, high in nutrients with a mid-range pH. Natural disturbance of periodic fire encourages oak regeneration & enriches herbaceous diversity. Community is typified by a prevalence of tuliptree in the canopy. Community is locally rare in Sussex County.	Fragmentation due to historic logging and agricultural practices. Encroachment by invasives such as Japanese stiltgrass, multiflora rose & honeysuckle can degrade the ground story and shrub layers of this community. Protect inverts from Mosquito drift of Adulticides & Dimilin applications. Protect from over abundant deer populations and excessive browsing.

Habitat and Plant Communities that Represent Existing BIDEH	Population/Habitat Attributes (Structure, Species Composition)	Natural Processes responsible for these conditions	Limiting Factors
Mid-Atlantic Mesic Coastal Plain Mixed Hardwood Forest 19 A	This community is distinguished by a mixture of decidous hardwood especially of tuliptree, American beech, and oaks. It is a mixed mesophytic forest dominated by *Quercus alba, Q. rubra, & Liriodendron tulipifera* with *Fagus grandifolia Carya spp* as associates; Understory dominated by highbush blueberry (*Vaccinium corymbosum),* lowbush blueberry (*V. pallidum),* and American holly (*Ilex opaca).* Herb layer includes pink lady's-slipper (*Cypripedium acaule),* partridge-berry *(Mitchella repens),* cranefly orchid (*Tipularia discolor),* downy rattlesnake-plantain *(Goodyera pubescens),* Swan's sedge *(Carex swanii), and* common Solomon's-seal (*Polygonatum biflorum).*	This community often develops where soils are moist. Forest community type usually found on soils that moderately drained, and characterized by acidic, sandy and silt loams derived from parent material of low to moderate fertility. Maintenance of closed-canopy conditions best to sustain forest structure and composition.	Fragmentation due to logging & agricultural practices. On refuge fragmented landscape setting is prone to invasion by exotic species, esp. multiflora rose, mile-a-minute weed, and Japanese stiltgrass. Habitat type is also rapidly disappearing at County & State Level due to development. Manage deer populations to prevent excessive overbrowsing.
Successional Sweetgum Forest 154 A; Mid-Atlantic to Late Successional Loblolly Pine-Sweetgum Forest 24A; Red Maple:Sweetgum Forest 3A	These communities result from succession following human activities of timber harvesting and clearing for agriculture. Stands are either dominated by *Liquidambar styraciflora*, sometimes to the exclusion of other species or stands are codominated by *Pinus taeda, P.virginiana & Acer rubrum.* Understory composition differ based on edaphic site factors (ranging from mesic to dry on a wide variety of generally acidic soils). A portion of successional sweetgum forest (SE of Hdqrts) contains an open, early successional grassland-like habitat within the sweetgum forest. The state rare plant lance-leaf orange milkweed (S-1)-*Asclepis lanceolata;* This population contains over 100 individuals and is the largest known population of this species on the Delmarva Peninsula.	These associations are found on uplands that have been heavily impacted by agriculture or other severe disturbances and are recovering. As the stands of *L. styraciflua* mature, they begin to assume the characteristics of more natural community types. Over time, sweetgum declines and is replaced by oaks, hickories, and/or pines.	Exotic encroachment of Lespedeza, Multiflora rose and Japanese Stiltgrass; Habitat containing rare milkweed also contains well-established reed canary grass (*Phalaris arundinacea).*

Habitat and Plant Communities that Represent Existing BIDEH	Population/Habitat Attributes (Structure, Species Composition)	Natural Processes responsible for these conditions	Limiting Factors
Pond Pine Woodland (7.5A) PondPine Sweetbay Highbush Blueberry/ Prickly Bog Sedge Association	A diagnostic feature of this community is pond pine as the main canopy species with an understory of red maples. This association is located around Flaxhole Pond in Unit III. Although *Pinus serotina* can be found in a few other locations in Delaware, the refuge location is the only site where there is a well-developed community in the state. This community is open and dominated by *Pinus serotina*. The understory has red maple (*Acer rubrum),* sweetgum (*L.styraciflua)*, and sweetbay magnolia *(Magnolia virginiana).* The shrub layer is dense and dominated by highbush blueberry (*Vaccinium corymbosum),* red chokeberry *(Photinia pyrifolia).* Other shrub layer associates include *Leucothoe racemosa*, *Itea virginica*, *Clethra alnifolia.* The uncommon Walter's greenbrier **(S3)** (*Smilax walteri)* occupies the vine layer. Common herbs include *Carex atlantica, C. lurida, Woodwardia virginica, Osmunda regalis,* and *Sagittaria latifolia.*	This community is located in saturated soils, often with standing water. Fire may have been an important ecological force in shaping this community which occurs in seasonally flooded shallow basins. Substrates are acidic, gleyed to mottled sandy or clay loams that develop in standing water for part of the year.	Fire suppression, invasive plant species encroachment and agricultural runoff causing eutrophication.

Table D-3. Summary of Biological Integrity, Diversity, and Environmental Health (BIDEH) Elements for Prime Hook National Wildlife Refuge
III. FORESTED WETLAND HABITATS - 1,237 ACRES 4/3/2012

Habitats (Plant Communities that Represent existing BIDEH	Population/Habitat Attributes (Structure & Species Composition)	Natural Processes Responsible for these conditions.	Limiting Factors
Red Maple Seaside Alder Swamp 799 A	This community is a low-growing, partially open to open saturated woodland basin swamp bordering a 7-mile freshwater non-tidal creek (Prime Hook Creek). It is mostly dominated by *Acer rubrum*. The understory along creekside edges is dominated by *Alnus maritima*, *Decodon verticillatus, Clethra alnifolia, Morella cerifera, Cephalanthus occidentalis*, and *Leucothoe racemosa* occur as associates in the shrub layer. Herbaceous layer includes Wlater's St John's wort (*Triadenum walteri),* cardinal flower (*Lobelia cardinalis)* weak stellate sedge (*Carex seorsa)* three-way sedge (*Dulichium arundinaceum)* royal fern (*Osmunda regalis),* and mild water-pepper (*Polygonum hydropiperoides)* plus rare plants listed below. ***Potential Focal Speces* = Birds: Kentucky Warbler, Prothonotary Warbler, Yellow-throated Vireo, Chimney Swift, Acadian Flycatcher, Cerulean Warbler (SEN), Swainson's Warbler (SEN), migrating and wintering landbirds.** ***Potential Indicator Species:* Carpenter Frog (S1), Cope's Gray Tree frog (S1), Ribbon Snake (S1), Rough Green Snake (S2), Sphinx Moth (S1S3), Great Purple Hairstreak (S1), Delaware Skipper & *Catocala praeclara.*** **Rare Plants: green fringe orchis (*Platanthera lacera-S3),* seaside alder *Alnus maritima (S3),* and gibbous grass *Sacciolepis striata (S2).***	Most of the substrate is saturated peat and muck characterized by hummock-and-hollow microtopography. Prime Hook Creek was historically tidally influenced up until 1983 when PHC became enclosed w/in a 2,500 freshwater impoundment. Maintenance and survival of this community may be dependent on artificial hydrological conditions created within a closed non-tidal freshwater impounded ecosystem.	This community may be successional due to water level management and impoundment infrastructure. Occasional storm surges may also influence community composition. *Phragmites* encroachment also a problem.

Habitats (Plant Communities that Represent existing BIDEH	Population/Habitat Attributes (Structure & Species Composition)	Natural Processes Responsible for these conditions.	Limiting Factors
Coastal Plain Depression Swamp (New Name =RedMaple/ Sweetgum Swamp) **335 A**	Signature trees of this community include *Acer rubrum, Liquidambar styraciflua, Quercos phellos, Nyssa sylvatica & Prunus serotina.* Other associates include *Nyssa biflora, Magnolia virginiana, Ilex opaca & Pinus taeda.* Shrub layer is characterized by *Leucothoe racemosa, Vaccinium corymbosum, Clethra alnifolia, Ilex verticillata & Rhodendron viscosum.* Common herbs include royal fern (*Osmunda regalis),* New York fern (*Thelypteris noveboracensis),* and netted chain fern (*Woodwardia areolata).* State rare plants include cattail sedge [*Carex typhina (S3)],* and blue-flag iris [*Iris prismatica (S3)].* **Potential Focal Species include breeding populations of Kentucky warbler, Prothonotary warbler, yellow-throated warbler, Acadian flycatcher; and migrating and wintering landbirds.** **Rare invertebrates, reptiles and amphibians same as found in red maple/seaside alder swamp association.**	This association is a seasonally flooded forest of shallow basins or depressions of the Coastal Plain of the Delaware Bay. Periodic flooding of depressions result in substrates that are acidic, gleyed to mottled, sandy or clay loams with a very high water table. **Note:** Coastal Plain Ponds, (also known as Carolina or Delmarva Bays) are unique, isolated non-tidal freshwater wetlands w/in a forested area. Three were inventoried on the refuge (Buttonbush & Swamp Cottonwood Coastal Plain Ponds and a 3rd community yet to be named, clumped in Coastal Plain Depression Swamp association.	Invasive Exotics like M-A-M & *Phragmites;* Alteration and drying by drainage ditching for farming and mosquito control activities; Negative impacts of drift of Dimilin or Adulticides are lethal to rare and common invertebrate species.

Habitats (Plant Communities that Represent existing BIDEH	Population/Habitat Attributes (Structure & Species Composition)	Natural Processes Responsible for these conditions.	Limiting Factors
Coastal Loblolly Pine Wetland Forest 91A	Refuge association is Loblolly Pine/Wax Myrtle/ Royal Fern Forest with a closed to partially open canopy dominated by *Pinus taeda* associated with *Acer rubrum* and/or *Liquidambar styraciflua.* Understory species include *Nyssa sylvatica, Ilex opaca, Magnolia virginica, Morella cerifera & Smilax walteri (S3).* Soils are characterized by moderately shallow muck (15 cm) overlying organic matter-stained sands. Herbs are sparse with *Woodwardia areolata & W. virginica* and the rare (S3) *Listera australis* (southern twayblade) as main plant species on forest floor. All forested wetland communities listed are extremely important to both short-distance and long-distance migratory and wintering landbird species.	Maritime coastal wetland forest areas occur in back dune depressions with high water tables and along fringes of estuaries from Delaware to NC. Fire may once have been an important ecological force in this community.	Development pressures and encroachment of exotic invasive species.
Atlantic White-Cedar Seaside Alder Swamp 10 A	The tree canopy is characterized by low-stature (<30 m) *Chamaecyparis thyoides* in association with *Alnus maritima* as an understory species on community edges adjacent to open water, as well as in canopy gaps. Other woody associates include *Morella cerifera, Ilex glabra, Clethra alnifolia, & Alnus serrulata.* The herbaceous layer is very diverse, comprised of *Decodon verticillatus, Peltandra virginica, Nymphaea odorata, Glycera obtuse, Carex atlantica* and several rare plants: S1 *Eriocaulon decangulare,* S2 *Drosera rotundifolia,* S2 *Juncus militaris.* Developed floating mats w/in this swamp association have unique and rare species assemblage including *Xyris difformis, Juncus canadensis, Fimbristylis autumnalis, Fuirena pumila* S3, *F. squarrosa* S2, *Juncus pelocarpus* S2, *Rhynchospora alba* S2, *R. scirpoides* S2, *Eriocaulon compressum* S2, *Pogonia ophioglossoides* S2, and the extremely rare coast sedge, S1-*Carex exilis.* ***Potential Focal Species:*** **Carpenter Frog, Cope's Gray Treefrog, Ribbon Snake, Rough Green Snake**	This open-canopy Atlantic white-cedar swamp occurs along streams of the Delmarva Peninsula. It is found along PHC area w/in Unit III 2,500 acre impounded freshwater marsh. These communities were once cedar-swamp streams now filling in with peat substrate, herbs and Seaside Alder, may be of artificial origin due to impounding the area since 1983.	Habitat Loss & Fragmentation; Encroachment of Invasive Species; This community is known to require fire in order to regenerate; Periodic Rx burns may help make community more robust, but adequate precautions must be taken to protect extant rare faunal species.

Habitats (Plant Communities that Represent existing BIDEH	Population/Habitat Attributes (Structure & Species Composition)	Natural Processes Responsible for these conditions.	Limiting Factors
Swamp Cottnwood Coastal Plain Pond (2 A)	This community is a small isolated non-tidal freshwater wetland developing in a depression dominated by *Populus heterophylla* & *Decodon verticillatus*. It is codominated by *Acre rubrum, Quercus palustris,* and *Liquidambar styraciflua*. Few species in the understory, mostly *A, rubrum & Fraxinus pennsylvancia* seedlings and *Clethra alnifolia*. Herbaceous layer is dominated by *Microstegium vimineum & Polygonum hydropiperoides*. **Potential Focal Species: *Catocala marorata (S1, G3)*; Both state & globally rare; host plant = Swamp Cottonwood, highlighting extremely important interaction between this plant & Marbled Underwing Moth.**	This community occupies shallow depressions that fill with water in the late fall and winter and then dry in the summer.	Japanese stilt grass invasive and agricultural runoff (pesticides, nitrates & phosphates) have contributed to degrading this community; Excessive Beaver damage to Cottonwood trees.

Table D-4. Summary of Biological Integrity, Diversity, and Environmental Health Elements for Prime Hook National Wildlife Refuge
IV. WETLAND HABITATS – 6,456 Acres 4/3/2012

Habitats (Plant Communities that Represent Existing BIDEH	Population/Habitat Attributes (Structure & Species Composition)	Natural Processes Responsible for these conditions	Limiting Factors
Emergent Wetlands/Moist-soil Impoundments (2946 A)/ Water (1554 A)	Wild Rice Freshwater Marsh *Zizania aquatica,* co-dominant w/ arrow-arum (*Peltandra virginica),* halbeard-leaf tearthumb (*Polygonum ariflofium)* mild water pepper (*P. hydropiperoides),* and seasonal annual moist soil plants like barnyard grass (*Echinochloa walteri,)* beggarticks *(Bidens laevis),* spike rushes (*Eleocharis spp),* fall panicum grass (*Panicum dichlorormiflorum), etc.* Additional associates include *Leersia oryzoides, Amaranthus cannabinus, Typha angustifolia, T. latifolia, Impatiens capensis, P. sagittatum, P. punctatum.* Small patches of rare (S1-S3) plant populations and other vascular plants are scattered throughout impounded emergent wetlands demonstrating considerable native plant diversity. Some examples include: • swamp sunflower *(Helianthus angustifolius)* • sea purslane *(Sesuvium maritimum)* • hemlock water-parsnip *(Sium suave)* • Canada richweed (*Pilea pumila)* • sweetflag (*Acornus calamus)* Diverse native plant communities also support diverse invertebrate species associated with specific plant communities. **Potential Focal Species: Migrating & wintering Ducks; migrant CAGOs (spring & fall); 6 key perennial vegetation communities support the Bronze Copper *(Lycaena hyllus).* This species is declining in the Delaware Estuary and the refuge is maintaining best state occurrences w/in its impounded marshes in the state; also true for *Photuris pensylvanica* firefly, *Lycaena hyllus (S1),* and *Ischnura kellicotti (S2).***	This habitat cover type is a composite of several smaller perennial plant communities, surrounded by annual moist-soil plants that are continually in flux due to dynamic hydrology, created by water level management and seasonal manipulations, climatic and seasonal storm severities.	Exotic plant invasions, especially *Phragmites* and *Ludwigia leptocarpa.*; Water quality issues due to eutrophication both from on-refuge and off-refuge sources, Mercury contamination of wetlands through atmospheric depostion; Ground-water depletion due to large commercial irrigation systems adjacent to refuge lands; Invertebrate communities should be protected from Adulticide applications.

Habitats (Plant Communities that Represent Existing BIDEH	Population/Habitat Attributes (Structure & Species Composition)	Natural Processes Responsible for these conditions	Limiting Factors
Coastal Plain Ponds (Freshwater Depressional Ponds) (10-A)	These are non-tidal, isolated, freshwater depressional wetlands with substrates that are a deep muck, with some areas of mucky sand and sand. Characteristic vegetation includes fragrant waterlily (*Nymphaea odorata),* watershiedl (*Brasenia schreberi)* seedboxes *(Ludwigia spp),* and bladderworts (*Utricularia spp).* Depressional Ponds also provide habitat for several state-rare plants: • Robbin's spikerush (S3) *Eleocharis robbinsii* • Cattail sedge (S3) *Carex typhina* • Slender blue-flag iris (S3) *Iris primatica*	Hydromorphic coastal pond plain community is limited to the Atlantic Coastal Plain from southern New England to Maryland. These wetlands are important ground-water recharge areas.	Global Ranking **G2**. In Delaware, Heritage scientists rank this community for protection, as it is increasing rare in the state due to the fact that coastal plain ponds are not legally regulated; Also ponds are vulnerable to destruction via ditching, draining, filling and agricultural runoff causing eutrophication. They are also threatened by hydrologic alteration (groundwater depletion).

Habitats (Plant Communities that Represent Existing BIDEH	Population/Habitat Attributes (Structure & Species Composition)	Natural Processes Responsible for these conditions	Limiting Factors
Peat-Mat (Bog) Communities (10 A) DNHP:➜ Most significant community-type found on refuge with respect to flora and faunal diversity.	The refuge contains several examples of Twig Rush/ Ten-Angle Pipewort/Tawny Cotton Grass Herbaceous Veg: which are the most floristically diverse habitat on the refuge and in the state with 66 species and varieties documented, supporting 24 state-rare plant species (See HMP Appendix ? for comprehensive plant list). *Cladium mariscoides* is dominant herb. Associated herbaceous plants include (S1) *Eriocaulon decangulare* & (S1) *Eriophorum virginicum Bidens coronata, B. mitis, Sagittaria engelmanniana, Rhynchospora alba, Spiranthes cernua, Eleocharis robbinsii & Bartonia paniculata.* Scattered shrubs include *Smilax walteri, Clethra alnifolia, S. laurifolia & Alnus maritima.* In addition, a subspecies new to the flora of Delaware and Delmarva Peninsula was discovered here: Bushy Bluestem [*Andropogon glomeratus* var.*hirsutior* **(S1)**]. Rare Fauna associated with flora include: • Elfin skimmer [S1] (*Nannothernis bella)* • Lilypad forktail [S1] (Ischnura kellicotti) • Sphagnum Sprite [S1] (Nehalennia gracilis) • Several firefly species *(Photuris pyralomimus, tremulans, and frontalis)* • New leafhopper species Delphacidae, *Megamelus species* currently being described. **Potential Focal Species:** ***Nannothemis bella (S1), Sphagnum Sprite (S1), Photuris pensylvanica (S2), P. tremulans (s1), Xestia youngii (S1) & Exyra fax (S1).***	Unique and rare community type that occurs on deep, mucky peat that forms in open-water depressions within impounded marsh, and/or seeps within a shrub dominated swamp matrix. Natural succession from open water to peatland to forested wetland. Early successional versions have thinner peat layers and less species-richness. Peat mosses documented here include *Sphagnum fimbriatum, S recurvum, & S. perichaetile.*	These sites support many state (DE) and globally rare plant species, associated rare invertebrates and are also valuable in supporting rare amphibian species that are found here. To maintain this habitat for rare plants and animals, active management of woody vegetation and control of non-native invasives encroaching along the perimeter as well as in the interior of these peat-mat communities is recommended (DNHP 2007).

Habitats (Plant Communities that Represent Existing BIDEH	Population/Habitat Attributes (Structure & Species Composition)	Natural Processes Responsible for these conditions	Limiting Factors
Wax-Myrtle Shrub Swamps (67 A)	Shrub canopy is relatively open to moderately dense and dominated by *Morella cerifera, Baccharis halimifolia.* Herbaceous layer diverse & characterized by *Eleocharis spp., Kostelezkya virginica, Hibiscus moscheutos, Typha angustifolia, Polygonum punctatum, Pluchea odorata, Spatina patens, Asclepias incarnate, Ptilimnium capillaceum, Cyperus filicinus, Panicum. virgatum, Schoenplectus americanus, Amaranthus cannabinus.* **Potential Focal Species: *Catocala muliercula* by securing health of host plant = *Morella cerifera.***	Oligohaline (0-5 ppt) shrubland of fresh to brackish waters on firm, partially decomposed peat lacking pronounced hummock and hollow micro-topography. This vegetation forms linear stands along waterways between freshwater marshes and adjacent swamp forests.	Habitat Degradation & Loss; Invasive species encroachment, mostly M-A-M & *Phragmites. Morella spp.* Rare in state landscape & serves as host plant for rare inverts.
Water Willow Shrub Swamp (2A)	Community dominated by broad-leaved deciduous shrub, *Decodon verticillatus.* These communities are is association w/ Peat-bog mats. *D. verticillatus* forms a dense, often monotypic stand. *Cephalanthus occidentalis* also occurs but with less abundance that water willow. Herbaceous species vary widely to include *Nuphar advena, Nymphoea odorata, Petlandra virginica, Pontedaria cordata, Utricularia spp & Potamogeton spp.*	This shrub border occurs as a fringe along PH Creek and other refuge freshwater waterways. Most often *Decodon verticillatus* will form a dense tangle bordering this creek.	Major limiting factor would be salt-water intrusion; Invasive species encroachment.
Buttonbush Coastal Pond Plain (1 A)	Substrate is a shallow organic layer overlying silt loam or clay loam. Diagnostic features are *Cephalanthus occidentalis* as dominant shrub w/ the moss *Fontinalis spp.*, draped on limbs. Characteristic herbs = *Polygonum hydropiperoides, Dulichium arundinaceum, Bidens frondosa, Scirpus cyperinus, Fimbristylis autumnalis, Carex lurida, Panicum dichotomiflorum* , and *P. amphibium.*	Small basin wetlands that drawdown entirely during dry years; most of the Coastal Plain ponds are sinkhole features that formed through dissolution of underlying carbonate-rich shell marl deposits.	Globally Ranked as (G3); Few occurrences in mid-Atlantic region as acreage is very small; community is threatened by groundwater alteration & agricultural runoff & drainage ditches.

Habitats (Plant Communities that Represent Existing BIDEH	Population/Habitat Attributes (Structure & Species Composition)	Natural Processes Responsible for these conditions	Limiting Factors
Irregularly Flooded Eastern Tidal Salt Shrub (96 A)	This shrubland occurs in patches above mean high tide and can be flooded by storm tides. Substrate is peat over sand, or sandy loam. Dominated by *Iva frutescens & Baccharis halimifolia.* Also associated w/ *Morella cerifera & Juniperus virginiana.* Herbaceous layer dominated by *S. patens;* other herbaceous associates include *Distichlis spicata, Hibiscus moscheutos, Teucrium candense, Toxicodendron radicans, Cuscuta gronovii & Solidago sempervirens.* **Potential Focal Species for Tidal Creek Shrubland/ Spartina High & Low Salt Marsh: Saltmarsh Sharp-tailed sparrow, Black Rail (SEN), Prairie Warbler, Seaside Sparrow, ABDU, Willet, Clapper Rail, Short-eared Owl, Henslow's Sparrow (SEN), Sedge Wren, Coastal Plain Swamp Sparrow.**	Maritime/estuarine shrubland of the mid-Atlantic occurring in association with salt marshes. It forms an ecotone between high marsh and adjacent upland vegetation. Seaward, this association grades into high salt marsh dominated by herbaceous vegetation, but landward, shrub cover becomes more dense. This community is differentiated from the Wax-Myrtle Shrub Swamp of *Morella cerifera/Baccharis halimifolia/SPartina spp* by the presence of *Iva frutescens* and higher salinity regimes, characteristic of diurnal to irregularly flooded mesohaline (5.0 – 18.0 ppt) areas bordering Broadkill River and Slaughter Canal.	Heavy salt spray and tidal flooding from severe storms can cause die-back in the shrub layer; *Phragmites* encroachment.

Habitats (Plant Communities that Represent Existing BIDEH	Population/Habitat Attributes (Structure & Species Composition)	Natural Processes Responsible for these conditions	Limiting Factors
North Atlantic High Marsh (85 A)	High Salt Marsh is dominated by *Spartina patens &* codominated by *Distichlis spicata & Juncus gerardii.* Other associates in low density include *Aster tenuifolius, A. subulatus, Atriplex patula, Solidago sempervirens & Panicum virgatum.* Salt panes are a prominent feature within this association. This community occupies zones extending from mean high tide landward to the limit of spring tides. Potential target Rocs include American Black Duck, breeding salt marsh passerines species, black rail,and willet, migrating and wintering waterfowl and waterbirds.	Vegetation occurs as a shifting mosaic of patches dominated by a single grass species dictated by hydroperiod, nutrient availability, salinity gradients, soil oxygen and interspecific competition. As sedimentation increases marsh elevation, vegetation shifts to upland border communities dominated by *Panicum virgatum & Juncus gerardii.* Local disturbance from ice scouring or extensive snow goose herbivory can cause invasion by *S. alterniflora*, or can lead to the formation of salt panes.	Diking and draining; OMWM excavations; altered hydrology; invasive species; sea level rise; mercury contamination and salt marsh die-back.
North Atlantic Low Salt Marsh (1685 A)	Tall grassland dominated by *S. alterniflora* forms a coarse peat over mucky silt to silty coarse fibrous peat with high organic matter content. Occurs in regularly flooded intertidal zone (from mean high tide to mean sea level; diurnally flooded by polyhaline (18-30 ppt) tides; tall-form alterniflora occurs nearest tidal waterways and grades into short-form, landward, where tidal range is restricted. Common associates in low density include *Distichlis spicata, Salicornia maritime, Juncus gerardii & J. roemerianus,* microscopic algae (esp. diatoms) are abundant on marsh surface.	Highly dynamic habitats; *Alterniflora* readily colonizes soft sediments off the seaward edge of the salt marsh. Grass culms and algal mats trap sediments brought in by tides. Peat development raises marsh elevation & low marsh succeeds to high marsh.	"Salt-Marsh Die-Back"; Tidal Ranges of less than 1 meter; altered hydrology; Invasive Species; Mercury Contamination.

Appendix D-5. Habitat Priorities at Prime Hook National Wildlife Refuge

Habitat Type	Reasons for Ranking	Limiting Factors/Threats
PRIORITY I HABITATS		
I. Barrier Island Beach and Salt Marsh Habitats		
Overwash Dunes	Presence of federally-listed species during migrational periods; Presence of nesting state-listed species; Importance to spring & fall migrating shorebirds and wading birds, including highest priority BCR 30 & MANEM species; Habitat type ranked S2/S3 & G2/G3; **Target Rocs*: American Oystercatcher, Red Knot, Sanderling, Whimbrel, Beach Dune Tiger Beetle, Horseshoe Crabs.* (See Note at Table's End)**	Human activities such as dune stabilization, ATV use; Running dogs and walking humans during nesting and critical migrational seasons; Loss of natural beach dynamics; Shoreline Protection Practices (Beach Replenishment & Artificial Dune Construction); Accidental spills of toxins and sewage; Invasive plants.
Dune Grassland	Maritime vegetation community supports uncommon state plants and rare invertebrate species; Ranked Globally as G2 and state ranked as **"Key Wildlife Habitat of Concern." Target Roc: Beach Dune Tiger Beetle.**	Artificial dune construction, trampling & ATV traffic; Adulticide Mosquito Chemical Use; Sea Level Rise and Climate Change; Invasive species.
Atlantic Coastal Interdune Swale	Uncommon plants including *Morella cerifera* canopy & herbaceous layer; Rare & unique invertebrate fauna absent from other state sites. **Target Rocs: Migratory landbirds in spring & fall and rare inverts; Only 2 State Reference site in Delaware of this habitat type: 1) PHNWR & 2) Great Marsh in Lewes.**	Habitat Loss and Fragmentation; Residential & Commercial Development; Adulticide Mosquito Chemical Use.
Maritime Red Cedar Woodland	Coastal Dune Community rare in Delaware (S1) w/ patches **Key Wildlife Habitat of Conservation Concern** of Ancient Sand Ridge Forest; Many rare S1 invertebrates dependent on vegetation within this community; Globally Ranked (G2).	Invasive plant species; Artificial dune stabilization; Residential/Commercial Development; Chemical applications of Dimilin & Mosquito Adulticides.
Salt Marsh • North Atlantic High Marsh • North Atlantic Low Marsh • Irregularly Flooded Eastern Tidal Salt Shrub • Salt Panne	Listed as a Habitat Of Conservation Concern in DWAP & refuge community harbors several bird species of state's greatest conservation need. **Target Rocs: Black rail, sharp-tail and seaside sparrows, coastal plain swamp sparrow, American black duck, gull-billed tern, common tern, black skimmer, least tern, Forster's tern, whimbrel and willet.** Black rails, Least & Forster's terns & Black skimmers are listed as state endangered species. Salt marsh sharp-tailed & seaside sparrows, American black duck, gull-billed & rosette terns are all listed as Tier 1 state birds (DWAP-2005).*	Altered hydrology due to OMWM excavations; Pesticides;Invasive species; Mercury contamination; Salt Marsh Die-Back; Climate Change; Sea Level Rise.

Habitat Type	Reasons for Ranking	Limiting Factors/Threats
PRIORITY I HABITATS (cont.)		
II. Forested Uplands (Priority NVCS Associations)		
Southern Red Oak Forest; Mid-Atlantic Coastal Plain Loblolly Pine Forest; Mesic Coastal Plain Oak Forest; Mid-Atlantic Mesic Mixed Hardwood Forest; Pond Pine Woodland; Northern Coastal Plain Basic Mesic Hardwood Forest.	Delaware Wildlife Action Plan (2005) has designated any forested Upland Blocks > 250 acres as **Key Wildlife Habitat of Conservation Concern** due to rarity of large contiguous forested blocks in state; **Target Rocs:** Delmarva fox squirrel, Bald Eagle, Breeding Landbirds, especially Wood thrush, Bay-breasted warbler, Black and white warbler, Great Crested Flycatcher, Kentucky warbler, Northern flicker, Scarlet Tanager, Whip-Poor-Will, Yellow-throated Vireo; Migrating Landbirds.	Major Habitat Loss of Forested Upland Habitats (> 75%) in state and Habitat Fragmentation due to clear cutting for development, & agricultural practices; Fire Suppression; Invasive plant species; Agricultural runoff & residential areas creating elevated levels of Nitrogen, Phosphorus, & Enterococcus bacteria; Climate change and sea level rise.
III. Forested and Emergent Wetlands		
Red Maple/Seaside Alder Swamp	Based on current knowledge this community does not exist anywhere else in Delaware or North America (DNHP-2007); Rare plants found here include seaside alder (S2/G3), green-fringe orchid (S3), Mitchell's sedge and gibbous grass (S2); Rare animal species include Carpenter Frog (S1), Cope's Gray Treefrog (S1), Ribbon Snake (S2), Rough Green Snake (S2), Great Purple Hairstreak (S1), several rare firefly species (*Photuris spp.)*, & *Praeclara* Underwing Moth (S1); **Target Rocs: Prothonotary Warbler, Acadian Flycatcher, & Yellow-throated Vireo.**	This community is anthropogenically maintained by the refuge's Unit III Impoundment Infrastructure (2 large water control structures & mile-long dike) that provides water level management capabilities within 2,500 acres of emergent marsh. Drastic alterations to water levels on Prime Hook Creek could negatively impact rare plants and animals dependent on the Red Maple/Seaside Alder Swamp community; Groundwater withdrawals.
Atlantic White Cedar/Seaside Alder Swamp	Community is distinguished by Atlantic White Cedar in the canopy & seaside alder (S3) in the understory. Several rare plants associated with this habitat type include: coast sedge (S1), bayonet rush (S2), & flattened pipewort (S2). Rare Herps are also associated: Carpenter Frog (S1) – only 2 known populations extant in De; Cope's Gray Treefrog (S1), Ribbon Snake (S2), & Rough green snake (S2).	Habitat fragmentation and loss; Lack of fire to regenerate white cedar stands; Invasive species.

Habitat Type	Reasons for Ranking	Limiting Factors/Threats
PRIORITY I HABITATS (cont.)		
III. Forested and Emergent Wetlands (cont.)		
Swamp Cottonwood Coastal Plain Pond	Only a few examples of this community remain in Delaware. State and Regionally rare and globally uncommon (S1/G3 Tier 1) Marbled Underwing Moth resides within this community in association with its host plant, swamp cottonwood. **Target Rocs: *Catocala marmorata, Populus heterophylla,* breeding & migrating landbirds.**	Drainage ditches dug for refuge farming, eutrophication from Ag-fertilizer and pesticide runoff, & high beaver densities, invasive species.
Coastal Plain Freshwater Depression Ponds	Coastal plain ponds are unique non-tidal, isolated freshwater depressional ponds surrounded by forested canopy. Globally rare (G2) refuge depressional ponds provide habitat for several state rare-plants: slender blue-flag iris (S2), cattail sedge (S3) & Robbins spike-rush (S3).Rare state animal species supported by this community include Carpenter Frog (S1), Cope Gray Tree Frog (S1), Great Purple Hairstreak (S1) & Marbled Underwing (S1).	Delaware Heritage scientists rank this community for protection as these areas are not legally regulated by Delaware; Ponds are vulnerable to destruction via ditching, draining, filling-in wet areas & agricultural runoff of nutrients & pesticides. They are also threatened by groundwater depletion due to large irrigation systems adjacent to refuge lands that alter hydrology supporting these habitats; Mosquito Adulticide & Dimilin pesticide applications kill rare invertebrates.
Buttonbush Coastal Plain Pond	Globally Ranked G3 with very few occurrences in mid-Atlantic region, and **Habitat of Conservation Concern** in Delaware Wildlife Action Plan.	Community is threatened by groundwater alteration, agricultural run-off of fertilizers and pesticides and drainage ditches.
Twig-Rush Peat Mat Community	Unique and rare community in Delaware and found nowhere else in the state; Several populations of Twig Rush (S1), Ten-Angle Pipewort (S1), Umbrella Flat-sedge (S1), Bushy Bluestem (S1) & Tawny Cotton Grass (S1) support the most floristically diverse habitat-type on the refuge and in Delaware with over 66 uncommon plant species documented by DNHP (Delaware Natural Heritage Program), including 24 very rare state plant species and rare invertebrate and amphibian species. **Target ROCs: Identified as Tier 1 SGCN in DWAP – Pitcher Plant Moth, Elfin Skimmer, Sphagnum Sprite, Blueberry Dart, & several fire fly species.**	Invasive plant species; Poor Water Quality; Pesticide contamination from Agricultural run-off; Mosquito Adulticide or Dimilin chemical applications, and salt water intrusion.

Habitat Type	Reasons for Ranking	Limiting Factors/Threats
PRIORITY I HABITATS (cont.)		
III. Forested and Emergent Wetlands (cont.)		
Emergent Impounded Wetlands	Refuge Habitat-type acreage (4,200 acres) offers greatest contribution to BIDEH of freshwater habitats not well represented in state and eco-region. Water level management capability creates habitat food resources for a large number of priority ROCS especially migrating and wintering ducks, migrant Canada Geese (spring & fall), significant anadramous fish resources and state rare invertebrate SGCN. Six key perennial freshwater wetland communities and annual moist-soil vegetation support the best populations of S1 & S2 – Tier 2 invertebrates listed in DWAP. The lack of other sites in Delaware plus the concentration of rare invertebrate species exemplify the importance of PHNWR's impounded wetlands to rare species' long-term persistence in the state. **Target Rocs: Black Rail, Virginia Rail, Clapper Rail, Forster Tern, Least Bittern, American Bittern, Pied-billed Grebe, American Black Duck, Northern Pintail, Canada Geese; breeding and migrating shorebirds especially Dunlin, Yellowlegs, Short-billed Dowitcher, Avocets; Alewife, Blue-back Herring, Stripe-Bass, American Eel, American Shad & Hickory Shad; Lilypad forktail damselfly (*Ischnura kellicotti-S1),* Elfin Skimmer (*Nannothemis bella-S1),* and *(Photuris pensylvanica-S2)* firefly.**	Exotic plant invasions, especially *Phragmites & Ludwigia leptocarpa;* Water quality issues due to eutrophication both from on-refuge and off-refuge point sources of agricultural run-off; Mercury contamination; Ground water depletion from large commercial irrigation systems adjacent to refuge lands; Mosquito adulticide applications and associated drift effects; ten 25 foot-wide drainage ditches on private property feeding directly into Prime Hook Creek Unit III impoundment; Accidental spills of toxin and sewage; Groundwater withdrawals; Control of Mosquitoes and Forest Pests by Aerial Application of Pesticides; Climate Changes; Seal Level Rise, and salt water intrusion.
PRIORITY II HABITATS		
Mid-Atlantic Maritime Salt Shrub	Dominated by *Iva frutescens* or *Baccharis halimifolia* within associated salt marsh areas; Important shrub component includes *Morella cerifera*; **Target Roc *Catocala muliercula* (DE – only occurrence –State Record)*:* DWAP & DNHP recommends targeting as SGCN by conserving areas which contain host plant (*M. cerifera)*.**	Storm surges can cause shrub-die back; Invasive species encroachment; Control of Mosquitoes and Forest Pests by Aerial Application of Pesticides having negative impacts on invertebrates.

Habitat Type	Reasons for Ranking	Limiting Factors/Threats
PRIORITY II HABITATS (cont.)		
III. Forested and Emergent Wetlands (cont.)		
Successional Maritime Forest	Community consists of 184 acres of stunted forest of blackberry & sweetgum w/some red maple; Shrub layer dominated by *Morella cerifera & pensylvanica;* Community Ranked G2G3, restricted in range to coastal areas of 7 NE states; **Target ROCS : *Catocala muliercula;* Several high priority BCR 30 and PIF 44 bird species like Prairie Warbler; Migrating songbirds;**	Community is naturally restricted to areas directly affected by maritime processes (e.g., salt spray and bay winds); Other threats include succession, lack of disturbance & invasive plants. Historic habitat in Delaware eliminated by extensive residential development, road expansion, & recreation.
Coastal Plain Depression Swamp	3 Coastal Plain communities have been inventories on PHNWR. **Target ROCS: Spring & Fall migrating songbirds; State rare plants include *Carex typhina* (S3), & *Iris prismatica* (S2); Rare animals include Carpenter Frog, Cope's Gray Treefrog, Ribbon Snake, Rough Green Snake, Great Purple Hairstreak, Delaware Skipper, *Catocala praeclara*.**	Nitrates, phosphates & pesticides from agricultural run-off; Invasive species encroachment.
Coastal Loblolly Pine Wetland Forest	Supports uncommon plant species but refuge only contains 91 acres; Ranked as G3 community due to limited distribution dominate shrub species *Morella cerifera*. **Target ROCS: Priority BCR 30 & PIF 44 breeding & migrating landbirds.**	Lack of fire; Invasive plants; Landscape position of this community limited to mid-Atlantic (DE, MD, VA, NC) faces development pressures & degradation from agricultural practices.
Successional Sweetgum, Loblolly Sweetgum & Red Maple Sweetgum Forests	Soils in these associations have been negatively impacted by agricultural practices & are recovering from poor soil fertility; Sweetgum components naturally restore native soil biota & are eventually replaced by oaks, hickories and/or pines;	Invasive encroachment especially from Multiflora Rose and Japanese Stiltgrass.
Wax-Myrtle Shrub Swamp	Supports uncommon plant species & associated rare invertebrates, but refuge contains only a small portion of this community type (67 acres); **Target Rocs: *Catocala muliercula*** by securing the health of host plant (Wax-myrtle).	Habitat loss & degradation; Invasive species encroachment especially *Phragmites* & Mile-A-Minute; Mosquito Adulticide Use
Water-Willow Shrub Swamp	Community dominated by broad-leaved deciduous shrub *Decodon verticillatus* & associated w/ Peat-Bog communities. Refuge contains only a small portion of this habitat-type. **Target Rocs: Migratory landbirds & waterfowl.**	Salt water intrusion & invasive species encroachment.

Habitat Type	Reasons for Ranking	Limiting Factors/Threats
PRIORITY II HABITATS (cont.)		
III. Forested and Emergent Wetlands (cont.)		
Brackish Tidal Creek Shrub Swamp	Connected to high & low salt marsh. **Target Rocs: Prairie warbler, short-eared owl, sedge wren, coastal plain swamp sparrow.**	Heavy salt spray & tidal flooding from severe storms can cause die-back in shrub layers; *Phragmites* encroachment.
Early Successional Upland Habitats	Semi-natural Northeast Successional Shrub & Fallow agricultural fields. **Target Rocs: Prairie Warbler, Blue winged warbler, Brown thrasher, Eastern Towee, Field Sparrow, Northern Bobwhite, Whip-poor-will, Willow Flycatcher, Woodcock, *Papaipema maritime* S1- maritime sunflower borer moth, migrating warblers and other landbirds.**	Invasive species encroachment; Lack of habitat manipulations (Fire, Mowing, Hydro-axe) to set back succession.

- American Oystercatcher is a state endangered species. Horseshoe crabs have been listed as a sensitive & significant Delaware keystone species, & ASMFC-listed species w/ MAFMC Fishery Management Plan & TNC Ecoregion target species. Red Knot, Sanderling, Whimbrel & Beach Dune Tiger Beetle are Tier 1 listed species in Delaware Wildlife Action Plan (DWAP-2005).

- Tier 1 species as identified by the state are those species that are in need of immediate conservation action in order to sustain or restore their populations. Tier 1 species are the major focus of the DWAP (Delaware Wildlife Action Plan) which is based on analyzing threats that impact their populations and habitats, and on developing conservation actions to eliminate, compensate or minimize identified threats.

Appendix D-6. Priority Resources of Concern for Prime Hook NWR

Keystone Resources of Concern		Life History and Habitat Structure Requirements ==➔ (Objectives)	Other Benefiting Species
Focal Species or Focal Group	**Habitat Type =➔ (Goals)**		
American Oystercatcher Umbrella species for all breeding shorebirds dependent on Overwash and Beach Habitats.	**BARRIER BEACH ISLAND HABITATS** • Overwash Grassland Dunes • Atlantic Coastal Interdune Swale	Breeding: Nest in coastal habitats with little vegetative cover, mostly sandy beaches, or blowout areas in dunes. They feed on invertebrates found in overwash habitats and/ or wrack piles at the high tide line.	Piping Plover, Red Knot, Ruddy Turnstone, Black-billied Plover, Black Skimmer, Great-black-backed gull, American Black Duck, Willet, Common tern, Forster's tern, Least tern, Common night-hawk, Eastern towhee, Savannah sparrow, Diamond Back Terrapin, Horseshoe Crab, Migrating and Wintering waterfowl and wading birds, rare state listed invertebrate & native plant species.
Sanderling		Migration/Wintering: Feed on small crabs, aquatic and terrestrial invertebrates in sandy beaches and/or dune overwash areas.	
Whimbrel		Migration: Sandy beach, tidal flats, shorelines and wet open fields. Food – primarily marine invertebrates and small crabs.	

Keystone Resources of Concern		Life History and Habitat Structure Requirements ==➔ (Objectives)	Other Benefiting Species
Focal Species or Focal Group	**Habitat Type =➔ (Goals)**		
Beach Dune Tiger Beetle *(Cicindela hirticollis)* **Keystone and Indicator species of healthy Sandy Beach and Dune Grassland Habitats.**	• Irregularly Flooded Eastern Tidal Salt Shrub • Maritime Red Cedar Woodland • Successional Maritime Forest	Life History: Larval burrows are shallow (8-20 cm) in sandy soils where subsurface soil is constantly moist. They over winter as either adult or a larva. Adults are active from April-Oct. with 2 peaks: April to late June and early August – September. Females that ovipost in late June or July have their larvae reaching the third instar stage by late September. They only occur in sandy beach habitats or in overwash areas (very uncommon in De) with high rates of erosion and low plant density. Their tight association with patchily distributed, early successional, sandy areas makes them excellent keystone organisms for barrier beach island habitats. Within Delaware's natural landscape, ***Cicindela hirticollis*** also considered an indicator species of good quality beach communities (beach and panicgrass) dune grassland associations.	
Migratory Shorebirds dependent on overwash dune grasslands		Feeding and roosting habitats during May and June migrational period and July through October migration.	
Migratory Landbirds dependent on Maritime Shrub, Red Cedar Woodland, and Successional Maritime Forest		Feeding and roosting habitats during spring and fall migrational periods.	
Little Wife Underwing *(Catocala muliercula)* **Indicator species of healthy Irregularly flooded Eastern tidal salt shrub and Red Cedar Woodland communities.**		Resident State Record: Host plant is southern bayberry (*Morella cerifera).* State recommends conserving all communities with a significant component of host plant representative of irregularly flooded eastern tidal salt shrub.	

Keystone Resources of Concern		Life History and Habitat Structure Requirements ==➔ (Objectives)	Other Benefiting Species
Focal Species or Focal Group	**Habitat Type =➔ (Goals)**		
Delmarva fox squirrel **Umbrella Species for large patches of mixed hardwood forest habitats, forest interior dwelling songbirds, and migratory landbirds.**	**FORESTED UPLAND HABITATS (775 acres)** • Southern Red Oak/ Heath Forest • Mesic Coastal Plain Oak Forest • Mid-Atlantic Coastal Plain Loblolly Pine Forest • Northern Coastal Plain Mesic Hardwood Forest • Mid-Atlantic Mesic Mixed Hardwood Forest • Successional Sweetgum • Northern Coastal Plain Basic Mesic Hardwood Forest • Pond Pine Woodland	Both upland and bottomland forests are occupied; Upland forest must contain a variety of nut-bearing (hardwoods) and seed-bearing trees (loblolly); Mature forest stands also contain over-age trees bearing hollows for den sites; Winter Food Resources: Hard mast production – (HSI model describes potential for optimum mast production will occur where a mix of white and red oaks, hickories, walnuts and other mast producing trees comprise at least 40% of total canopy cover ; with mast producing trees $\geq$ 15 dbh. As tree canopy closure increases (> 60%), mast quality and quantity is reduced due to suppression and shading of tree crowns by adjacent trees. Optimum canopy closure between 20% to 60% . Canopy closure less than 20% or greater than 60 % is indicative of less suitable habitat for DFS. Generally, understory vegetation comprised of shrubs can decrease habitat quality. Optimum conditions occur when shrub crown closure is 30% or less. Habitat quality will decrease as the shrub density increases above 30% regardless of tree canopy closure and overstory size.	Frosted elfin, Marbled underwing, Tearful underwing, Noctuid moths (*Zeta metata & metatoides)*, American Red Start, Blue-winged Warbler, Worm-eating Warbler, Eastern wood pewee, Willow flycatcher, Eastern phoebe, Louisiana waterthrush, Eastern towhee, Baltimore oriole, Chuck will's widow, Red-bellied woodpecker, Downy woodpecker, Hairy woodpecker, Red-headed woodpecker, Cooper's Hawk, Red-tailed hawk, Barred owl, Silver-haired bat, Eastern Red bat, Hoary bat, Coyote, Deer, Turkey, Eastern box turtle, Five-lined skink, Corn snake, Red salamander and other native reptiles & amphibians.
Wood Thrush Nest Location/Type: Canopy/Open Cup Feeding Location = Canopy		Breeding: Mature deciduous or mixed (oak/pine) forests, preferably late-successional, mesic forests with a moderately dense shrub-subcanopy layer, moist soil and leaf litter. Trees taller than (50 feet), fairly open with substrate moisture more important than canopy cover. Probability of occurrence increases with forest patch size to a maximum of 500 (ha) (1235 acres) but does occur in fragments as small as 25 acres.	
Black and White Warbler Nest Location/Type: Ground/Open Cup Feeding Location: Canopy at mid-story.		Breeding: Area sensitive species that nests in mature and second-growth moist deciduous and mixed hardwood forests. Highly sensitive to forest fragmentation requiring blocks $\geq$ 740 acres (299 ha).	

Keystone Resources of Concern		Life History and Habitat Structure Requirements ==➔ (Objectives)	Other Benefiting Species
Focal Species or Focal Group	**Habitat Type =➔ (Goals)**		
Scarlet Tanager Nest Location/Type: Canopy/Open Cup Feeding Location = Canopy		Nests in mature deciduous forest, mixed swamp and floodplain forests and rich moist upland forests; Prefers oak trees > 9 inch dbh, with relatively closed canopy, a dense understory with a high diversity of shrubs; minimum forest area needed to sustain a viable population from 10-15 ha. In Maryland, 50% occurrence is reached for forest patches of 15 ha but 100 ha (250 acres) has been suggested as optimal patch size.	
Yellow-throated Vireo Nest = Canopy/Open Cup Feeding Location: High in canopy		Nests in rich mesophytic deciduous forest similar to Scarlet Tanager breeding habitat requirements.	
Kentucky Warbler Nest =Understory or ground/Open Cup Feeding Location = Ground		Breeding Habitats include mesophytic and rich deciduous forest, secondary growth and swamps with a slightly open canopy, dense understory and well-developed ground cover.	
Great Crested Flycatcher Nest = Snag/Cavity Feeding Location = Ground		Mature deciduous and mixed deciduous-coniferous forest near swamps and open water areas but more tolerant of forest fragmentation. Accepts a wide range of open to moderately closed canopy situations.	
Northern Flicker Nest Location = Snag/ Cavity Feeding Location = Sub-canopy		Open woodlands and edges of mature forest and or open areas with dead trees. Declining Flicker populations mostly due to loss of suitable nesting sites (dead trees).	
Whip-poor-will Nest Location: Ground/ Scrape Feeding Location: Sparse understory and open areas.		Deciduous and mixed upland forest adjacent to open areas (fields, wetlands or open water) with well spaced trees and a low canopy. Uncommon in mature forest, prefers even-aged successional habitats from regeneration to pole-stage stands. Data suggest that average home range (~ 125 acres or 50 ha) and most home ranges contain 50% open habitat.	

Keystone Resources of Concern		Life History and Habitat Structure Requirements ==➔ (Objectives)	Other Benefiting Species
Focal Species or Focal Group	**Habitat Type =➔ (Goals)**		
Bay-breasted Warbler & **Migratory Landbirds**		Migration: Seasonal frugivores; Many mature forest breeders use early successional habitats during post breeding periods with tall canopies (shrub-sapling canopies) that provide structured resources for protection from aerial predators and microhabitats with plentiful fruit and insect food resources. Radar studies have demonstrated that refuge forested upland areas are critical stopover habitats for fall migrating songbirds on Delmarva Peninsula.	
Bald Eagle		Breeding: Upland mature deciduous, coniferous or mixed forest near fishable waters. Coastal location of PHNWR makes anadromous fish species important food items in spring and summer, and large numbers of waterfowl are most important prey in fall and winter. Wintering: Congregate in large trees with stout branches, protection from storm winds and seclusion from human activity.	
Long-horned beetle *(Prionus laticollis)*		**Indicator Species of mature, healthy, diverse hardwood forest.**	
Acadian Flycatcher	**FORESTED WETLAND HABITATS (1,238 acres)** • Red Maple/Seaside Alder Swamp • Coastal Plain Depression Swamp • Atlantic White Cedar/Seaside Alder Saturated Forest • Swamp Cottonwood Coastal Plain Pond	Habitat generalist in mature wet or moist deciduous forests with dense understory. Breeds in large tracts of mature mesic forest patches with shrubby understory near creek or stream; often associated with swamps surrounded by dry forest tracts.	Delmarva Fox Squirrel's critical late winter and early spring feeding habitats; Black-crown and Yellow-crowned night herons; Wood Thrush, Northern Parula, American redstart, Worm-eating warbler, Kentucky warbler, rare obligate amphibian species like Carpenter Frog and Cope's Gray Treefrog, Eastern Ribbon Snake, Rough Green Snake, Eastern Spadefoot, Wood duck, other common reptile and amphibian species.

Keystone Resources of Concern		Life History and Habitat Structure Requirements ==➔ (Objectives)	Other Benefiting Species
Focal Species or Focal Group	**Habitat Type =➔ (Goals)**		
Prothonotary Warbler		Breeding: Requires swampy lowland forest or palustrine woods near standing water, especially mature bottomland hardwood forests subjected to flooding; Requires variety of natural cavities (2 to 35 feet high) over water.	
Yellow-throated Vireo		Mature floodplain forests and/or moist rich upland oaks (20-60 feet) tall; will also use deciduous-coniferous forest edge; Feeds extensively on moth and butterfly larvae in canopy of mature woods.	
Migratory Landbirds		Radar studies showed that refuge forested wetland areas provide critical stopover habitats for songbirds (esp. warblers & sparrows) during spring migration up the Delmarva Peninsula.	
Black Rail	**SALT MARSH HABITATS (2,200 acres)** • North Atlantic High Marsh • North Atlantic Low Marsh • Irregularly flooded Eastern tidal Salt Shrub • Salt Pannes	Breeding: Coastal salt and brackish marsh areas where nests are placed in high salt marsh flooded during extreme high tides. Nests placed in areas dominated by salt hay *(Spartina patens)*. These areas may also contain spike grass *(Distichlis spicata)*, black rush *(Juncus gerardi)*, or marsh elder *(Iva frutescens)*. Low salt marsh habitats dominated by salt-marsh cordgrass (*S. alterniflora)* are less favorable.	Detritus consumers and small carnivores: copepods, insect larvae, grass shrimp, mysids, amphipods, nematodes, fiddlesr crabs, bivalve mollusks; sheepshead and other minnow fish species, leaf hoppers, seaside dragonfly, other insect species, Common tern, King rail, Sora, Pied-billed grebe, Black-necked-stilt, Sedge wren, Marsh wren, American bittern, Northern harrier, Peregrine falcon, Marsh rice rat and other small mammals, short-eared and barn owls,;

Keystone Resources of Concern		Life History and Habitat Structure Requirements ==➔ (Objectives)	Other Benefiting Species
Focal Species or Focal Group	**Habitat Type =➔ (Goals)**		
Clapper Rail		Breeding: Preferred habitat is *Spartina* marsh and tend to concentrate along tidal creeks; Nests are usually in dense cover near water and built well above high tide mark; Diet > 90% animal matter, mostly parasitic worms (Ascaridae), clam worms (*Nereis Spp.*), shrimp (*Palaemonetes Spp.)*, snails (*Littorina & Melampus Spp.)*, fiddler crabs (*Uca Spp.)* and fish (*Fundulus Spp.)* but fiddler crabs is the most important food associated with smooth cordgrass. Tall form *S. alternifora* along ditches and ditched ponds provide the best breeding habitats.	
Least Tern		Breeding: Require open sand, soil, or dried mud in proximity of an estuary, river or tidal creek. Nests are located in areas of sparse vegetation and will not nest in areas with > 20% vegetation cover or in areas of tall vegetation. Nesting sites characterized as unstable areas created and maintained by tidal action or flooding with food requirements related to abundance and accessibility of small fish.	
Gull-billed tern		Breeding: In sandy beaches and saltwater coastal areas; forages over salt marshes and other open coastal areas mostly for insects & small fish.	
Black skimmers		Breeding: Coastal beach, sandbars, and/or salt marsh; feeds on aquatic invertebrates and small fish.	
Whimbrel		Migration: Use wetlands, salt marsh habitats and mudflats at low tide; migrating and wintering diets include worms, grubs, fiddler crabs and other aquatic organisms.	
Willet		Breeding: In salt marshes, shallow brackish marshes, wet meadows, mudflats, and/or native grassland habitats.	

Keystone Resources of Concern		Life History and Habitat Structure Requirements ==➔ (Objectives)	Other Benefiting Species
Focal Species or Focal Group	**Habitat Type =➔ (Goals)**		
Sharp-tailed Sparrow		Breeds exclusively in high salt marsh; Significant microhabitat characteristics of breeding populations include: 1) suitable elevated nest sites where there is a deep layer of *Spartina patens* thatch to protect nests from periodic tidal and storm flooding & 2) nearby openings in vegetation, pools, pannes or ditch edges and open mud for foraging; Optimum habitat contains nesting and feeding microhabitats in close proximity. *Juncus gerardi* is a good indicator of the very best saltmarsh sharp-tailed habitat.	
Seaside Sparrow **Keystone and indicator species of healthy *Spartina* High and Low Salt Marsh.**		Salt marsh specialists and indicator species of salt marsh ecosystem health; Wider habitat tolerance than sharp-tail sparrow; also found nesting in low salt marsh areas not used by sharp-tails. Presence of tall-form *S. alterniflora* good indicator of seaside sparrow habitat.	
Coastal Plain Swamp Sparrow **Keystone and Indicator species of North Atlantic High Marsh, Maritime Shrub and Irregularly Flooded Eastern Tidal Salt Shrub.**		Mid-Atlantic wetland specialist breeding from May to September. Favors *Spartina* High Marsh areas within a specific zone of salinity (< 15 ppt) consisting of patches of High Tide Bush (*Iva frutescens*) with an understory of salt hay (*S. patens).* Other plant species are often used as singing perches by males like *Spartina. cynosuroides.* Tidal guts and brackish ponds also present within optimal breeding habitats. Patches of *Schoenoplectus americanus* and *S. cynosuroides* are predictors of greatest nest success while *Iva* patches are marginal.	

Keystone Resources of Concern		Life History and Habitat Structure Requirements ==➔ (Objectives)	Other Benefiting Species
Focal Species or Focal Group	**Habitat Type =➔ (Goals)**		
American Black Duck		Wintering: Four variables limit ABDU use on estuarine open water (subtidal & intertidal) habitats critical for loafing, resting, feeding and escape habitats. These include 2 physical variables (water depth & presence of tidal flats) & 2 biological factors (aquatic plant & clam densities. Optimal subtidal open water is (< 1m deep) with 30% to 70% availability of shallow tidal waters interspersed with exposed mud flat feeding habitats ranging from 20-60% cover. This habitat structure provides critical animal foods in winter diet (mussels, snails, clams, crabs, amphipods & decapods), especially when impounded habitats are covered by snow or ice. Quality of water feeding habitats that support rooted vascular aquatic plant beds (>20%) occupied by *Ruppia* and/or *Potamogeton* are best. Optimal invert densities in wintering salt marsh habitats = >300 clams/m^2.	
American Black Duck	**IMPOUNDED FRESH/BRACKISH WETLANDS (4,200 acres)**	Impounded marshes with associated ponds and creeks also provide food and protection from storms, escape and resting cover. Optimal hemi-marsh conditions with >25% emergent vegetation supporting $\geq$ 750 snails/m^2 about (= 70 snails/ft^2) preferred.	Herons & Egrets, Osprey, Black-crowned night-heron, Gull-billed tern, Common tern, Mallard, Green-winged teal, Blue-winged teal, Ring-necked duck, Northern shoveler, American widgeon, Gadwall, Wood duck, Canada geese, snow geese, Tundra Swan, Banded Sun Fish, Four Spine Stickle Back, Black-Banded Sun Fish, Comely Shiner, White and Yellow perch.

Keystone Resources of Concern		Life History and Habitat Structure Requirements ==➔ (Objectives)	Other Benefiting Species
Focal Species or Focal Group	**Habitat Type =➔ (Goals)**		
Northern Pintail		Wintering: Prefer large, open shallow marshes with extensive emergent and submerged vegetation between 5 – 30 cm deep; Feeds on predominantly native plant seeds and vegetative material; Important moist-soil seeds include barnyard grass, sedges, smartweeds; important invertebrate foods in winter include snails, chironomids, & beetle (Coleoptera larvae); In brackish habitats wigeongrass, alkali bulrush, sea purslane and spike rush also provide good food and cover..	
Fall Migrating & Wintering Dabbling Ducks		Greatest densities in lacustrine, littoral, emergent, nonpersistent wetlands, characterized by beds of aquatic vegetation, emergent vegetation, interspersed with open water. Food consumption mostly, plant (75%) foods, with some animal (25%) foods.	
Spring Migrating Dabbling Ducks		Habitat Use & Staging Areas: Concentrate on larger wetland patches > 100 acres, with greater consumption of animal (65%) foods to plant (35%) foods.	
Snow Geese		Strategies to decrease: Modify Refuge upland habitat management of open field areas by reducing the acreage in agricultural habitats in favor of more natural habitats, to reduce Snow Goose use, increase migratory landbird use and benefit E/T species.	
Virginia Rail		Breeding: Prefers fresh or brackish marshes with shallow water and abundant emergent vegetation; Constructs nest in cattails or sedges just above shallow water, covered with a loose canopy of vegetation. Attaches nest to surrounding vegetation or on a clump of grass or tussock. Diet includes snails, worms and occasional small fish.	

Keystone Resources of Concern		Life History and Habitat Structure Requirements ==➔ (Objectives)	Other Benefiting Species
Focal Species or Focal Group	Habitat Type =➔ (Goals)		
Forster's Tern		Breeding: Extensive marshy areas (salt to freshwater) with vegetated nest sites partly open to water; Usually nests in small colonies (1-10 birds) on mats of floating dead vegetation, flattened cattails, muskrat houses near edges of open water and/or shallow depression in sand or mud; Sometimes uses abandoned nests of Pied-billed Grebes; Also *Spartina* grasses are often important components of nesting habitat as they are a major component of wrack and provide escape cover for chicks.	
Least Bittern		Breeding and wintering least bitterns inhabit freshwater to brackish wetlands, with dense emergent vegetation such as cattail and bulrush; Patches of > 5 ha with rank and tall (> 1m) emergent vegetation over relatively deep water (30-70 cm) interspersed with patches of open water are required for breeding; Nests usually placed over water or near open water; Diet consists of fish, tadpoles, aquatic insects and aquatic insects. Least Bitterns prefer more densely vegetated, deeper water habitats than American bitterns.	
American Bittern		In comparison to the sympatric Least Bittern, American Bittern uses a wider variety of wetland cover types. Breeding: Shallow freshwater wetlands with abundant emergent vegetation interspersed with patches of open water and aquatic-bed vegetation; Readily use wetlands created by impoundments associated with water depths < 10 cm with sparse to dense vegetative cover in patches > 25 ha. Slow, incomplete drawdown of impoundments can promote favorable emergent vegetative areas with appropriate water levels, while maintaining populations of small fish, amphibians and aquatic invertebrates.	
Dunlin		Migration: Favors coastal habitats with mudflats or sand flats, open beaches, tidal ditches and creeks and flooded grassland; Impounded mudflat habitats with water depths (0-4 cm) and invertebrate densities ≥ 4 gm/m^2.	

Keystone Resources of Concern		Life History and Habitat Structure Requirements ==➔ (Objectives)	Other Benefiting Species
Focal Species or Focal Group	**Habitat Type =➔ (Goals)**		
Short-billed Dowitcher		Migration: Shallow pools in salt marshes, sandy beaches or impounded wetland mudflat habitats with water depth range from 2 to 8 cm and aquatic insect densities $\geq$ 4 gm/ m^2.	
American Avocet		Spring/Fall Migration: Wetlands bordered by open flats or areas with scattered tufts of native grasses interspersed with open water.	
Greater/Lesser Yellowlegs		Migration: Shallow fresh, brackish and salt waters, mudflats, tidal flats, marshes and pools, rain pools in fields, and damp grassy meadows.	
River Herring; Important ecological roles in freshwater and estuarine food webs occupying level between zooplankton (their principal food) and piscivores. **Alewife & Blue-Back Herring:**		Schools of river herring enter estuarine & freshwater habitats once a year to spawn from March to July. Juvenile dispersal back to ocean from Oct – Nov or following spring. Habitat Cover Needs: Large creeks, streams and ponds including barrier beach ponds. Spawning substrates include sand, soft substrates, detritus and submerged vegetation with sluggish water flows and water depths from 15 cm to 3 m. Food for Larva & Juvenile: Larvae feed on copepods; Young-of-the year consume Chironmidae until July, switching to cladocerans in August to October.	
American Eel		Highly migratory with spawning and larval development and migration occurring in open ocean; Feeding/growth (elvers) occurring in estuarine and freshwater habitats, with migration of adults out to ocean again (Catadromous Life Cycle). Glass eels migrate into estuaries and freshwater habitats and metamorphose to elvers. Preferred freshwater habitats include lentic and lotic habitats where elvers feed mostly on invertebrates.	

Keystone Resources of Concern		Life History and Habitat Structure Requirements ==➔ (Objectives)	Other Benefiting Species
Focal Species or Focal Group	**Habitat Type =➔ (Goals)**		
Striped Bass		Adults migrate in early spring from Atlantic Ocean to freshwater habitats and juveniles migrate back to ocean in 2 – 5 years. **Nursery Requirements & Larvae Habitat:** Survival of larvae depends on temperature, salinity & D. O. Optimal temps (18 – 21°C with tolerances 12 -23 ° C) and salinity ranges 2 to 10 ppt. Low dissolved oxygen causes larvae mortality. Larvae food includes mysid shrimp, amphipods and fish up to 20 mm in length. Juveniles feed on mysids and insects.	
Rare Plant Communities	Impounded Freshwater Wetlands	Maintenance of Impoundment Infrastructure (Dikes, water control structures and dunes) to control salt water intrusion and set back succession in impounded wetlands.	See HMP for extensive list of rare plant communities and associated rare fauna dependent on these communities.
Prairie Warbler Nest Location = Subcanopy/ Open Cup Feeding Location: Subcanopy	**Early Successional Upland Habitats** • **Grasslands** • **Shrublands** • Transitional Shrubland • Young Shrubland • Old Shrubland • **Transitional forested areas in saplings**	Optimal breeding habitats = Young Shrubland with herbaceous vegetation < 20 cm (8 in) tall with patches of sparse cover. Other associated habitats include poor soils, brushy dune areas, coastal pine subclimax, burned-over and cut-over areas, fallow fields with scattered trees, corridors in hardwood swamps and grassland-forest ecotone.	Frosted elfin, American burying beetle, migrating and resident butterfly species, other early upland successional-dependent invertebrate species, Eastern box turtle, Milk snake, Short-eared owl, Northern Harrier, Common nighthawk, Black-billed and yellow billed cuckoos, Chestnut-sided Warbler, Yellow Warbler, Chimney swift, Least Flycatcher, Eastern Kingbird, Yellow-breasted Chat, Vesper Sparrow, Savannah Sparrow, Grasshopper Sparrow, Henslow sparrow, Black-bellied Plover, Migratory Canada geese, American woodcock, Least shrew, rare plant species.

Keystone Resources of Concern		Life History and Habitat Structure Requirements ==➔ (Objectives)	Other Benefiting Species
Focal Species or Focal Group	**Habitat Type =➔ (Goals)**		
Blue-winged Warbler Nest Location = Vine Tangle/Open Cup Feeding Location: subcanopy		Migrating: Dense growth near borders of swamps or creeks, woodland edges, brushy overgrown fields and thickets. Optimal breeding habitat = Old Shrubland. Prefers old fields with saplings greater than 3 m tall.	
Brown Thrasher Nest Location = Ground/ Cup Feeding Location: Sub-canopy		Optimal breeding habitat = Young Shrubland. Other associated habitats b include brushy edges of woodlands, dry thickets, overgrown fields, early successional woodlands, forest ecotones, shrubby undergrowth in open woods.	
Whip-poor-will Nest Location: Gound/No nest Feeding Location: open areas		Breeding structural habitat require-ments include Old Shrubland and open woodland, early successional forest, brushy field edges or deciduous and/or mixed forests with little to no brushy understory.	
Willow Flycatcher Nest Location: Subcanopy/ open cup Feeding Location = Canopy and subcanopy		Optimal breeding habitats = Young Shrubland: Fairly open areas with scattered shrubs. Breeding habitats range from brushy fields, shrubby swales to open woodland edges; Prefers edge habitats that include thickets or areas with small trees and shrubs surrounded by grasslands.	
Eastern Towhee Nest Location: Shrub/Cup Feeding Location: Shrub/ Thickets		Optimal breeding habitat = Young Shrubland: Habitat includes dense brushy areas, edges of woods, hedgerows and road thickets.	
Field Sparrow Nest Location = Shrub or sapling/Open Cup Feeding Location = Shrub/ Thickets		Optimal breeding habitat = Transitional Shrubland: Habitat includes areas with short structured grasses with shrubs or low trees, brushy hedgerows, abandoned fields where briars and brush starting to regenerate.	

Keystone Resources of Concern		Life History and Habitat Structure Requirements ==➔ (Objectives)	Other Benefiting Species
Focal Species or Focal Group	**Habitat Type =➔ (Goals)**		
Northern Bobwhite Nest Location = Tall grasslands and shallow depression lined with grass on ground Feeding Location = Ground in early successional habitats		Optimal breeding habitat = Grassland: Variety of early successional habitats including native grasslands, hedgerows, woodlands with grass and forbs ground cover, active and fallow crop fields. Regular habitat disturbance critical in maintaining bobwhite habitat. Grassland community types adjacent to Transitional Shrublands with defined edges provide ideal nesting, brood-rearing, feeding, loafing, travel and escape cover.	
Henslow's Sparrow **Umbrella species for entire suite of early successional, grassland-dependent species, both breeding and migrating.**		Optimal breeding habitat: Patch sizes ≥ 30 ha (75 acres) in moderately tall grassy vegetation (> 30 cm), with well-developed litter layer and minimal woody species encroachment (< 20 %).	
Papaipema maritima (S1-Maritime Sunflower Borer Moth); This species is thought to represent a subspecies near the brink of extirpation and was last recorded in Delaware in 1934. **Indicator species of healthy early sucsessional grassland habitats.**		Rarest animal species found in state surveys of Refuge habitats (2004-2005). Species is totally dependent on the giant sunflower (***Helianthus giganteus-S3)*** that thrives in herbaceous early successional habitats.	

Appendix D–Table A. Species List and Priority Refuge Habitats for Prime Hook National Wildlife Refuge in Milton, Delaware of the Coastal Delaware National Wildlife Refuge Complex

Species List and Priority Refuge Habitats	Seasons on Refuge[1]	Refuge Purpose Species	BIDEH	Federal T&E for DE[2]	State T&E[3]	BCR 30[4]	PIF 44[5]	State Comprehensive Wildlife Conservation Plan Priorities[6]	USFWS Birds of Conservation Concern[7]	Federal Trust Fish Species (USFWS Trend Data)[8]	Shorebird Plan-Atlantic Flyway[9]	Waterbird Plan[10]	MANEM Conservation Priority[11]	Waterfowl Plan[12]
I. BARRIER ISLAND BEACH HABITATS														
Overwash Dunes **(Priority I Habitat)**			X					X						
Beachgrass/Panicgrass Dune Grassland **(Priority I)**			X					X						
Atlantic Coast Interdune Swale **(Priority I)**			X					X						
Maritime Red Cedar Woodland **(Priority I)**			X					X						
Mid-Atlantic Maritime Salt Shrub **(Priority II)**			X					X						
Successional Maritime Forest **(Priority II)**			X					X						
II(A). FORESTED UPLAND HABITATS														
Southern Red Oak/Heath Forest **(Priority I)**			X					X						
Mesic Coastal Plain Oak Forest **(Priority I)**			X					X						
Coastal Loblolly Pine Forest **(Priority I)**			X					X						
Mesic Coastal Plain Rich Forest **(Priority I)**			X					X						
Mesic Coastal Plain Mixed Hardwood Forest **(Priority I)**			X					X						
Pond Pine Sweetbay Prickly Bog Sedge **(Priority I)**			X					X						
Successional Sweetgum; Red Maple Sweetgum Forest **(Priority II)**			X											

Species List and Priority Refuge Habitats

	Seasons on Refuge[1]	Refuge Purpose Species	BIDEH	Federal T&E for DE[2]	State T&E[3]	BCR 30[4]	PIF 44[5]	State Comprehensive Wildlife Conservation Plan Priorities[6]	USFWS Birds of Conservation Concern[7]	Federal Trust Fish Species (USFWS Trend Data)[8]	Shorebird Plan-Atlantic Flyway[9]	Waterbird Plan[10]	MANEM Conservation Priority[11]	Waterfowl Plan[12]
II(B). WETLAND FORESTS														
Red Maple/Seaside Alder Swamp **(Priority I)**			X					X						
Atlantic White Cedar/Seaside Alder Saturated Forest **(Priority I)**			X					X						
Swamp Cottonwood Coastal Plain Seasonal Pond **(Priority I)**			X					X						
II(B). WETLAND FORESTS (cont.)														
Coastal Plain Depression Swamp **(Priority II)**			X					X						
Coastal Loblolly Pine Wetland Forest **(Priority II)**			X											
III. WETLANDS														
Coastal Plain Freshwater Depressional Ponds **(Priority I)**			X					X						
Twig-Rush Peat Mat Community **(Priority I)**			X					X						
Button-Bush Coastal Plain Pond **(Priority I)**			X					X						
Emergent Impounded Wetlands **(Priority I)**			X					X						
Wax-myrthle Shrub Swamp **(Priority II)**			X					X						
North Atlantic High Salt Marsh **(Priority I)**			X					X						
Water Willow Shrub Swamp **(Priority II)**			X											
Brackish Tidal Creek Shrubland **(Priority II)**			X											
North Atlantic Spartina Low Salt Marsh **(Priority I)**			X					X						
IV. EARLY SUCCESSIONAL UPLAND HABITATS														
Native Grassland and Herbaceous			X					X						
Native Transitional Habitats : Grassland/.Shrubland/Young Trees			X					X						

Species List and Priority Refuge Habitats

	Seasons on Refuge[1]	Refuge Purpose Species	BIDEH	Federal T&E for DE[2]	State T&E[3]	BCR 30[4]	PIF 44[5]	State Comprehensive Wildlife Conservation Plan Priorities[6]	USFWS Birds of Conservation Concern[7]	Federal Trust Fish Species (USFWS Trend Data)[8]	Shorebird Plan-Atlantic Flyway[9]	Waterbird Plan[10]	MANEM Conservation Priority[11]	Waterfowl Plan[12]
WATERBIRDS														
American bittern *Botaurus lentiginosus*	SpSF	X				M		2				-	HH	
American coot *Fulica americana*	FW	X						2					L	
American white pelican *Pelecanus erythrorhynchos*	S	X												
Arctic tern *Sterna paradisaea*	SpF	X						2				H	HH	
Audubon's shearwater *Puffinus lheriminieri*	SpF	X				H		1				HI	HH	
Black rail *Laterullus jamaicensis*	SpSF	X			E	HH	1a	1	X			-	HH	
Black skimmer *Rhynchos niger*	SpSF	X			E	M	1a	1	X			H	HH	
Black-crowned night heron *Nycticorax nycticorax*	Yr	X			E			1				M	HH	
Black-headed gull *Larus ridibundus*	W	X												
Brown pelican *Pelecanus occidentalis*	S	X						2					M	
Cattle egret *Bubulus ibis*	SpSF	X						2					M	
Caspian tern *Sterna caspia*	SpSF	X										L	L	
Clapper rail *Rallus longirostris*	Yr	X				H	2b					-	H	
Common Moorhen *Gallinula chloropus*	SpSF	X						2				M	L	
Common tern *Sterna hirundo*	SpSF	X			E	M		1	X			L	HH	
Cory's shearwater *Calonectris diomedea*	W	X				M						M	H	
Double-crested cormorant *phalacrocorax auritus*	Yr	X						2					L	
Forster's tern *Sterna forsteri*	Yr	X			E	H	2b	1				M	H	
Glossy ibis *Plegadis falcinellus*	Yr	X				H		2				L	HH	

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WATERBIRDS (cont.)														
Great black-backed gull *Larus marinus*	Yr	X						2					L	
Great blue heron *Ardea herodias*	Yr	X						2					H	
Great cormorant *Phalacrocorax carbo*	SpW	X						2					H	
Great egret *Ardea alba*	Yr	X						2					M	
Greater shearwater *Puffinus gravis*	W	X				H		2				H	HH	
Green Heron *Butorides virescens*	SpSF	X												
Gull-billed tern *Sterna nilotica*	SpS	X				HH		2				H	HH	
Herring gull *Larus argentatus*	Yr	X										L	H	
King rail *Rallus elegans*	SpF	X				M	1b	2				-	HH	
Laughing gull *Larus atricilla*	SpSF	X												
Least bittern *Ixobrychus exilis*	SpS	X				M		2				-	HH	
Least tern *Sterna antillarum*	SpSF	X			E	H	1a	1	X			H	HH	
Little blue heron *Egretta caerulea*	SpSF	X				M		2				H	HH	
Northern gannet *Morus bassanus*	SpS	X				H						N	M	
Pied-billed grebe *Podilymbus podiceps*	Yr	X			E			1					HH	
Red-throated loon *Gavia stellata*	SpSF	X				HH		2				-	HH	
Roseate tern *Sterna dougallii*	SF	X		E		HH		1				H	HH	
Ross' gull *Rhodostethia rosea*	W	X												
Royal tern *Sterna maxima*	SpSF	X				M						M	H	
Snowy egret *Egretta thula*	Yr	X				M		2				H	HH	

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WATERBIRDS (cont.)														
Sora *Porzana carolina*	SpSF	X				M		2				-	H	
Tricolored heron *Egretta tricolor*	SpSF	X				M		2				H	HH	
Virginia rail *Rallus limicola*	Yr	X					2a							
Yellow rail *Coturnicops noveboracensis*	SpF	X						2					H	
Yellow-crowned night heron *Nyctanassa violacea*	SpS	X			E	M		1				M	H	
WATERFOWL														
American black duck *Ana rubripes*	Yr	X				HH	1a	1						D
American wigeon *Ana americana*	FW	X				M								S
Atlantic brant *Branta bernicula*	FW	X				HH		2						S
Black-bellied whistling duck *Dendrocygna autumnalis*	FW	X												
Black scoter *Melanitta nigra*	FW	X				H		2						D
Blue-winged teal *Anas dicors*	SpSF	X												S
Bufflehead *Bucephala albeola*	SpFW	X				H		2						I
Canada goose – Atlantic Population *Branta canadensis*	FW	X				HH								I
Canada goose – N. Atlantic	FW	X				H		1						U
Resident Canada Geese *Branta canadensis*	Yr													I
Canvasback *Aythya valisineria*	W	X				H								
Common eider *Somateria mollissima*	W	X				H		2						S
Common goldeneye *Bucephala clangula*	SpFW	X				M								S

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WATERFOWL (cont.)														
Gadwall *Ana strepera*	Yr	X				M								I
Greater scaup *Aythya marila*	SpFW	X				H		2						S
Green-winged teal *Anas crecca carolinensis*	Yr	X				M								I
Harlequin duck *Histronicus histrionicus*	W	X				M								S
Hooded merganser *Lophodytes cucullatus*	Yr	X				M		2						I
King eider *Somateria spectabilis*	W	X												
Lesser scaup *Aythya affinis*	SpFW	X				H		2						D
Long-tailed duck *Clangula hyemalis*	SpFW	X				H		2						D
Mallard *Ana platyrhynochos*	Yr	X				H		2						S
Northern pintail *Anas acuta*	SpFW	X				M								D
Northern shoveler *Anas clypeata*	SpFW	X						2						
Red-breasted merganser *Mergus serrator*	SpFW	X				M								I
Redhead *Aytha americana*	SpFW	X						2						
Ring-necked *Aythya collaris*	SpFW	X						2						
Ruddy duck *Oxyura jamaicensis*	Yr	X				M								I
Snow Geese *Chen caerulescens*	Sp FW	X												I
Surf scoter *Melanitta perspicillata*	FW	X				H		2						D
Tundra swan – Eastern *Cygnus columbianus*	SpFW	X				H		2						I
White-winged scoter *Melanitta fusca*	FW	X				H		2						D
Wood duck – Eastern *Aix sponsa*	Yr	X				M								I

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SHOREBIRDS														
American avocet *Recurvirostra americana*	SpSF	X				M					3			
American golden plover *Pluvialis dominica*	SpSF	X				H		2			4			
American oystercatcher *Haematopus palliates*	SpS	X			E	HH	1a	1	X		5			
American woodcock *Scolopax minor*	Yr	X				HH	1a	1			5			
Baird's sandpiper *Calidris bairdii*	SF	X									2			
Black-bellied plover *Pluvalis squatarola*	SpSF	X				H		2			3			
Black-necked stilt *Himantopus mexicanus*	SpSF	X						2						
Buff-breasted sandpiper *Tryngites subruficollis*	F	X				H		2	X		4			
Common snipe *Gallinago delicate*	Yr	X				M					3			
Dunlin *Calidris alpina*	Yr	X				H		2			3			
Eskimo curlew *Numenius borealis*				E							5			
Greater yellowlegs *Tringa melanoleuca*	Yr	X				H		2			4			
Hudsonian godwit *Limosa haemastica*	SpSF	X				H		2	X		4			
Killdeer *Charadrius vociferous*	Yr	X				M					2			
Least sandpiper *Calidris minutilla*	Yr	X				M					3			
Lesser yellowlegs *Tringa flavipes*	Yr	X				M					2			
Long-billed dowitcher *Limnodromus scolopaceus*	SpSF	X									2			

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SHOREBIRDS (cont.)														
Marbled godwit *Limosa fedoa*	SpF	X				H		2	X		4			
Pectoral sandpiper *Calidris melanotos*	SpSF	X									2			
Piping plover *Charadrius melodus*	SF	X		T	E	HH	1a	1			5			
Purple Sandpiper *Calidris maritima*	W	X				H								
Red knot *Calidris melodus*	SpS	X				HH		1	X		5			
Red phalarope *Phalaropus fulicarius*	SpF	X				M					3			
Red-necked phalarope *Phalaropus lobatus*	SpSF	X				M		2			3			
Ruddy turnstone *Arenaria interpres*	Yr	X				HH					4			
Ruff *Philomachus pugnax*	SpF	X						1			4			
Sanderling *Calidris alba*	Yr	X				HH								
Semipalmated plover *Charadrius semipalmatus*	SpSF	X				M					2			
Semipalmated sandpiper *Calidris pusilla*	SpSF	X				H		2			4			
Short-billed dowitcher *Limnodromus griseus*	Yr	X				H		2			3			
Solitary sandpiper *Tringa solitaria*	SpSF	X				H		2			3			
Spotted sandpiper *Actitis macularius*	SpSF	X				M		1			3			
Stilt sandpiper *Calidris himantopus*	SpSF	X									3			
Upland sandpiper *Bartramia longicauda*	SpSF	X			E	M	1b	1	X		4			
Western sandpiper *Calidris mauri*	SpSF	X				M					2			
Whimbrel *Numenius phaeopus*	SpS	X				HH		1	X		5			
White-rumped sandpiper *Calidris fuscicollis*	SpSF	X				H		2			3			

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SHOREBIRDS (cont.)														
Willet *Tringa semipalmata*	SpSF	X				H	2b	2			4			
Wilson's phalarope *Phalaropus tricolor*	SpSF	X				H		2			3			
Wilson's plover *Charadrius wilsonia*	SpS	X				H	1b	2	X		4			
LANDBIRDS														
Acadian flycatcher *Empidonax virescens*	SpSF	X												
American kestrel *Falco sparverius*	Yr	X												
American redstart *Setophaga ruticilla*	SpSF	X						1						
American robin *Turdus migratorius*	Yr	X												
Bachman's sparrow						M								
Bald eagle *Haliaeetus leucocephalus*	Yr	X			E	M	3	1						
Baltimore oriole *Icterus galbula*	SpSF	X				H		2	X					
Bank swallow *Hirundo rustica*	SpSF	X						2						
Barn owl *Tyto alba*	Yr	X						2						
Barred owl *Strix varia*	Yr	X						2						
Bay-breasted warbler *Dendroica castanea*	SpF	X				H								
Bicknell's thrush *Catharus bicknelli*	SpF	X				H		1						
Blackburnian warbler						M								
Black-capped chickadee *Poecile atricapillus*	Yr	X						1						
Black-throated blue warbler *Dendroica caerules*	SpF	X												
Black-throated green warbler *Dendroica virens*	SpF	X												

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LANDBIRDS (cont.)														
Black vulture *Coragyps atratus*	Yr	X						2						
Black-and-white warbler *Mniotilta varia*	SpSF	X				H		2						
Black-billed cuckoo *Coccyzus erythropthalmus*	SpSF	X						2						
Blue-gray gnatcatcher *Polioptila caerulea*	SpSF	X												
Blue-headed vireo *Vireo solitarius*	SpF	X												
Blue-winged warbler *Vermivora pinus*	SpF	X					1b	1	X					
Bobolink *Dolichonyx oryzivorus*	SpF	X						2						
Broad-winged Hawk		X				H								
Brown creeper *Certhia americana*	SpFW	X			E			1						
Brown thrasher *Toxostoma rufum*	Yr	X				H	2a	2						
Brown-headed nuthatch *Sitta pusilla*	Yr	X				M	1b	2						
Canada warbler *Wilsonia canadensis*	SpSF	X				M	1b	2	X					
Cedar waxwing *Bombycilla cedrorum*	Yr	X												
Cerulean warbler *Dendroica cerulea*	SpSF	X			E	M		1	X					
Chestnut-sided warbler *Dnedroica pensylvanica*	SpSF	X						2						
Chimney swift *Chaetura pelagica*	SpSF	X				H	2a	2						
Chuck-will's-widow *Caprimulgus carolinensis*	SpSF	X												
Coastal plain swamp sparrow *Melospiza Georgiana nigrescens*	Yr	X				M								
Common nighthawk *Chordeiles minor*	SpSF	X						1						
Common yellowthroat *Geothlypis trichas*	Yr	X												

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LANDBIRDS (cont.)														
Cooper's hawk *Accipter cooperii*	Yr	X			E			1						
Eastern bluebird *Sialia sialis*	SpS	X				H								
Eastern kingbird *Tyrannus tyrannus*	SpSF	X						2						
Eastern phoebe *Sayornis phoebe*	Yr	X												
Eastern towhee *Pipilo erythrophthalmus*	Yr	X					2a	2						
Eastern wood-pewee *Contopus virens*	SpSF	X					2a							
Field sparrow *Spizella pusilla*	Yr	X				H	2a	2						
Golden crowned kinglet *Regulus satrapa*	Yr	X												
Golden-winged warbler *Vermivora chrysoptera*	SpF	X				M		2	X					
Grasshopper sparrow *Ammodramus savannarum*	SpSF	X				M	2c	2						
Gray catbird *Dumetella carolinensis*	Yr	X				M	2a							
Great crested flycatcher *Myiarchus crinitus*	SpSF	X				H		2						
Henslow's sparrow *Ammodramus henslowii*	S	X			E	H	1b	1	X					
Hermit thrush *Catharus*	SpSF	X												
Hooded warbler *Wilsonia citrina*	SpSF	X			E			1						
Horned Lark *Eremophila alpestris*	SpSF	X												
Ipswitch Savannah Sparrow						M								
Kentucky warbler *Oporornis formosus*	SpSF	X				H	1a	2	X					
Least flycatcher *Empidonax minimus*	SpSF	X						2						
Loggerhead shrike *Lanius ludovicianus*					E	M		1						

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LANDBIRDS (cont.)														
Long-eared owl *Asio otus*	W	X						1						
Louisiana waterthrush *Seiurus motacilla*	SpS	X				H	2c	2						
Marsh wren *Cistothotus palustris*	Yr	X				H	2a	2	X					
Merlin *Falco columbarius*	SpFW	X												
Nelson's sharp-tailed sparrow *Ammodramus nelsoni*	W	X				M								
Northern bobwhite *Colinus virginianus*	Yr	X				H	2a	2						
Northern flicker *Colaptes auratus*	Yr	X				H		2						
Northern harrier *Circus cyaneus*	Yr	X			E			1						
Northern shrike *Lanius excubitor*	W	X												
Northern waterthrush *Seiurus noveboracensis*	SpF	X												
Northern parula *Parula americana*	SpFW	X			E			1						
Orange-crowned warbler *Vermivora celata*	F	X												
Osprey *Pandion haliaetus*	SpSF	X						1						
Peregrine falcon	SpFW	X						2	X					
Palm warbler *Dendroica palmarum*	SpF	X												
Pine warbler *Dendroica pinus*	Yr	X												
Prairie warbler *Dendroica discolor*	SpSF	X					1a	1	X					
Prothonotary warbler *Protonotaria citrea*	SpSF	X				H	1a	2						
Red-breasted nuthatch *Sitta canadensis*	SpFW	X												

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LANDBIRDS (cont.)														
Red-eyed vireo *Vireo olivaceus*	SpSF	X					1b							
Red-headed woodpecker *Melanerpes erythrocephalus*	Yr	X			E	M	1b	1	X					
Red-shouldered hawk *Buteo lineatus*	Yr	X						2						
Saltmarsh sharp-tailed sparrow *Ammodramus caudacutus*	Yr	X					1a	1	X					
Savannah sparrow *Passerculus sandwichenis*	SpFW	X						2						
Scarlet tanager *Piranga olivacea*	SpSF	X				H	2a	2						
Seaside Sparrow *Ammodramus maritimus*	Yr	X				M	1a	1	X					
Sedge wren *Cistothorus platensis*	Yr	X			E	M	2c	1	X					
Sharp-shinned hawk *Accipter striatus*	SpFW	X						1						
Short-eared owl *Asio flammeus*	SpFW	X			E	M	1b	1	X					
Summer tanager *Piranga rubra*	SpSF	X												
Swainson's warbler *Catharus ustulatus*	SF	X			E	M	1b	1						
Veery *Catharus fuscescens*	SpF	X						2						
Vesper sparrow *Pooecetes gramineus*	SpS	X						2						
Warbling vireo *Vireo gilvus*	SpS	X						2						
Whip-poor-will *Caprimulgus vociferus*	SpSF	X				H	2a	2	X					
White-breasted nuthatch *Sitta carolinensis*	Yr	X												
White-eyed vireo *Vireo griseus*	SpSF	X												
Willow flycatcher *Empidonax traillii*	SpSF	X				H	1b	2						
Wood thrush *Hylocichla mustelina*	SpSF	X					1a	1	X					

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LANDBIRDS (cont.)														
Worm-eating warbler *Helmitheros vermivorum*	SpS	X				H	1a	2	X					
Yellow-billed cuckoo *Coccyzus americanus*	SpSF	X												
Yellow-breasted chat *Icteria virens*	Yr	X						2						
Yellow-rumped warbler *Dendroica coronata*	SpFW	X												
Yellow-throated vireo *Vireo flavifrons*	SpSF	X				H	2a	2						
Yellow-throated warbler *Denroica dominica*	SpSf	X						2						
Yellow warbler *Dendroica petechia*	SpSF	X												
MAMMALS														
American beaver *Castor canadensis* (S3)	Yr													
American mink *Mustela vison* (S3)	Yr													
Big brown bat *Eptesicus fuscus*	Yr													
Coyote *Canis latrans*	Yr							2						
Delmarva fox squirrel *Sciurus niger cinereus*	Yr	X		E	E			1						
Eastern cottontail *Sylvilagus floridanus*	Yr													
Eastern gray squirrel *Sciurus carolinensis*	Yr													
Eastern mole *Scalopus aquaticus*	Yr													
Eastern pipistrelle *Pipistrellus subflavus*	Yr													
Eastern red bat *Lasiurus borealis*	Yr							2						

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MAMMALS (cont.)														
Eastern small-footed bat								1						
Evening bat *Nycticeius humeralis*								2						
Gray fox *Urocyon cinereoargenteus*	Yr													
Hoary bat *Lasiurus cinereus*	Yr							2						
Little brown bat *Myotis lucifugus*	Yr													
Long-tailed weasel *Mustela frenata*	Yr							2						
Marsh rice rat *Oryzomys palustris* (S3)	Yr													
Maryland shrew *Sorex fontinalis*														
Masked shrew *Sorex cinereus*	Yr													
Meadow jumping mouse *Zapus hudsonius*	Yr							2						
Meadow vole *Microtus pennsylvanicus*	Yr													
Muskrat *Ondatra zibethicus*	Yr													
North American least shrew *Cryptotis parva*	Yr													
Northern raccoon *Procyon lotor*	Yr							2						
Northern river otter *Lutra canadensis*	Yr													
Red fox *Vulpes vulpes*	Yr													
Short-tailed shrew *Blarina brevicauda*	Yr													
Silver-haired bat *Lasionycteris noctivagans*	Yr							2						
Southern flying squirrel *Glaucomys volans*	Yr													

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MAMMALS (cont.)														
Star-nosed mole *Condylura cristata* (S4)	Yr													
Striped skunk *Mephitis mephitis*	Yr													
Virginia opossum *Didelphis marsupialis*	Yr													
White-footed mouse *Permomyscus lencopus*	Yr													
White-tailed deer *Odocoileus virginianus*	Yr													
Woodchuck *Marmota monax*	Yr													
Woodland vole *Microtus pinetorum* (S4)	Yr													
AMPHIBIANS														
American bullfrog *Rana catesbeiana*	Yr													
Barking tree frog *Hyla gratiosa*	Yr				E			1						
Carpenter fog *Rana virgatipes*	Yr				S1			1						
Cope's gray treefrog *Hyla versicolor*	Yr				S1			2						
Eastern cricket frog *Acris creoitans crepitans*	Yr													
Eastern mud salamander *Pseudotriton montanus montanus*	Yr							2						
Eastern spadefoot toad *Scaphiopus holbrookii*	Yr							2						
Eastern red-backed salamander *Plethodon cinereus*	Yr													
Eastern Tiger salamander *Ambystoma tigrinum tigrinum*					E			1						

Species List and Priority Refuge Habitats

	Seasons on Refuge[1]	Refuge Purpose Species	BIDEH	Federal T&E for DE[2]	State T&E[3]	BCR 30[4]	PIF 44[5]	State Comprehensive Wildlife Conservation Plan Priorities[6]	USFWS Birds of Conservation Concern[7]	Federal Trust Fish Species (USFWS Trend Data)[8]	Shorebird Plan-Atlantic Flyway[9]	Waterbird Plan[10]	MANEM Conservation Priority[11]	Waterfowl Plan[12]
Four-toed salamander *Hemidactylium scutatum*	Yr							2						
AMPHIBIANS (cont.)														
Fowler's toad *Bufo fowleri*	Yr													
Green treefrog *Hyla cinerea*	Yr													
Marbled salamander *Amsystoma opacum*	Yr													
New Jersey chorus frog *Pseudacris feriarum kalmi*	Yr													
Northern green frog *Rana clamitans melanota*	Yr													
Northern red salamander *Pseudotrton rubber ruber*	Yr													
Northern spring peeper *Pseudacris crucifer crucifer*	Yr													
Pickerel frog *Rana palustris*	Yr													
Southern leopard frog *Rana sphenocephala sphenocephala*	Yr													
Spotted salamander *Ambystoma maculatum*	Yr							2						
Wood frog *Rana sylvatica*	Yr													
REPTILES														
Atlantic green turtle *Chelonia mydas mydas*				T	E			1						
Atlantic hawksbill turtle *Eretmochelys imbricata imbricata*				E				2						
Atlantic leatherback turtle *Dermochelys coriacea*				E	E			1						
Atlantic loggerhead turtle *Caretta caretta*				T	E			1						
Black rat snake *Elaphe obsolete obsoleta*	Yr													
Bog turtle *Glyptemys muhlenbergii*				T	E			1						
Broadhead skink *Eumeces laticeps*								1						

Species List and Priority Refuge Habitats

	Seasons on Refuge[1]	Refuge Purpose Species	BIDEH	Federal T&E for DE[2]	State T&E[3]	BCR 30[4]	PIF 44[5]	State Comprehensive Wildlife Conservation Plan Priorities[6]	USFWS Birds of Conservation Concern[7]	Federal Trust Fish Species (USFWS Trend Data)[8]	Shorebird Plan-Atlantic Flyway[9]	Waterbird Plan[10]	MANEM Conservation Priority[11]	Waterfowl Plan[12]
REPTILES (cont.)														
Corn snake *Elaphe guttata guttata*	Yr				E			1						
Diamond Back Terrapin *Malaclemys terrapin terrapin*	SpSF							2						
Eastern box turtle *Terrapene carolina carolina*	Yr							1						
Eastern hognose snake *Heterodon platirhinos*	Yr							2						
Eastern kingsnake *Lampropeltis getula getula*	Yr							2						
Eastern milk snake *Lampropeltis triangulum*								1						
Eastern mud turtle *Kinosternon subrubrum subrubrum*	Yr													
Eastern painted turtle *Chrysemys picta picta*	Yr													
Eastern snapping turtle *Chelydra serpentine serpentine*	Yr													
Kemp's ridley sea turtle *Lepidochelys kempii*				E	E			1						
Northern black racer *Coluber constrictor constrictor*	Yr													
Northern brown snake *Storeria dekayi dekayi*	Yr													
Northern copperhead *Agkistrodon contortrix mokasen*								2						
Northern red-bellied snake *Storeria occipitomaculata occipitomaculata*	Yr							2						
Northern water snake *Nerodia sipedon sipedon*	Yr													
Queen snake *Regina septemvittata*								2						
Redbelly water snake N*erodia erythrogaster*								1						
Red-bellied turtle/Northern red-bellied cooter *Pseudemys rubiventris*	Yr							2						

Species List and Priority Refuge Habitats

	Seasons on Refuge[1]	Refuge Purpose Species	BIDEH	Federal T&E for DE[2]	State T&E[3]	BCR 30[4]	PIF 44[5]	State Comprehensive Wildlife Conservation Plan Priorities[6]	USFWS Birds of Conservation Concern[7]	Federal Trust Fish Species (USFWS Trend Data)[8]	Shorebird Plan-Atlantic Flyway[9]	Waterbird Plan[10]	MANEM Conservation Priority[11]	Waterfowl Plan[12]
REPTILES (cont.)														
Ribbon Snake *Thamnophis sauritus sauritus*	Yr				S2			2						
Rough green snake *Opheodrys aestivus aestivus*	Yr				S2			2						
Smooth/Eastern earthsnake *Virginia valeriae*								2						
Spotted turtle *Clemmys guttata*	Yr				S2			1						
Stinkpot *Sternotherus odoratus*	Yr													
FISH														
Alewife *Alosa pseudoharengus*	SpS		X							D				
American brook lamprey *Lampetra appendix*								2		D				
American Eel *Anguilla rostrata*	SpSF		X		S1			1						
American Shad *Alosa sapidissima*	SpSF		X					1						
Atlantic croaker *Micropogonias undulatus*	SpSF		X					2		D				
Atlantic silverside *Menidia menidia*	SpSF		X							D				
Atlantic sturgeon *Acipenser oxyrinchus oxyrinchus*					E			1						
Banded killifish *Ictalurus melas*	Yr													
Banded sunfish *Enneacanthus obessus*	Yr				S2			2						
Bay anchovy *Anchoa mitchilli*	SpS							2						
Black bullhead *Ictalurus melas*	Yr													
Black crappie *Pomoxis nigromaculatus*	Yr													
Blueback herring *Alosa aestivalis*	SpSS		X							D				
Blue ridge sculpin *Cottus caeruleomentum*	Yr							1						

Species List and Priority Refuge Habitats

	Seasons on Refuge[1]	Refuge Purpose Species	BIDEH	Federal T&E for DE[2]	State T&E[3]	BCR 30[4]	PIF 44[5]	State Comprehensive Wildlife Conservation Plan Priorities[6]	USFWS Birds of Conservation Concern[7]	Federal Trust Fish Species (USFWS Trend Data)[8]	Shorebird Plan-Atlantic Flyway[9]	Waterbird Plan[10]	MANEM Conservation Priority[11]	Waterfowl Plan[12]
FISH (cont.)														
Bluespotted sunfish *Enneacanthus gloriosus*	Yr													
Bridle shiner *Notropis bifrenatus*								1						
Brown bullhead *Ameiurus nebulosus*	Yr													
Brown Shiner *Ameiurus nebulosus*	Yr													
Carp *Cyprinus carpio*	Yr				SE									
Chain pickerel *Esox niger*	Yr													
Channel catfish *Ictalurus punctatus*	Yr													
Comely shiner *Notropis amoenus*	Yr				S2			2						
Cravelle jack *Caranx hippos*	Yr													
Eastern mudminnow *Umbra pygmaea*	Yr													
Fat sleeper *Dormitator maculates*	SpS							2						
Fourspine stickleback *Apeltes quadracus*	SpSF				S2			2						
Gizzard shad *Dorosoma cepedianum*	SpSF													
Glassy darter *Etheostoma vitreum*	Yr							2						
Hickory shad *Alosa mediocris*	SpSF		X		S2			2						
Inland silverside *Menidia beryllina*	Yr													
Ironcolor shiner *Notropis chalybaeus*								1						
Largemouth bass *Micropterus salmoides*	Yr													
Mosquito fish *Gambusia affinis*	Yr													
Least brook lamprey *Lampetra aepyptera*								2						

Species List and Priority Refuge Habitats

	Seasons on Refuge[1]	Refuge Purpose Species	BIDEH	Federal T&E for DE[2]	State T&E[3]	BCR 30[4]	PIF 44[5]	State Comprehensive Wildlife Conservation Plan Priorities[6]	USFWS Birds of Conservation Concern[7]	Federal Trust Fish Species (USFWS Trend Data)[8]	Shorebird Plan-Atlantic Flyway[9]	Waterbird Plan[10]	MANEM Conservation Priority[11]	Waterfowl Plan[12]
FISH (cont.)														
Mud sunfish *Acantharchus pomotis*	Yr				S2			1						
Mummichog *Fundulus heteroclitus*	Yr													
Naked goby *Gobisoma bosc*	Yr													
Pumpkinseed *lepomis gibbosus*	Yr													
Rainwater killifish *Lucania parva*	Yr													
Redbreast sunfish *Lepomis auritus*	Yr													
Rough silverside *Membras martinica*	Yr													
Round whitefish *Prosopium cylindraceum*	Yr													
Sheepshead minnow *Cyprinodon variegatus*	Yr													
Shield darter *Percina peltata*								1		D				
Shorthead redhorse *Moxostoma macrolepidotum*								1						
Shortnose sturgeon *Acipenser brevirostrum*				E				1						
Spot *Leiostomus xanthurus*	Yr							1						
Spotfin killifish *Fundulus luciae*	Yr				S3			2						
Striped bass *Morone saxatilis*	SpSF		X							I				
Striped killifish *Fundulus majalis*	Yr													
Striped mullet *Mugil cephaslus*	Yr													
Summer flounder *Paralichthys dentatus*	SpSF													
White catfish *Ameiurus catus*	Yr													
White crappie *Pomoxis annularis*	Yr													

Species List and Priority Refuge Habitats

	Seasons on Refuge[1]	Refuge Purpose Species	BIDEH	Federal T&E for DE[2]	State T&E[3]	BCR 30[4]	PIF 44[5]	State Comprehensive Wildlife Conservation Plan Priorities[6]	USFWS Birds of Conservation Concern[7]	Federal Trust Fish Species (USFWS Trend Data)[8]	Shorebird Plan-Atlantic Flyway[9]	Waterbird Plan[10]	MANEM Conservation Priority[11]	Waterfowl Plan[12]
FISH (cont.)														
White mullet *Mugil curema*	Yr													
White perch *Morone americana*	Yr													
White shark *Carcharodon carcharias*								2						
White sucker *Catostomus commersoni*	Yr													
Yellow bullhead *Ameiurus natalis*	Yr				S3			1						
Yellow perch *Perca flavescens*	Yr													
SHELLFISH														
Atlantic marsh fiddler crab *Uca pugnax*	Yr													
Blue claw *Callinectus sapidus*	Yr													
Mud crab *Rithropanopeus harrisii*	Yr													
Red-jointed fiddler crab *Uca minax*	Yr													
INVERTEBRATES (730+ species documented only a few are listed)														
American burying beetle				E				1						
Bethany beach firefly					E			1						
Frosted elfin					E			1						
Hessel's hairstreak					E			1						
King's hairstreak					E			1						
Mulberry wing					E			1						
Northeastern beach tiger beetle				T				2						

Species List and Priority Refuge Habitats

	Seasons on Refuge[1]	Refuge Purpose Species	BIDEH	Federal T&E for DE[2]	State T&E[3]	BCR 30[4]	PIF 44[5]	State Comprehensive Wildlife Conservation Plan Priorities[6]	USFWS Birds of Conservation Concern[7]	Federal Trust Fish Species (USFWS Trend Data)[8]	Shorebird Plan-Atlantic Flyway[9]	Waterbird Plan[10]	MANEM Conservation Priority[11]	Waterfowl Plan[12]
INVERTEBRATES (cont.) (730+ species documented only a few are listed)														
Rare skipper					E			1						
Seth forest water scavenger beetle					E			1						
Spectral / Little white / Dune ghost tiger beetle					E			1						
White tiger beetle					E			1						
Beach Dune Tiger Beetle *Cincindela hirticollis*	Yr				S1			2						
Bronze Copper *Lycaena hyllus*	SpSF				S2			2						
Catocala lacrymosa (Tearful underwing)	Yr				S1			1						
C. marmorata **(S1G3)** (Marbled underwing)	Yr				S1			1						
C. muliercula **(STATE RECORD)**	Yr													
Delaware Skipper *Anatrytone logan*	SpSF				S1			2						
Drasteria graphica	Yr				S1			2						
Elfin Skipper *Nannothemis obella*	Yr				S1			2						
Great Purple Hairstreak *Atlides halesus*	Yr				S1			2						
Hydrangia sphinx *Darapsa versicolor*	Yr				S1			2						
Lilypad Forktail *Ischnura kellicotti*	Yr				S1			2						
Little Glassy Wing *Pompeius verna*	Yr				S1			2						
Maritime sunflower borer *Papaipema maritima*	Yr				S1			1						
Megamelus sp **(New Species to Science)**														
Photuris pyralominus **(STATE RECORD Firefly)**					S1			1						
P. tremulans	Yr				S1			1						

Species List and Priority Refuge Habitats

	Seasons on Refuge[1]	Refuge Purpose Species	BIDEH	Federal T&E for DE[2]	State T&E[3]	BCR 30[4]	PIF 44[5]	State Comprehensive Wildlife Conservation Plan Priorities[6]	USFWS Birds of Conservation Concern[7]	Federal Trust Fish Species (USFWS Trend Data)[8]	Shorebird Plan-Atlantic Flyway[9]	Waterbird Plan[10]	MANEM Conservation Priority[11]	Waterfowl Plan[12]
INVERTEBRATES (cont.) (730+ species documented only a few are listed)														
P. frontalis	Yr				S1			1						
Photuris BBB **(New Species to Describe)**														
Pitcher Plant Borer Moth *Exyra fax*	Yr				S1			1						
Prionus laticollis **(COUNTY RECORD Long-Horned Beetle)**														
Southern Broken Dash	Yr				S1			1						
Tree hopper *Archasia pallida ?* (New species description-classification)	Yr													
Sphagnum sprite *Nehalennia gracilis*	Yr				S1			1						
Young blueberry darter *Xestia youngii*	Yr				S1			2						
Zale metata **(STATE RECORD)**	Yr				S2			2						
Z. metatoides	Yr				S2			2						
FRESHWATER MUSSELS (Unknown – No Inventories or Research ever conducted on Refuge)														
Alewife floater								2						
Angular disc								2						
Armed snaggletooth								2						
Black gloss								2						
Brook floater					E			1						
Coastal plain tigersnail								2						

Species List and Priority Refuge Habitats

	Seasons on Refuge[1]	Refuge Purpose Species	BIDEH	Federal T&E for DE[2]	State T&E[3]	BCR 30[4]	PIF 44[5]	State Comprehensive Wildlife Conservation Plan Priorities[6]	USFWS Birds of Conservation Concern[7]	Federal Trust Fish Species (USFWS Trend Data)[8]	Shorebird Plan-Atlantic Flyway[9]	Waterbird Plan[10]	MANEM Conservation Priority[11]	Waterfowl Plan[12]
FRESHWATER MUSSELS (cont.) (Unknown – No Inventories or Research ever conducted on Refuge)														
Creeper/ Squawfoot								2						
Crested vertigo								2						
Dwarf wedgemussel				E	E			1						
Eastern lampmussel					E			1						
Eastern pond mussel					E			1						
Flamed tigersnail								2						
Glass spot								2						
Gray-foot lancetooth								2						
Hairy slitmouth								2						
Honey vertigo								2						
Northern lance mussel								2						
Northern three-tooth								2						
Obese thorn								2						
Pyramid dome								2						
Slender walker								2						
Swamp vertigo								2						
Tidewater mucket					E			1						
Toothed hive								2						
Triangle floater								1						

Species List and Priority Refuge Habitats

	Seasons on Refuge[1]	Refuge Purpose Species	BIDEH	Federal T&E for DE[2]	State T&E[3]	BCR 30[4]	PIF 44[5]	State Comprehensive Wildlife Conservation Plan Priorities[6]	USFWS Birds of Conservation Concern[7]	Federal Trust Fish Species (USFWS Trend Data)[8]	Shorebird Plan-Atlantic Flyway[9]	Waterbird Plan[10]	MANEM Conservation Priority[11]	Waterfowl Plan[12]
FRESHWATER MUSSELS (cont.) (Unknown – No Inventories or Research ever conducted on Refuge)														
White-lip dagger								2						
Winding mantleslug								2						
Yellow lampmussel					E			1						
PLANTS														
American Chaffseed				E										
Seabeach amaranth				T										
Canby's dropwart				E										
Knieskern's beaked-rush				T										
Sensitive joint-vetch				T										
Small whorled pogonia				T										
Swamp pink				T										

Individual Rare Plant Species recorded on Refuge (See Habitat Management Plan {HMP} for comprehensive plant species list and state rankings)

[1]Seasons on the Refuge: Sp = Spring; S = Summer; F = Fall; W = Winter; YR = Year-Round

[2] US Fish and Wildlife Service. Threatened and Endangered Species System (TESS). Report for the state of Delaware, and Delaware Comprehensive Wildlife Conservation Strategy. 2005. Data from the Excel file developed by the Federal Aid office of US Fish and Wildlife Service, Hadley, MA. Sept. 2006.
T = threatened; E = endangered

[3]Delaware Comprehensive Wildlife Conservation Strategy. 2005. Data from the Excel file developed by the Federal Aid office of US Fish and Wildlife Service, Hadley, MA. Sept. 2006.

E = endangered; T = threatened
Does not include state listed plants.

[4]BCR 30 Mid-Atlantic/Southern New England Bird Conservation Region. Final Implementation Plan, June 2008. Melanie Steinkamp, Atlantic Coast Joint Venture, Laurel, MD.

HH=highest priority: H = high priority; M = medium priority

[5]PIF 44 Mid-Atlantic Coastal Plain Partners In Flight. Updated Northeast Physiographic Areas PIF Scores, October 2003. Migratory Bird Office U.S. Fish and Wildlife Service, Hadley, MA.

1a = high continental concern and high regional responsibility
1b = high continental concern and low regional responsibility
2a = high regional concern
2b = high regional responsibility
2c = high regional threats
3 = additional federally listed species
4 = additional state listed species

[6]Delaware Comprehensive Wildlife Conservation Strategy. 2005. Data from the Excel file developed by the Federal Aid office of US Fish and Wildlife Service, Hadley, MA. Sept. 2006.

1 = most in need
2 = in need, not as urgent

Listed all birds, mammals, fish, reptiles, amphibians and non-arthropod invertebrates. For arthropod invertebrates (209 species), only the federal and state listed endangered and threatened species are listed.

[7]US Fish and Wildlife Service. 2002. Birds of conservation concern 2002. Division of Migratory Bird Management, Arlington, Virginia. 99pp. (Online version available at http://migratorybirds.fws.gov/reports/bbc2002.pdf)

[8]Federal Trust Fish Species US Fish and Wildlife Service Population Trend Data.

I = increasing; D = decreasing

[9]North Atlantic Regional Shorebird Plan. Clark and Niles 2000.

5 = highly imperiled – all species listed as threatened or endangered nationally, plus all species with significant population declines and either low populations or some other high risk factor.

4 = species of high concern – populations of these species are known or thought to be declining and have some other known or potential threat as well.

3 = species of moderate concern – populations of these species are either a) declining with moderate threats or distributions; b) increasing but with known or potential threats and moderate to restricted distributions; or c) of moderate size.

2 = species of low concern – populations of these species are either a) stable with moderate threats and distributions; b) increasing but with known or potential threats and moderate to restricted distributions; or c) of moderate size.

1 = species not at risk – all other species where there is apparently no current risk of population decline.

[10]Waterbird Plan: James A. Kushlan, Melanie J. Steinkamp, Katharine C. Parsons, Jack Capp, Martin Acosta Cruz, Malcolm Coulter, Ian Davidson, Loney Dickson, Naomi Edelson, Richard Elliot, R. Michael Erwin, Scott Hatch, Stephen Kress, Robert Milko, Steve Miller, Kyra Mills, Richard Paul, Roberto Phillips, Jorge E. Saliva, Bill Sydeman, John Trapp, Jennifer Wheeler, and Kent Wohl. 2002. Waterbird Conservation for the Americas: The North American Waterbird Conservation Plan, Version 1. Waterbird Conservation for the Americas. Washington, DC, U.S A.

HI = highly imperiled; H = high risk; M = moderate risk; L = low risk; NR = not currently at risk; - = species to be assessed in Version 2 of the North American Waterbird Conservation Plan

[11] MANEM Waterbird Working Group. 2006. Waterbird Conservation Plan for the Mid-Atlantic/New England/Maritimes Region: 2006-2010. Waterbird Conservation for the Americas (www.waterbirdconservation.org).

Table 10 – Regional waterbird population conservation priorities in the Mid-Atlantic/New England/Maritimes region of North America.

HH = highest; H = high; M = moderate; L = low (did not include all the Low species)

[12]North American Waterfowl Management Plan, Plan Committee. 2004. North American Waterfowl Management Plan 2004. Implementation Framework: Strengthening the Biological Foundation. Canadian Wildlife Service, U.S. Fish and Wildlife Service, Secretaria de Medio Ambiente y Recursos Naturales, 106 pp.

Population trend 1970 – 2003:

I = increasing; S = stable; D = decreasing; U = unknown

Appendix E

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Swamp sparrow

Findings of Appropriateness and Compatibility Determinations

Findings of Appropriateness and Compatibility Determinations

Finding of Appropriateness—Camping. E-1

Finding of Appropriateness—Commercial Fishing and Crabbing E-3

Finding of Appropriateness—Dog Walking. E-5

Finding of Appropriateness—Geocaching and Metal Detecting. E-7

Finding of Appropriateness—Horseback Riding E-9

Finding of Appropriateness—Non-Service Competitive & Non-Competitive Events (weddings, cross country races, volksmarch walks, running events, family reunions, fishing derbies, bicycle races….). . E-11

Finding of Appropriateness—Off-Road Bicycling/Mountain Bicycling E-13

Finding of Appropriateness—Off-Road Vehicles E-15

Finding of Appropriateness—Operation of Model Planes and Boats on the Refuge E-17

Finding of Appropriateness—Organized or Facility-supported Picnicking E-19

Finding of Appropriateness—Rollerblading and Ice Skating E-21

Finding of Appropriateness—Swimming and Sunbathing. E-23

Finding of Appropriateness—Cooperative Farming E-25

Finding of Appropriateness—Commercial Wildlife and Nature Photography E-29

Compatibility Determination—Commercial Wildlife and Nature Photography E-31

Finding of Appropriateness—Commercially Guided Wildlife Observation E-37

Compatibility Determination—Commercially Guided Wildlife Observation E-39

Finding of Appropriateness—Field Trails for Dogs E-51

Compatibility Determination—Field Trials for Dogs E-53

Finding of Appropriateness—Commercial Forest Management E-57

Compatibility Determination—Commercial Forest Management E-59

Finding of Appropriateness—Research by Non-Service Personnel. E-69

Compatibility Determination—Research by Non-Service Personnel. E-73

Finding of Appropriateness—Mosquito Management. E-81

Compatibility Determination—Mosquito Management. E-83

Finding of Appropriateness—Turtle Harvesting (Trapping) E-101

Compatibility Determination—Turtle Harvesting (Trapping) E-103

Compatibility Determination—Federal Aviation Administration (FAA) Vortac Tower E-107

Compatibility Determination—Recreational Fresh & Saltwater Fishing & Crabbing E-111

Compatibility Determination—Hunting E-119

Compatibility Determination— Wildlife Observation, Wildlife Photography, Environmental Education, and Interpretation E-151

603 FW 1
Exhibit 1

FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Prime Hook National Wildlife Refuge

Use: Camping

This exhibit is not required for wildlife-dependent recreational uses, forms of take regulated by the State, or uses already described in a refuge CCP or step-down management plan approved after October 9, 1997.

Decision criteria:	**YES**	**NO**
(a) Do we have jurisdiction over the use?	✔	
(b) Does the use comply with applicable laws and regulations (Federal, State, Tribal, and local)?	✔	
(c) Is the use consistent with applicable Executive orders and Department and Service policies?		✔
(d) Is the use consistent with public safety?	✔	
(e) Is the use consistent with goals and objectives in an approved management plan or other document?		✔
(f) Has an earlier documented analysis not denied the use or is this the first time the use has been proposed?		✔
(g) Is the use manageable within available budget and staff?		✔
(h) Will this be manageable in the future within existing resources?		✔
(i) Does the use contribute to the public's understanding and appreciation of the refuge's natural or cultural resources, or is the use beneficial to the refuge's natural or cultural resources?		✔
(j) Can the use be accommodated without impairing existing wildlife-dependent recreational uses or reducing the potential to provide quality (see section 1.6D. for description), compatible, wildlife-dependent recreation into the future?		✔

Where we do not have jurisdiction over the use ("no" to [a]), there is no need to evaluate it further as we cannot control the use. Uses that are illegal, inconsistent with existing policy, or unsafe ("no" to [b], [c], or [d]) may not be found appropriate. If the answer is "no" to any of the other questions above, we will generally not allow the use.

If indicated, the refuge manager has consulted with State fish and wildlife agencies. Yes ____ No ✔.

When the refuge manager finds the use appropriate based on sound professional judgment, the refuge manager must justify the use in writing on an attached sheet and obtain the refuge supervisor's concurrence.

Based on an overall assessment of these factors, my summary conclusion is that the proposed use is:

Not Appropriate ✔ **Appropriate** _____

Refuge Manager: _____ Date: _____

If found to be **Not Appropriate**, the refuge supervisor does not need to sign concurrence if the use is a new use.

If an existing use is found **Not Appropriate** outside the CCP process, the refuge supervisor must sign concurrence.

If found to be **Appropriate**, the refuge supervisor must sign concurrence:

Refuge Supervisor: _____ Date: _____

A compatibility determination is required before the use may be allowed.

603 FW 1
Exhibit 1
Page 2

JUSTIFICATION FOR A FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Prime Hook National Wildlife Refuge

Use: Camping

NARRATIVE:

The National Wildlife Refuge System Improvement Act of 1997 (P.L. 105-57) identifies six legitimate and appropriate uses of wildlife refuges; environmental education, interpretation, hunting, fishing, wildlife observation and wildlife photography. These priority public uses are dependent upon healthy wildlife populations. Where these uses are determined to be compatible, they are to receive enhanced consideration over other uses in planning and management. All other recreational uses are now considered general uses. As noted in the Appropriate Use Policy: "General public uses that are not wildlife-dependent recreational uses (as defined in the Improvement Act) and do not contribute to the fulfillment of refuge purposes, or goals, or objectives as described in current refuge management plans are the lowest priorities for refuge managers to consider. These uses are likely to divert refuge management resources from priority general public uses or away from the responsibilities to protect and manage fish, wildlife, and plants and their habitats. Therefore, both law and policy have a general presumption against allowing such uses within the Refuge System."

Camping is not a priority public use, but a general use. This use does not, as a standalone activity, contribute to the fulfillment of refuge purposes, and would detract from the refuge staff's responsibilities to protect and manage fish, wildlife, and plants and their habitats, as well as detracting from administering priority uses. The refuge does not have the facilities or staff to manage this use. Camping is not consistent with Service policy on secondary uses and would divert existing and future resources from accomplishing priority tasks. It also presents unacceptable levels of risk from the potential spread of campfires to wildfires. This use is also not consistent with any approved refuge management plan. The general use of camping is, therefore, determined to be inappropriate.

603 FW 1
Exhibit 1

FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Prime Hook National Wildlife Refuge

Use: Commercial Fishing and Crabbing

This exhibit is not required for wildlife-dependent recreational uses, forms of take regulated by the State, or uses already described in a refuge CCP or step-down management plan approved after October 9, 1997.

Decision criteria:	**YES**	**NO**
(a) Do we have jurisdiction over the use?	✔	
(b) Does the use comply with applicable laws and regulations (Federal, State, Tribal, and local)?	✔	
(c) Is the use consistent with applicable Executive orders and Department and Service policies?	✔	
(d) Is the use consistent with public safety?	✔	
(e) Is the use consistent with goals and objectives in an approved management plan or other document?		✔
(f) Has an earlier documented analysis not denied the use or is this the first time the use has been proposed?		✔
(g) Is the use manageable within available budget and staff?		✔
(h) Will this be manageable in the future within existing resources?		✔
(i) Does the use contribute to the public's understanding and appreciation of the refuge's natural or cultural resources, or is the use beneficial to the refuge's natural or cultural resources?		✔
(j) Can the use be accommodated without impairing existing wildlife-dependent recreational uses or reducing the potential to provide quality (see section 1.6D. for description), compatible, wildlife-dependent recreation into the future?		✔

Where we do not have jurisdiction over the use ("no" to [a]), there is no need to evaluate it further as we cannot control the use. Uses that are illegal, inconsistent with existing policy, or unsafe ("no" to [b], [c], or [d]) may not be found appropriate. If the answer is "no" to any of the other questions above, we will generally not allow the use.

If indicated, the refuge manager has consulted with State fish and wildlife agencies. Yes ___✔___ No ____.

When the refuge manager finds the use appropriate based on sound professional judgment, the refuge manager must justify the use in writing on an attached sheet and obtain the refuge supervisor's concurrence.

Based on an overall assessment of these factors, my summary conclusion is that the proposed use is:

Not Appropriate ___✔___ **Appropriate** _____

Refuge Manager: _____ Date: _____

If found to be **Not Appropriate**, the refuge supervisor does not need to sign concurrence if the use is a new use.

If an existing use is found **Not Appropriate** outside the CCP process, the refuge supervisor must sign concurrence.

If found to be **Appropriate**, the refuge supervisor must sign concurrence:

Refuge Supervisor: _____ Date: _____

A compatibility determination is required before the use may be allowed.

JUSTIFICATION FOR A FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Prime Hook National Wildlife Refuge

Use: Commercial Fishing & Crabbing

NARRATIVE:

The National Wildlife Refuge System Improvement Act of 1997 (P.L. 105-57) identifies six legitimate and appropriate uses of wildlife refuges; environmental education, interpretation, hunting, fishing, wildlife observation and wildlife photography. These priority public uses are dependent upon healthy wildlife populations. Where these uses are determined to be compatible, they are to receive enhanced consideration over other uses in planning and management.

Commercial fishing has occurred in the tidal waterways of Slaughter Canal for over 30 years by a small number of fishermen; however, the refuge has recently enhanced the priority uses of hunting, fishing, wildlife observation and photography. Commercial fishing, which is not a priority public use, is not consistent with goals and objectives in any refuge management plan, conflicts with rod and reel recreational fishermen and wildlife observers using canoes/kayaks, and has the potential to harm non-targeted fisheries through incidental by-catch.

The Service has statutory authority under the National Wildlife Refuge System Administration Act of 1966 (Administration Act) to regulate activities that occur on water bodies within refuge units. In addition, under Delaware law, the rights of property owners extend to natural low water. Therefore, Slaughter Canal, which is an excavated waterway, is owned by the United States as the property owner.

Fishing for bait fish is permitted for recreational uses only, subject to regulations stated in Title 7 (Conservation) of the Delaware State Code. Commercial crabbing is prohibited in refuge waters as stated in Title 7 (§ 2304) of the Delaware State Code.

Commercial fishing and crabbing is considered an economic use of a national wildlife refuge and is guided by the following policies:

16USC668dd, 50 CFR 27.97, Private Operations
Soliciting business or conducting a commercial enterprise on any national wildlife refuge is prohibited except as may be authorized by special permit.

16USC668dd, 50 CFR, Subpart A, 29.1 Allowing Economic Uses on National Wildlife Refuges
We may only authorize public or private economic use of the natural resources of any national wildlife refuge, in accordance with 16 U.S.C. 715s, where we determine that the use contributes to the achievement of the national wildlife refuge purposes or the National Wildlife Refuge System mission.

5 RM 17, Commercial & Economic Uses on National Wildlife Refuges

Due to these reasons, these activities will materially interfere with and detract from the mission of the Refuge System and purposes for which the refuge was established. In addition, these activities will not fulfill one or more purposes of the refuge or the Refuge System. The use of commercial fishing and crabbing is therefore determined to be inappropriate.

603 FW 1
Exhibit 1

FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Prime Hook National Wildlife Refuge

Use: Dog Walking

This exhibit is not required for wildlife-dependent recreational uses, forms of take regulated by the State, or uses already described in a refuge CCP or step-down management plan approved after October 9, 1997.

Decision criteria:	**YES**	**NO**
(a) Do we have jurisdiction over the use?	✔	
(b) Does the use comply with applicable laws and regulations (Federal, State, Tribal, and local)?	✔	
(c) Is the use consistent with applicable Executive orders and Department and Service policies?		✔
(d) Is the use consistent with public safety?	✔	
(e) Is the use consistent with goals and objectives in an approved management plan or other document?		✔
(f) Has an earlier documented analysis not denied the use or is this the first time the use has been proposed?		✔
(g) Is the use manageable within available budget and staff?	✔	
(h) Will this be manageable in the future within existing resources?	✔	
(i) Does the use contribute to the public's understanding and appreciation of the refuge's natural or cultural resources, or is the use beneficial to the refuge's natural or cultural resources?		✔
(j) Can the use be accommodated without impairing existing wildlife-dependent recreational uses or reducing the potential to provide quality (see section 1.6D. for description), compatible, wildlife-dependent recreation into the future?		✔

Where we do not have jurisdiction over the use ("no" to [a]), there is no need to evaluate it further as we cannot control the use. Uses that are illegal, inconsistent with existing policy, or unsafe ("no" to [b], [c], or [d]) may not be found appropriate. If the answer is "no" to any of the other questions above, we will generally not allow the use.

If indicated, the refuge manager has consulted with State fish and wildlife agencies. Yes ____ No ___✔___.

When the refuge manager finds the use appropriate based on sound professional judgment, the refuge manager must justify the use in writing on an attached sheet and obtain the refuge supervisor's concurrence.

Based on an overall assessment of these factors, my summary conclusion is that the proposed use is:

Not Appropriate ___✔___ **Appropriate** _____

Refuge Manager: _____ Date: _____

If found to be **Not Appropriate**, the refuge supervisor does not need to sign concurrence if the use is a new use.

If an existing use is found **Not Appropriate** outside the CCP process, the refuge supervisor must sign concurrence.

If found to be **Appropriate**, the refuge supervisor must sign concurrence:

Refuge Supervisor: _____ Date: _____

A compatibility determination is required before the use may be allowed.

603 FW 1
Exhibit 1
Page 2

JUSTIFICATION FOR A FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Prime Hook National Wildlife Refuge

Use: Dog Walking

NARRATIVE:

The National Wildlife Refuge System Improvement Act of 1997 (P.L. 105-57) identifies six legitimate and appropriate uses of wildlife refuges; environmental education, interpretation, hunting, fishing, wildlife observation and wildlife photography. These priority public uses are dependent upon healthy wildlife populations. Where these uses are determined to be compatible, they are to receive enhanced consideration over other uses in planning and management. All other recreational uses are now considered general uses. As noted in the Appropriate Use Policy: "General public uses that are not wildlife-dependent recreational uses (as defined in the Improvement Act) and do not contribute to the fulfillment of refuge purposes, or goals, or objectives as described in current refuge management plans are the lowest priorities for refuge managers to consider. These uses are likely to divert refuge management resources from priority general public uses or away from the responsibilities to protect and manage fish, wildlife, and plants and their habitats. Therefore, both law and policy have a general presumption against allowing such uses within the Refuge System."

The refuge has re-examined and evaluated our existing policy on dog walking to better meet the needs of our public while also minimizing wildlife disturbances. Since the refuge mission consists of providing habitats for wintering and migrating birds that include waterfowl, shorebirds, wading birds, marshbirds and landbirds, minimizing those uses that provide the greatest potential conflicts and disturbances to those migratory bird species is a priority. Dogs have been shown by recent research to displace native migratory bird species (Banks & Bryan. 2007; Fernandez-Juricic and Telleria. 2000).

Minimizing negative impacts to other associated wildlife species that also share many of these same habitats is also a responsibility of refuge staff. Research has revealed that dog presence results in definite predator-type defense reactions by native wild mammals, including avoidance/vacating the area (Lima et al.1999; Mitchell & Banks. 2005; Lenth, et al. 2006.)

This determination does not extend to the use of (dog) retrievers by waterfowl hunters and upland game hunters engaged in legal hunting activities on the refuge.

Hunting with a retriever is a much less frequent occurrence than general dog walking, which presumably could occur daily and result in far greater negative impacts to wildlife and habitat. Furthermore, hunting is a priority public use of the National Wildlife Refuge System, and the use of retriever dogs helps to facilitate the use while minimizing potential negative impacts during hunts.

LITERATURE CITED

See CCP Bibliography.

603 FW 1
Exhibit 1

FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Prime Hook National Wildlife Refuge

Use: Geocaching and Metal Detecting

This exhibit is not required for wildlife-dependent recreational uses, forms of take regulated by the State, or uses already described in a refuge CCP or step-down management plan approved after October 9, 1997.

Decision criteria:	**YES**	**NO**
(a) Do we have jurisdiction over the use?	✔	
(b) Does the use comply with applicable laws and regulations (Federal, State, Tribal, and local)?		✔
(c) Is the use consistent with applicable Executive orders and Department and Service policies?	✔	
(d) Is the use consistent with public safety?	✔	
(e) Is the use consistent with goals and objectives in an approved management plan or other document?		✔
(f) Has an earlier documented analysis not denied the use or is this the first time the use has been proposed?		✔
(g) Is the use manageable within available budget and staff?		✔
(h) Will this be manageable in the future within existing resources?		✔
(i) Does the use contribute to the public's understanding and appreciation of the refuge's natural or cultural resources, or is the use beneficial to the refuge's natural or cultural resources?		✔
(j) Can the use be accommodated without impairing existing wildlife-dependent recreational uses or reducing the potential to provide quality (see section 1.6D. for description), compatible, wildlife-dependent recreation into the future?	✔	

Where we do not have jurisdiction over the use ("no" to [a]), there is no need to evaluate it further as we cannot control the use. Uses that are illegal, inconsistent with existing policy, or unsafe ("no" to [b], [c], or [d]) may not be found appropriate. If the answer is "no" to any of the other questions above, we will generally not allow the use.

If indicated, the refuge manager has consulted with State fish and wildlife agencies. Yes ____ No ___✔___.

When the refuge manager finds the use appropriate based on sound professional judgment, the refuge manager must justify the use in writing on an attached sheet and obtain the refuge supervisor's concurrence.

Based on an overall assessment of these factors, my summary conclusion is that the proposed use is:

Not Appropriate ___✔___ **Appropriate** _____

Refuge Manager: _____ Date: _____

If found to be **Not Appropriate**, the refuge supervisor does not need to sign concurrence if the use is a new use.

If an existing use is found **Not Appropriate** outside the CCP process, the refuge supervisor must sign concurrence.

If found to be **Appropriate**, the refuge supervisor must sign concurrence:

Refuge Supervisor: _____ Date: _____

A compatibility determination is required before the use may be allowed.

JUSTIFICATION FOR A FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Prime Hook National Wildlife Refuge

Use: Geocaching and Metal Detecting

NARRATIVE:

The National Wildlife Refuge System Improvement Act of 1997 (P.L. 105-57) identifies six legitimate and appropriate uses of wildlife refuges; environmental education, interpretation, hunting, fishing, wildlife observation and wildlife photography. These priority public uses are dependent upon healthy wildlife populations. Where these uses are determined to be compatible, they are to receive enhanced consideration over other uses in planning and management. All other recreational uses are now considered general uses. As noted in the Appropriate Use Policy: "General public uses that are not wildlife-dependent recreational uses (as defined in the Improvement Act) and do not contribute to the fulfillment of refuge purposes, or goals, or objectives as described in current refuge management plans are the lowest priorities for refuge managers to consider. These uses are likely to divert refuge management resources from priority general public uses or away from the responsibilities to protect and manage fish, wildlife, and plants and their habitats. Therefore, both law and policy have a general presumption against allowing such uses within the Refuge System."

The geocaching and metal detecting are not priority public uses, but general uses. They do not, as standalone activities, contribute to the fulfillment of refuge purposes, and would detract from the refuge staff's responsibilities to protect and manage fish, wildlife, and plants and their habitats, as well as detract from administering priority uses. Geocaching and metal detecting are not wildlife dependent recreational activities and could potentially impact other refuge management activities on the refuge. Due to the potential historic and cultural resources on the refuge, geocaching and metal detecting could impact the Service's ability to protect and manage these resources. In addition geocaching and metal detecting do not comply with existing federal regulations. The placement of any object on or the removal of any object from a National Wildlife Refuge violates several federal regulations including but not limited to the following:

16USC668dd, 50 CFR 27.93, Abandonment of Property
> Abandoning, discarding, or otherwise leaving any personal property in any national wildlife refuge is prohibited.

16USC668dd, 50 CFR 26.21a, Trespass
> No person shall trespass, including but not limited to entering, occupying, using, or being upon, any national wildlife refuge, except as specifically authorized in this subchapter C or in other applicable Federal regulations.

16USC668dd, 50 CFR 27.63, Search for and removal of other valued objects
> (a) No person shall search for buried treasure, treasure trove, valuable semiprecious rocks, stones, or mineral specimens on national wildlife refuges unless authorized by permit or by provision of this subchapter C.

16USC668dd, 50 CFR 27.97, Private Operations
> Soliciting business or conducting a commercial enterprise on any national wildlife refuge is prohibited except as may be authorized by special permit.

The refuge does not have the facilities or staff to manage these uses. The general uses of geocaching and metal detecting are, therefore, determined to be inappropriate.

603 FW 1
Exhibit 1

FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Prime Hook National Wildlife Refuge

Use: Horseback Riding

This exhibit is not required for wildlife-dependent recreational uses, forms of take regulated by the State, or uses already described in a refuge CCP or step-down management plan approved after October 9, 1997.

Decision criteria:	**YES**	**NO**
(a) Do we have jurisdiction over the use?	✔	
(b) Does the use comply with applicable laws and regulations (Federal, State, Tribal, and local)?	✔	
(c) Is the use consistent with applicable Executive orders and Department and Service policies?		✔
(d) Is the use consistent with public safety?		✔
(e) Is the use consistent with goals and objectives in an approved management plan or other document?		✔
(f) Has an earlier documented analysis not denied the use or is this the first time the use has been proposed?		✔
(g) Is the use manageable within available budget and staff?		✔
(h) Will this be manageable in the future within existing resources?		✔
(i) Does the use contribute to the public's understanding and appreciation of the refuge's natural or cultural resources, or is the use beneficial to the refuge's natural or cultural resources?		✔
(j) Can the use be accommodated without impairing existing wildlife-dependent recreational uses or reducing the potential to provide quality (see section 1.6D. for description), compatible, wildlife-dependent recreation into the future?		✔

Where we do not have jurisdiction over the use ("no" to [a]), there is no need to evaluate it further as we cannot control the use. Uses that are illegal, inconsistent with existing policy, or unsafe ("no" to [b], [c], or [d]) may not be found appropriate. If the answer is "no" to any of the other questions above, we will generally not allow the use.

If indicated, the refuge manager has consulted with State fish and wildlife agencies. Yes ____ No ___✔___.

When the refuge manager finds the use appropriate based on sound professional judgment, the refuge manager must justify the use in writing on an attached sheet and obtain the refuge supervisor's concurrence.

Based on an overall assessment of these factors, my summary conclusion is that the proposed use is:

Not Appropriate ___✔___ **Appropriate** _____

Refuge Manager: _____ Date: _____

If found to be **Not Appropriate**, the refuge supervisor does not need to sign concurrence if the use is a new use.

If an existing use is found **Not Appropriate** outside the CCP process, the refuge supervisor must sign concurrence.

If found to be **Appropriate**, the refuge supervisor must sign concurrence:

Refuge Supervisor: _____ Date: _____

A compatibility determination is required before the use may be allowed.

603 FW 1
Exhibit 1
Page 2

JUSTIFICATION FOR A FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Prime Hook National Wildlife Refuge

Use: Horseback Riding

NARRATIVE:

The National Wildlife Refuge System Improvement Act of 1997 (P.L. 105-57) identifies six legitimate and appropriate uses of wildlife refuges; environmental education, interpretation, hunting, fishing, wildlife observation and wildlife photography. These priority public uses are dependent upon healthy wildlife populations. Where these uses are determined to be compatible, they are to receive enhanced consideration over other uses in planning and management. All other recreational uses are now considered general uses. As noted in the Appropriate Use Policy: "General public uses that are not wildlife-dependent recreational uses (as defined in the Improvement Act) and do not contribute to the fulfillment of refuge purposes, or goals, or objectives as described in current refuge management plans are the lowest priorities for refuge managers to consider. These uses are likely to divert refuge management resources from priority general public uses or away from the responsibilities to protect and manage fish, wildlife, and plants and their habitats. Therefore, both law and policy have a general presumption against allowing such uses within the Refuge System."

The horseback riding is not a priority public use, but a general use. This use does not, as a standalone activity, contribute to the fulfillment of refuge purposes, and would detract from the refuge staff's responsibilities to protect and manage fish, wildlife, and plants and their habitats, as well as detract from administering priority uses. The refuge does not have the facilities or staff to manage this use. Horseback Riding is not consistent with Service policy on secondary uses and would divert existing and future resources from accomplishing priority tasks. It also presents unacceptable levels of risk from the potential spread of invasive species from horse droppings and could present conflicts with other refuge users. This use is not consistent with any approved refuge management plan. The general use of horseback riding is, therefore, determined to be inappropriate.

603 FW 1
Exhibit 1

FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Prime Hook National Wildlife Refuge

Use: Non-Service Competitive & Non-Competitive Events (weddings, cross country races, volksmarch walks, running events, family reunions, fishing derbies, bicycle races, etc.)

This exhibit is not required for wildlife-dependent recreational uses, forms of take regulated by the State, or uses already described in a refuge CCP or step-down management plan approved after October 9, 1997.

Decision criteria:	**YES**	**NO**
(a) Do we have jurisdiction over the use?	✔	
(b) Does the use comply with applicable laws and regulations (Federal, State, Tribal, and local)?	✔	
(c) Is the use consistent with applicable Executive orders and Department and Service policies?	✔	
(d) Is the use consistent with public safety?	✔	
(e) Is the use consistent with goals and objectives in an approved management plan or other document?		✔
(f) Has an earlier documented analysis not denied the use or is this the first time the use has been proposed?		✔
(g) Is the use manageable within available budget and staff?		✔
(h) Will this be manageable in the future within existing resources?		✔
(i) Does the use contribute to the public's understanding and appreciation of the refuge's natural or cultural resources, or is the use beneficial to the refuge's natural or cultural resources?		✔
(j) Can the use be accommodated without impairing existing wildlife-dependent recreational uses or reducing the potential to provide quality (see section 1.6D. for description), compatible, wildlife-dependent recreation into the future?		✔

Where we do not have jurisdiction over the use ("no" to [a]), there is no need to evaluate it further as we cannot control the use. Uses that are illegal, inconsistent with existing policy, or unsafe ("no" to [b], [c], or [d]) may not be found appropriate. If the answer is "no" to any of the other questions above, we will generally not allow the use.

If indicated, the refuge manager has consulted with State fish and wildlife agencies. Yes ____ No ✔.

When the refuge manager finds the use appropriate based on sound professional judgment, the refuge manager must justify the use in writing on an attached sheet and obtain the refuge supervisor's concurrence.

Based on an overall assessment of these factors, my summary conclusion is that the proposed use is:

Not Appropriate ✔ **Appropriate** _____

Refuge Manager: _____ Date: _____

If found to be **Not Appropriate**, the refuge supervisor does not need to sign concurrence if the use is a new use.

If an existing use is found **Not Appropriate** outside the CCP process, the refuge supervisor must sign concurrence.

If found to be **Appropriate**, the refuge supervisor must sign concurrence:

Refuge Supervisor: _____ Date: _____

A compatibility determination is required before the use may be allowed.

JUSTIFICATION FOR A FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Prime Hook National Wildlife Refuge

Use: Non-Service Competitive & Non-Competitive Events (weddings, cross country races, volksmarch walks, running events, family reunions, fishing derbies, bicycling races, etc.)

NARRATIVE:

The National Wildlife Refuge System Improvement Act of 1997 (P.L. 105-57) identifies six legitimate and appropriate uses of wildlife refuges; environmental education, interpretation, hunting, fishing, wildlife observation and wildlife photography. These priority public uses are dependent upon healthy wildlife populations. Where these uses are determined to be compatible, they are to receive enhanced consideration over other uses in planning and management. All other recreational uses are now considered general uses. As noted in the Appropriate Use Policy: "General public uses that are not wildlife-dependent recreational uses (as defined in the Improvement Act) and do not contribute to the fulfillment of refuge purposes, or goals, or objectives as described in current refuge management plans are the lowest priorities for refuge managers to consider. These uses are likely to divert refuge management resources from priority general public uses or away from the responsibilities to protect and manage fish, wildlife, and plants and their habitats. Therefore, both law and policy have a general presumption against allowing such uses within the Refuge System."
The non-Service competitive and non-competitive activities are not priority public uses, but are general uses and sometimes economic uses. They do not, as standalone activities, contribute to the fulfillment of refuge purposes, and would detract from the refuge staff's responsibilities to protect and manage fish, wildlife, and plants and their habitats, as well as detracting from administering priority uses.

Events would include but not be limited to cross country races, weddings, volksmarch walks, running events, family reunions, fishing derbies, and bicycle races. These uses are not wildlife dependent recreation uses under the National Wildlife Refuge Improvement Act of 1997. These events on the refuges are not necessary for safe, practical, and effective conduct of existing wildlife-dependent recreational uses. The effects of this use pose a threat to habitat and wildlife resources, and temporarily displace wildlife. Special events do not appreciably contribute to the public's understanding and appreciation of the refuge's natural and cultural resources nor is the use beneficial to the refuge's resources. These uses would also impact other refuge uses which are wildlife dependent recreational uses. The refuge does not have the facilities or staff to manage these uses. These uses are also in violation of several federal regulations including but not limited to the following:

16USC668dd, 50 CFR 27.97, Private Operations
> Soliciting business or conducting a commercial enterprise on any national wildlife refuge is prohibited except as may be authorized by special permit.

16USC668dd, 50 CFR 27.86, Begging
> Begging on any national wildlife refuge is prohibited. Soliciting of funds for the support or assistance of any cause or organization is also prohibited unless properly authorized.

16USC668dd, 50 CFR, Subpart A, 29.1 Allowing Economic Uses on National Wildlife Refuges
> We may only authorize public or private economic use of the natural resources of any national wildlife refuge, in accordance with 16 U.S.C. 715s, where we determine that the use contributes to the achievement of the national wildlife refuge purposes or the National Wildlife Refuge System mission.

These events may also have impacts to the refuge's natural resources. These events can contribute to short-term disturbances of nesting and wintering birds and other wildlife due to the large number of people in attendance. Increased erosion of trails and other sensitive areas could occur with increased traffic that special events produce as well. Due to these reasons, these activities will materially interfere with and detract from the mission of the Refuge System and purposes for which the refuge was established. In addition, these activities will not fulfill one or more purposes of the refuge or the National Wildlife Refuge System. These general uses and sometimes economic uses are, therefore, determined to be inappropriate on Prime Hook NWR.

603 FW 1
Exhibit 1

FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Prime Hook National Wildlife Refuge

Use: Off-Road Bicycling/Mountain Bicycling

This exhibit is not required for wildlife-dependent recreational uses, forms of take regulated by the State, or uses already described in a refuge CCP or step-down management plan approved after October 9, 1997.

Decision criteria:	**YES**	**NO**
(a) Do we have jurisdiction over the use?	✔	
(b) Does the use comply with applicable laws and regulations (Federal, State, Tribal, and local)?	✔	
(c) Is the use consistent with applicable Executive orders and Department and Service policies?	✔	
(d) Is the use consistent with public safety?	✔	
(e) Is the use consistent with goals and objectives in an approved management plan or other document?		✔
(f) Has an earlier documented analysis not denied the use or is this the first time the use has been proposed?		✔
(g) Is the use manageable within available budget and staff?		✔
(h) Will this be manageable in the future within existing resources?		✔
(i) Does the use contribute to the public's understanding and appreciation of the refuge's natural or cultural resources, or is the use beneficial to the refuge's natural or cultural resources?		✔
(j) Can the use be accommodated without impairing existing wildlife-dependent recreational uses or reducing the potential to provide quality (see section 1.6D. for description), compatible, wildlife-dependent recreation into the future?	✔	

Where we do not have jurisdiction over the use ("no" to [a]), there is no need to evaluate it further as we cannot control the use. Uses that are illegal, inconsistent with existing policy, or unsafe ("no" to [b], [c], or [d]) may not be found appropriate. If the answer is "no" to any of the other questions above, we will generally not allow the use.

If indicated, the refuge manager has consulted with State fish and wildlife agencies. Yes ____ No ___✔___.

When the refuge manager finds the use appropriate based on sound professional judgment, the refuge manager must justify the use in writing on an attached sheet and obtain the refuge supervisor's concurrence.

Based on an overall assessment of these factors, my summary conclusion is that the proposed use is:

Not Appropriate ___✔___ **Appropriate** _____

Refuge Manager: _____ Date: _____

If found to be **Not Appropriate**, the refuge supervisor does not need to sign concurrence if the use is a new use.

If an existing use is found **Not Appropriate** outside the CCP process, the refuge supervisor must sign concurrence.

If found to be **Appropriate**, the refuge supervisor must sign concurrence:

Refuge Supervisor: _____ Date: _____

A compatibility determination is required before the use may be allowed.

JUSTIFICATION FOR A FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Prime Hook National Wildlife Refuge

Use: Off-Road Bicycling/Mountain Bicycling

NARRATIVE:

The National Wildlife Refuge System Improvement Act of 1997 (P.L. 105-57) identifies six legitimate and appropriate uses of wildlife refuges; environmental education, interpretation, hunting, fishing, wildlife observation and wildlife photography. These priority public uses are dependent upon healthy wildlife populations. Where these uses are determined to be compatible, they are to receive enhanced consideration over other uses in planning and management. All other recreational uses are now considered general uses. As noted in the Appropriate Use Policy: "General public uses that are not wildlife-dependent recreational uses (as defined in the Improvement Act) and do not contribute to the fulfillment of refuge purposes, or goals, or objectives as described in current refuge management plans are the lowest priorities for refuge managers to consider. These uses are likely to divert refuge management resources from priority general public uses or away from the responsibilities to protect and manage fish, wildlife, and plants and their habitats. Therefore, both law and policy have a general presumption against allowing such uses within the Refuge System."

Off-road bicylcling/mountain bicycling is not a priority public use, but a general use. This use does not, as a standalone activity, contribute to the fulfillment of refuge purposes, and would detract from the refuge staff's responsibilities to protect and manage fish, wildlife, and plants and their habitats, as well as detract from administering priority uses. The refuge does not have the facilities or staff to manage this use. Potential impacts include: soil compaction and erosion, trampling and mortality of fragile plant communities, habitat loss/deterioration, a shift in plant communities along trails, wildlife disturbance, and a concern for safety due to excessive speed of cyclists. Off-road bicycling could cause damage to refuge soils and vegetation, as well as unacceptable levels of wildlife disturbance. It is not consistent with Service policy on secondary uses and is not consistent with any approved refuge management plan. The general use of off-road bicycling/mountain bicycling is, therefore, determined to be inappropriate.

603 FW 1
Exhibit 1

FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Prime Hook National Wildlife Refuge

Use: Off-Road Vehicles

This exhibit is not required for wildlife-dependent recreational uses, forms of take regulated by the State, or uses already described in a refuge CCP or step-down management plan approved after October 9, 1997.

Decision criteria:	**YES**	**NO**
(a) Do we have jurisdiction over the use?	✔	
(b) Does the use comply with applicable laws and regulations (Federal, State, Tribal, and local)?	✔	
(c) Is the use consistent with applicable Executive orders and Department and Service policies?		✔
(d) Is the use consistent with public safety?		✔
(e) Is the use consistent with goals and objectives in an approved management plan or other document?		✔
(f) Has an earlier documented analysis not denied the use or is this the first time the use has been proposed?	✔	
(g) Is the use manageable within available budget and staff?		✔
(h) Will this be manageable in the future within existing resources?		✔
(i) Does the use contribute to the public's understanding and appreciation of the refuge's natural or cultural resources, or is the use beneficial to the refuge's natural or cultural resources?		✔
(j) Can the use be accommodated without impairing existing wildlife-dependent recreational uses or reducing the potential to provide quality (see section 1.6D. for description), compatible, wildlife-dependent recreation into the future?		✔

Where we do not have jurisdiction over the use ("no" to [a]), there is no need to evaluate it further as we cannot control the use. Uses that are illegal, inconsistent with existing policy, or unsafe ("no" to [b], [c], or [d]) may not be found appropriate. If the answer is "no" to any of the other questions above, we will generally not allow the use.

If indicated, the refuge manager has consulted with State fish and wildlife agencies. Yes ____ No ___✔___.

When the refuge manager finds the use appropriate based on sound professional judgment, the refuge manager must justify the use in writing on an attached sheet and obtain the refuge supervisor's concurrence.

Based on an overall assessment of these factors, my summary conclusion is that the proposed use is:

Not Appropriate ___✔___ **Appropriate** _____

Refuge Manager: _____ Date: _____

If found to be **Not Appropriate**, the refuge supervisor does not need to sign concurrence if the use is a new use.

If an existing use is found **Not Appropriate** outside the CCP process, the refuge supervisor must sign concurrence.

If found to be **Appropriate**, the refuge supervisor must sign concurrence:

Refuge Supervisor: _____ Date: _____

A compatibility determination is required before the use may be allowed.

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Exhibit 1
Page 2

JUSTIFICATION FOR A FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Prime Hook National Wildlife Refuge

Use: Off-Road Vehicles

NARRATIVE:

The National Wildlife Refuge System Improvement Act of 1997 (P.L. 105-57) identifies six legitimate and appropriate uses of wildlife refuges; environmental education, interpretation, hunting, fishing, wildlife observation and wildlife photography. These priority public uses are dependent upon healthy wildlife populations. Where these uses are determined to be compatible, they are to receive enhanced consideration over other uses in planning and management. All other recreational uses are now considered general uses. As noted in the Appropriate Use Policy: "General public uses that are not wildlife-dependent recreational uses (as defined in the Improvement Act) and do not contribute to the fulfillment of refuge purposes, or goals, or objectives as described in current refuge management plans are the lowest priorities for refuge managers to consider. These uses are likely to divert refuge management resources from priority general public uses or away from the responsibilities to protect and manage fish, wildlife, and plants and their habitats. Therefore, both law and policy have a general presumption against allowing such uses within the Refuge System."

Allowing the use of off-road vehicles on the refuge is not a priority public use, but a general use. This use does not, as a standalone activity, contribute to the fulfillment of refuge purposes, and would detract from the refuge staff's responsibilities to protect and manage fish, wildlife, and plants and their habitats, as well as detract from administering priority uses. The use of off road vehicles is not consistent with two executive orders, E.O. 11644 and E.O. 11989, which require that refuges promote safety, minimize conflicts among users, monitor effects of off –road vehicles use if allowed, and close areas to use of off-road vehicles if they will cause adverse effects on soil, vegetation, wildlife, habitat or cultural or historic resources. Potential impacts include: soil compaction and erosion, trampling and mortality of fragile plant communities, habitat loss/deterioration, a shift in plant communities along trails, wildlife disturbance, and a concern for safety due to excessive speed of off-road vehicle users. This use is not consistent with any approved refuge management plan and would divert existing and future resources from accomplishing priority tasks. We do not believe it would contribute to public appreciation or understanding of refuge resources and we believe it could cause conflicts with priority public uses. The refuge does not have the facilities or staff to manage this use. Therefore, the general use of off-road vehicles is determined to be inappropriate.

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Exhibit 1

FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Prime Hook National Wildlife Refuge

Use: Operation of Model Planes and Boats on the Refuge

This exhibit is not required for wildlife-dependent recreational uses, forms of take regulated by the State, or uses already described in a refuge CCP or step-down management plan approved after October 9, 1997.

Decision criteria:	**YES**	**NO**
(a) Do we have jurisdiction over the use?	✔	
(b) Does the use comply with applicable laws and regulations (Federal, State, Tribal, and local)?	✔	
(c) Is the use consistent with applicable Executive orders and Department and Service policies?	✔	
(d) Is the use consistent with public safety?	✔	
(e) Is the use consistent with goals and objectives in an approved management plan or other document?		✔
(f) Has an earlier documented analysis not denied the use or is this the first time the use has been proposed?		✔
(g) Is the use manageable within available budget and staff?		✔
(h) Will this be manageable in the future within existing resources?		✔
(i) Does the use contribute to the public's understanding and appreciation of the refuge's natural or cultural resources, or is the use beneficial to the refuge's natural or cultural resources?		✔
(j) Can the use be accommodated without impairing existing wildlife-dependent recreational uses or reducing the potential to provide quality (see section 1.6D. for description), compatible, wildlife-dependent recreation into the future?	✔	

Where we do not have jurisdiction over the use ("no" to [a]), there is no need to evaluate it further as we cannot control the use. Uses that are illegal, inconsistent with existing policy, or unsafe ("no" to [b], [c], or [d]) may not be found appropriate. If the answer is "no" to any of the other questions above, we will generally not allow the use.

If indicated, the refuge manager has consulted with State fish and wildlife agencies. Yes ____ No ___✔___.

When the refuge manager finds the use appropriate based on sound professional judgment, the refuge manager must justify the use in writing on an attached sheet and obtain the refuge supervisor's concurrence.

Based on an overall assessment of these factors, my summary conclusion is that the proposed use is:

Not Appropriate ___✔___ **Appropriate** _____

Refuge Manager: _____ Date: _____

If found to be **Not Appropriate**, the refuge supervisor does not need to sign concurrence if the use is a new use.

If an existing use is found **Not Appropriate** outside the CCP process, the refuge supervisor must sign concurrence.

If found to be **Appropriate**, the refuge supervisor must sign concurrence:

Refuge Supervisor: _____ Date: _____

A compatibility determination is required before the use may be allowed.

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Exhibit 1
Page 2

JUSTIFICATION FOR A FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Prime Hook National Wildlife Refuge

Use: Operation of Model Planes and Boats on the Refuge

NARRATIVE:

The National Wildlife Refuge System Improvement Act of 1997 (P.L. 105-57) identifies six legitimate and appropriate uses of wildlife refuges; environmental education, interpretation, hunting, fishing, wildlife observation and wildlife photography. These priority public uses are dependent upon healthy wildlife populations. Where these uses are determined to be compatible, they are to receive enhanced consideration over other uses in planning and management. All other recreational uses are now considered general uses. As noted in the Appropriate Use Policy: "General public uses that are not wildlife-dependent recreational uses (as defined in the Improvement Act) and do not contribute to the fulfillment of refuge purposes, or goals, or objectives as described in current refuge management plans are the lowest priorities for refuge managers to consider. These uses are likely to divert refuge management resources from priority general public uses or away from the responsibilities to protect and manage fish, wildlife, and plants and their habitats. Therefore, both law and policy have a general presumption against allowing such uses within the Refuge System."

The operation of model planes and boats are not priority public uses, but are general uses. They do not, as standalone activities, contribute to the fulfillment of refuge purposes, and would detract from the refuge staff's responsibilities to protect and manage fish, wildlife, and plants and their habitats, as well as detract from administering priority uses. The refuge does not have the facilities or staff to manage these uses. These uses are not consistent with Service policy on secondary uses and are not consistent with any approved refuge management plan. The general uses of Operation of Model Planes and Boats are, therefore, determined to be inappropriate.

603 FW 1
Exhibit 1

FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Prime Hook National Wildlife Refuge

Use: Organized or Facility-supported Picnicking

This exhibit is not required for wildlife-dependent recreational uses, forms of take regulated by the State, or uses already described in a refuge CCP or step-down management plan approved after October 9, 1997.

Decision criteria:	**YES**	**NO**
(a) Do we have jurisdiction over the use?	✔	
(b) Does the use comply with applicable laws and regulations (Federal, State, Tribal, and local)?	✔	
(c) Is the use consistent with applicable Executive orders and Department and Service policies?	✔	
(d) Is the use consistent with public safety?	✔	
(e) Is the use consistent with goals and objectives in an approved management plan or other document?		✔
(f) Has an earlier documented analysis not denied the use or is this the first time the use has been proposed?	✔	
(g) Is the use manageable within available budget and staff?		✔
(h) Will this be manageable in the future within existing resources?		✔
(i) Does the use contribute to the public's understanding and appreciation of the refuge's natural or cultural resources, or is the use beneficial to the refuge's natural or cultural resources?	✔	
(j) Can the use be accommodated without impairing existing wildlife-dependent recreational uses or reducing the potential to provide quality (see section 1.6D. for description), compatible, wildlife-dependent recreation into the future?	✔	

Where we do not have jurisdiction over the use ("no" to [a]), there is no need to evaluate it further as we cannot control the use. Uses that are illegal, inconsistent with existing policy, or unsafe ("no" to [b], [c], or [d]) may not be found appropriate. If the answer is "no" to any of the other questions above, we will generally not allow the use.

If indicated, the refuge manager has consulted with State fish and wildlife agencies. Yes ____ No ___✔___.

When the refuge manager finds the use appropriate based on sound professional judgment, the refuge manager must justify the use in writing on an attached sheet and obtain the refuge supervisor's concurrence.

Based on an overall assessment of these factors, my summary conclusion is that the proposed use is:

Not Appropriate ___✔___ **Appropriate** _____

Refuge Manager: _____ Date: _____

If found to be **Not Appropriate**, the refuge supervisor does not need to sign concurrence if the use is a new use.

If an existing use is found **Not Appropriate** outside the CCP process, the refuge supervisor must sign concurrence.

If found to be **Appropriate**, the refuge supervisor must sign concurrence:

Refuge Supervisor: _____ Date: _____

A compatibility determination is required before the use may be allowed.

JUSTIFICATION FOR A FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Prime Hook National Wildlife Refuge

Use: Organized or Facility-supported Picnicking

NARRATIVE:

Organized picnicking is not identified as a priority public use of the National Wildlife Refuge System under the National Wildlife Refuge System Administration Act of 1966 (16 U.S.C. 668dd-668ee), as amended by the National Wildlife Refuge System Improvement Act of 1997 (NWRSIA). Organized picnicking, although permitted in the past, will no longer be allowed on the Refuge for several reasons.

The refuge does not have the infrastructure in place to accommodate for organized picnicking activities. Continuing to allow this use may result in increased soil and vegetation compaction, disturbance to wildlife, and trash and food waste that may attract nuisance species to the area. Although the refuge is prohibiting organized picnicking, this does not preclude visitors from bringing food with them for nutrition or safety while they participate in other appropriate and compatible activities on the refuge such as hiking, backpacking, or wildlife observation.

Finally, organized picnicking was not an activity in which the public expressed interest during our public scoping meetings.

After reevaluating organized picnicking under Service policies, required infrastructure, and demand, this activity will no longer be allowed. Since organized picnics have not been observed on the Refuge, the expectation is that prohibiting this activity will not significantly affect current or future visitors. However, prohibiting organized picnicking may positively impact wildlife and wildlife habitat, if only by reducing the amount of soil compaction, vegetation trampling, and trash and food waste that might occur on and off trails, and the frequency and extent of wildlife disturbance.

The general use of organized or facility-supported picnicking is therefore determined to be inappropriate.

603 FW 1
Exhibit 1

FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Prime Hook National Wildlife Refuge

Use: Rollerblading and Ice Skating

This exhibit is not required for wildlife-dependent recreational uses, forms of take regulated by the State, or uses already described in a refuge CCP or step-down management plan approved after October 9, 1997.

Decision criteria:	**YES**	**NO**
(a) Do we have jurisdiction over the use?	✔	
(b) Does the use comply with applicable laws and regulations (Federal, State, Tribal, and local)?	✔	
(c) Is the use consistent with applicable Executive orders and Department and Service policies?	✔	
(d) Is the use consistent with public safety?		✔
(e) Is the use consistent with goals and objectives in an approved management plan or other document?		✔
(f) Has an earlier documented analysis not denied the use or is this the first time the use has been proposed?		✔
(g) Is the use manageable within available budget and staff?		✔
(h) Will this be manageable in the future within existing resources?		✔
(i) Does the use contribute to the public's understanding and appreciation of the refuge's natural or cultural resources, or is the use beneficial to the refuge's natural or cultural resources?		✔
(j) Can the use be accommodated without impairing existing wildlife-dependent recreational uses or reducing the potential to provide quality (see section 1.6D. for description), compatible, wildlife-dependent recreation into the future?		✔

Where we do not have jurisdiction over the use ("no" to [a]), there is no need to evaluate it further as we cannot control the use. Uses that are illegal, inconsistent with existing policy, or unsafe ("no" to [b], [c], or [d]) may not be found appropriate. If the answer is "no" to any of the other questions above, we will generally not allow the use.

If indicated, the refuge manager has consulted with State fish and wildlife agencies. Yes ____ No ___✔___.

When the refuge manager finds the use appropriate based on sound professional judgment, the refuge manager must justify the use in writing on an attached sheet and obtain the refuge supervisor's concurrence.

Based on an overall assessment of these factors, my summary conclusion is that the proposed use is:

Not Appropriate ___✔___ **Appropriate** _____

Refuge Manager: _____ Date: _____

If found to be **Not Appropriate**, the refuge supervisor does not need to sign concurrence if the use is a new use.

If an existing use is found **Not Appropriate** outside the CCP process, the refuge supervisor must sign concurrence.

If found to be **Appropriate**, the refuge supervisor must sign concurrence:

Refuge Supervisor: _____ Date: _____

A compatibility determination is required before the use may be allowed.

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Exhibit 1
Page 2

JUSTIFICATION FOR A FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Prime Hook National Wildlife Refuge

Use: Rollerblading and Ice Skating

NARRATIVE:

The National Wildlife Refuge System Improvement Act of 1997 (P.L. 105-57) identifies six legitimate and appropriate uses of wildlife refuges; environmental education, interpretation, hunting, fishing, wildlife observation and wildlife photography. These priority public uses are dependent upon healthy wildlife populations. Where these uses are determined to be compatible, they are to receive enhanced consideration over other uses in planning and management. All other recreational uses are now considered general uses. As noted in the Appropriate Use Policy: "General public uses that are not wildlife-dependent recreational uses (as defined in the Improvement Act) and do not contribute to the fulfillment of refuge purposes, or goals, or objectives as described in current refuge management plans are the lowest priorities for refuge managers to consider. These uses are likely to divert refuge management resources from priority general public uses or away from the responsibilities to protect and manage fish, wildlife, and plants and their habitats. Therefore, both law and policy have a general presumption against allowing such uses within the Refuge System."

Rollerblading and ice skating are not priority public uses, but are general uses. They do not, as standalone activities, contribute to the fulfillment of refuge purposes, and would detract from the refuge staff's responsibilities to protect and manage fish, wildlife, and plants and their habitats, as well as detract from administering priority uses. The refuge does not have the facilities or staff to manage these uses. These uses are not consistent with Service policy on secondary uses and are not consistent with any approved refuge management plan. Safety is a major concern with these uses. The general uses of rollerblading and ice skating are, therefore, determined to be inappropriate.

603 FW 1
Exhibit 1

FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Prime Hook National Wildlife Refuge

Use: Swimming and Sunbathing

This exhibit is not required for wildlife-dependent recreational uses, forms of take regulated by the State, or uses already described in a refuge CCP or step-down management plan approved after October 9, 1997.

Decision criteria:	**YES**	**NO**
(a) Do we have jurisdiction over the use?	✔	
(b) Does the use comply with applicable laws and regulations (Federal, State, Tribal, and local)?	✔	
(c) Is the use consistent with applicable Executive orders and Department and Service policies?	✔	
(d) Is the use consistent with public safety?		✔
(e) Is the use consistent with goals and objectives in an approved management plan or other document?		✔
(f) Has an earlier documented analysis not denied the use or is this the first time the use has been proposed?		✔
(g) Is the use manageable within available budget and staff?		✔
(h) Will this be manageable in the future within existing resources?		✔
(i) Does the use contribute to the public's understanding and appreciation of the refuge's natural or cultural resources, or is the use beneficial to the refuge's natural or cultural resources?		✔
(j) Can the use be accommodated without impairing existing wildlife-dependent recreational uses or reducing the potential to provide quality (see section 1.6D. for description), compatible, wildlife-dependent recreation into the future?		✔

Where we do not have jurisdiction over the use ("no" to [a]), there is no need to evaluate it further as we cannot control the use. Uses that are illegal, inconsistent with existing policy, or unsafe ("no" to [b], [c], or [d]) may not be found appropriate. If the answer is "no" to any of the other questions above, we will generally not allow the use.

If indicated, the refuge manager has consulted with State fish and wildlife agencies. Yes ____ No ___✔___.

When the refuge manager finds the use appropriate based on sound professional judgment, the refuge manager must justify the use in writing on an attached sheet and obtain the refuge supervisor's concurrence.

Based on an overall assessment of these factors, my summary conclusion is that the proposed use is:

Not Appropriate ___✔___ **Appropriate** _____

Refuge Manager: _____ Date: _____

If found to be **Not Appropriate**, the refuge supervisor does not need to sign concurrence if the use is a new use.

If an existing use is found **Not Appropriate** outside the CCP process, the refuge supervisor must sign concurrence.

If found to be **Appropriate**, the refuge supervisor must sign concurrence:

Refuge Supervisor: _____ Date: _____

A compatibility determination is required before the use may be allowed.

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Exhibit 1
Page 2

JUSTIFICATION FOR A FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Prime Hook National Wildlife Refuge

Use: Swimming and Sunbathing

NARRATIVE:

The National Wildlife Refuge System Improvement Act of 1997 (P.L. 105-57) identifies six legitimate and appropriate uses of wildlife refuges; environmental education, interpretation, hunting, fishing, wildlife observation and wildlife photography. These priority public uses are dependent upon healthy wildlife populations. Where these uses are determined to be compatible, they are to receive enhanced consideration over other uses in planning and management. All other recreational uses are now considered general uses. As noted in the Appropriate Use Policy: "General public uses that are not wildlife-dependent recreational uses (as defined in the Improvement Act) and do not contribute to the fulfillment of refuge purposes, or goals, or objectives as described in current refuge management plans are the lowest priorities for refuge managers to consider. These uses are likely to divert refuge management resources from priority general public uses or away from the responsibilities to protect and manage fish, wildlife, and plants and their habitats. Therefore, both law and policy have a general presumption against allowing such uses within the Refuge System."

Swimming and sunbathing are not priority public uses, but are general uses. They do not, as standalone activities, contribute to the fulfillment of refuge purposes, and would detract from the refuge staff's responsibilities to protect and manage fish, wildlife, and plants and their habitats, as well as detract from administering priority uses. The refuge does not have the facilities or staff to manage these uses. These uses are not consistent with Service policy on secondary uses and are not consistent with any approved refuge management plan. Safety is also an issue. The general uses of swimming and sunbathing are, therefore, determined to be inappropriate.

603 FW 1
Exhibit 1

FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Prime Hook National Wildlife Refuge

Use: Cooperative Farming

This exhibit is not required for wildlife-dependent recreational uses, forms of take regulated by the State, or uses already described in a refuge CCP or step-down management plan approved after October 9, 1997.

Decision criteria:	**YES**	**NO**
(a) Do we have jurisdiction over the use?	✔	
(b) Does the use comply with applicable laws and regulations (Federal, State, Tribal, and local)?	✔	
(c) Is the use consistent with applicable Executive orders and Department and Service policies?	✔	
(d) Is the use consistent with public safety?	✔	
(e) Is the use consistent with goals and objectives in an approved management plan or other document?		✔
(f) Has an earlier documented analysis not denied the use or is this the first time the use has been proposed?	✔	
(g) Is the use manageable within available budget and staff?	✔	
(h) Will this be manageable in the future within existing resources?	✔	
(i) Does the use contribute to the public's understanding and appreciation of the refuge's natural or cultural resources, or is the use beneficial to the refuge's natural or cultural resources?	✔	
(j) Can the use be accommodated without impairing existing wildlife-dependent recreational uses or reducing the potential to provide quality (see section 1.6D. for description), compatible, wildlife-dependent recreation into the future?	✔	

Where we do not have jurisdiction over the use ("no" to [a]), there is no need to evaluate it further as we cannot control the use. Uses that are illegal, inconsistent with existing policy, or unsafe ("no" to [b], [c], or [d]) may not be found appropriate. If the answer is "no" to any of the other questions above, we will generally not allow the use.

If indicated, the refuge manager has consulted with State fish and wildlife agencies. Yes ___✔___ No ____.

When the refuge manager finds the use appropriate based on sound professional judgment, the refuge manager must justify the use in writing on an attached sheet and obtain the refuge supervisor's concurrence.

Based on an overall assessment of these factors, my summary conclusion is that the proposed use is:

Not Appropriate ___✔___ **Appropriate** _____

Refuge Manager: _____ Date: _____

If found to be **Not Appropriate**, the refuge supervisor does not need to sign concurrence if the use is a new use.

If an existing use is found **Not Appropriate** outside the CCP process, the refuge supervisor must sign concurrence.

If found to be **Appropriate**, the refuge supervisor must sign concurrence:

Refuge Supervisor: _____ Date: _____

A compatibility determination is required before the use may be allowed.

JUSTIFICATION FOR A FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Prime Hook National Wildlife Refuge

Use: Cooperative Framing

NARRATIVE:

Cooperative farming has taken place on the refuge since its founding, and was utilized by the refuge to meet its wildlife habitat management targets (specifically, its wintering and stopover waterfowl food targets) in an efficient manner. The refuge is a globally important migratory stopover site and wintering area for a number of waterfowl species. Waterfowl are dependent upon availability of both high protein and high-energy foods to get them through the winter in a sufficient body condition such that they may survive, migrate north, and breed the following spring. As native aquatic habitats have declined in quality and quantity over the last 50 years, field foraging species, especially the migratory Canada goose, obtain much of their protein and energy in the fall and winter within upland fields, especially agricultural fields. High protein foods are especially important in the early fall and late winter to support the continued growth of juveniles, to support the winter molt, and to prepare birds for spring migration and subsequent reproduction. High-energy foods (carbohydrates) are essential for waterfowl for maintaining body warmth during the coldest times of the winter. Thus, a variety of forage and grain crops need to be available to migratory geese during the winter months, preferably in close proximity to other feeding and resting areas, such as the refuge's impoundments, moist soil units, and salt marsh habitat.

Historically, cropland management has been largely driven by the wildlife manager's interest in game species, alone. The tradition of providing supplemental feed for waterfowl is deeply ingrained in wildlife management history and the local psyche. Forty plus years ago, the concept of waste corn remaining in fields after harvest was widely depended upon as a tool for providing foods for waterfowl. Today, even though the potential agricultural production of row crops can be high for wildlife, corn and soybeans produced on refuge by farmers result in all the grain being harvested as cooperative's share, and what little waste corn remains more often than not germinates before migratory waterfowl arrive.

The numbers of non-migratory Canada geese that nest and or reside on the refuge, as well as across the flyway, have undergone dramatic population growth and have increased to levels that are increasingly coming into conflict with people and human activities. The Service addressed these concerns through the preparation of a Final Environmental Impact Statement (FEIS), Resident Canada Goose Management, published in November 2005. The reduction and/or elimination of farming on the refuge would further support the strategies to reduce, manage, and control resident Canada goose populations. In 2007, the Final Environmental Impact Statement for Light Goose Management was published and in 2008 the final rule was published. This plan, also known as the Snow Goose Conservation Order, supports the reduction of farming and sanctuary for snow geese on the refuge.

The Delaware Wildlife Action Plan (DNREC, 2005) includes the migratory Canada goose as one of the Species of Greatest Conservation Need in the state of Delaware; however, the refuge furnishes 4,200 acres of impounded wetlands that contribute to this purpose. The refuge cannot meet all life cycle requirements of all migratory birds on its limited acreage. The Delmarva goose population (Canada and snow) averaged 698,266 over the 10 year period from 2001-2010, as recorded by the mid-winter waterfowl inventory. The limited acreage of refuge cropland could not sustain even the local wintering goose population throughout the winter.

Goose hunting on Delmarva is a major recreational and economic industry. Providing habitat for Canada geese provides habitat for snow geese as well. Unfortunately, snow geese are well known for being more destructive of agricultural crops, as well as native marshes.

A number of regional bird conservation plans now cover the mid-Atlantic. Focus areas for habitat acquisition and enhancement for all migratory birds overlap both refuges in Delaware. These plans include:

- Atlantic Coast Joint Venture Waterfowl Implementation Plan
- Partners in Flight Bird Conservation Plan for The Mid-Atlantic Coastal Plain
- North Atlantic Regional Shorebird Plan
- Mid-Atlantic / New England / Maritimes Regional Waterbird Conservation Plan
- New England/Mid-Atlantic Coast BCR Implementation Plan – BCR 30
- Atlantic Coast Joint Venture Strategic Plan

Fragmenting native habitats has contributed to a substantial degree to the decline in many federal trust resources, including numerous species of migratory birds, including but not limited to, waterfowl (DNREC, 2005).

The BCR 30 Plan lists species of concern. We have compiled the species considered "High" and "Highest" on this list, highlighting waterfowl species of interest to the refuge, as well as landbird species that would potentially frequent native Delaware habitats (appendix D. Table A). Forest interior dwelling species (FIDS) are noted. These species are habitat area dependent, requiring large blocks of forest, not agricultural cropland, to meet some, if not all of their lifecycle needs.

The refuge must carefully consider its contribution to the management of trust resources locally and across the larger landscape. Cropland is not limiting within the daily foraging flights of migratory and wintering waterfowl. There is well over one million acres of cropland on the Delmarva Peninsula. In light of the fact that habitat fragmentation caused, in part, by clearing land for agricultural crops (DNREC, 2005) is recognized as a major cause in the decline in many federal trust resource populations, cooperative farming can no longer be justified.

In the future, the refuge may assume use of force account farming, (i.e. a non-economic management activity conducted by refuge staff), on a limited basis, to prepare refuge acreage for habitat restoration. Should cooperative farming be regarded as essential once again in the future, the refuge may revisit this activity and re-evaluate the finding of Appropriateness and Compatibility, as required by 5 RM 17, 6 RM 4, 603 FW 1 , 603 FW 2 and 601 FW 3.

LITERATURE CITED:

See CCP Bibliography.

603 FW 1
Exhibit 1

FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Prime Hook National Wildlife Refuge

Use: Commercial Wildlife and Nature Photography

This exhibit is not required for wildlife-dependent recreational uses, forms of take regulated by the State, or uses already described in a refuge CCP or step-down management plan approved after October 9, 1997.

Decision criteria:	**YES**	**NO**
(a) Do we have jurisdiction over the use?	✔	
(b) Does the use comply with applicable laws and regulations (Federal, State, Tribal, and local)?	✔	
(c) Is the use consistent with applicable Executive orders and Department and Service policies?	✔	
(d) Is the use consistent with public safety?	✔	
(e) Is the use consistent with goals and objectives in an approved management plan or other document?	✔	
(f) Has an earlier documented analysis not denied the use or is this the first time the use has been proposed?		✔
(g) Is the use manageable within available budget and staff?	✔	
(h) Will this be manageable in the future within existing resources?	✔	
(i) Does the use contribute to the public's understanding and appreciation of the refuge's natural or cultural resources, or is the use beneficial to the refuge's natural or cultural resources?	✔	
(j) Can the use be accommodated without impairing existing wildlife-dependent recreational uses or reducing the potential to provide quality (see section 1.6D. for description), compatible, wildlife-dependent recreation into the future?	✔	

Where we do not have jurisdiction over the use ("no" to [a]), there is no need to evaluate it further as we cannot control the use. Uses that are illegal, inconsistent with existing policy, or unsafe ("no" to [b], [c], or [d]) may not be found appropriate. If the answer is "no" to any of the other questions above, we will generally not allow the use.

If indicated, the refuge manager has consulted with State fish and wildlife agencies. Yes ____ No ___✔___.

When the refuge manager finds the use appropriate based on sound professional judgment, the refuge manager must justify the use in writing on an attached sheet and obtain the refuge supervisor's concurrence.

Based on an overall assessment of these factors, my summary conclusion is that the proposed use is:

Not Appropriate _____ **Appropriate** ___✔___

Refuge Manager: _____ Date: _____

If found to be **Not Appropriate**, the refuge supervisor does not need to sign concurrence if the use is a new use.

If an existing use is found **Not Appropriate** outside the CCP process, the refuge supervisor must sign concurrence.

If found to be **Appropriate**, the refuge supervisor must sign concurrence:

Refuge Supervisor: _____ Date: _____

A compatibility determination is required before the use may be allowed.

JUSTIFICATION FOR A FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Prime Hook National Wildlife Refuge

Use: Commercial Wildlife and Nature Photography

NARRATIVE:

The National Wildlife Refuge System Improvement Act of 1997 (P.L. 105-57) identifies six legitimate and appropriate uses of wildlife refuges: environmental education, interpretation, hunting, fishing, wildlife observation and wildlife photography. These priority public uses are dependent upon healthy wildlife populations. Where these uses are determined to be compatible, they are to receive enhanced consideration over other uses in planning and management.

Commercial photography has the potential to inspire and educate the public about the Refuge System, natural habitats, and wildlife.

Commercial photography is not identified as a priority public use of the National Wildlife Refuge System, is considered an economic use of a national wildlife refuge, and is guided by the following policies:

16USC668dd, 50 CFR 27.71, Motion or Sound Pictures
The taking or filming of any motion or sound pictures on a national wildlife refuge for subsequent commercial use is prohibited except as may be authorized under the provisions of 43 CFR part 5.

16USC668dd, 50 CFR 27.97, Private Operations
Soliciting business or conducting a commercial enterprise on any national wildlife refuge is prohibited except as may be authorized by special permit.

16USC668dd, 50 CFR 27.86, Begging
Begging on any national wildlife refuge is prohibited. Soliciting of funds for the support or assistance of any cause or organization is also prohibited unless properly authorized.

16USC668dd, 50 CFR, Subpart A, 29.1 Allowing Economic Uses on National Wildlife Refuges
We may only authorize public or private economic use of the natural resources of any national wildlife refuge, in accordance with 16 U.S.C. 715s, where we determine that the use contributes to the achievement of the national wildlife refuge purposes or the National Wildlife Refuge System mission.

8 RM 16, Audio Visual Productions

5 RM 17, Commercial & Economic Uses on National Wildlife Refuges

43 CFR Part 5, Making Pictures, Television Productions or Sound Tracks on Certain Areas Under the Jurisdiction of the Department of the Interior

Public Law 106-206, Commercial Filming

This activity will not materially interfere with or detract from the mission of the Refuge System or purposes for which Prime Hook NWR was established. In addition, this activity will fulfill one or more purposes of the refuge or the National Wildlife Refuge System.

COMPATIBILITY DETERMINATION

USE:

Commercial Wildlife and Nature Photography

REFUGE NAME:

Prime Hook National Wildlife Refuge, hereafter referred to as the Refuge, located in Sussex County, Delaware.

ESTABLISHING AND ACQUISITION AUTHORITY(IES):

(1) Migratory Bird Conservation Act {16 U.S.C. 715d}

(2) Refuge Recreation Act {16 U.S.C. 460 K-1}

REFUGE PURPOSE(S):

(1) "…for use as an inviolate sanctuary, or for any other management purposes, for migratory birds…" {16 U.S.C. 715d; Migratory Bird Conservation Act}

(2) "…incidental fish and wildlife-oriented recreational development" {16 U.S.C. 460k-1; Refuge Recreation Act}

(3) "the protection of natural resources" {16 U.S.C. 460k-1; Refuge Recreation Act}

(4) "the conservation of endangered or threatened species…" {16 U.S.C. 460k-1; Refuge Recreation Act}

NATIONAL WILDLIFE REFUGE SYSTEM MISSION:

The mission of the Refuge System is to administer a national network of lands and waters for the conservation, management, and where appropriate, restoration of the fish, wildlife, and plant resources and their habitats within the United States for the benefit of present and future generations of Americans.

DESCRIPTION OF USE:

The use is commercial photography, either still or motion pictures, of wildlife, or nature scenes for conservation uses. This is not a priority public use, but would be contributing to priority public uses.

This use typically involves creating a documentary film, taking still photographs, or recording wildlife sounds that are intended to be or could be sold for income or revenue or traded for goods or services. Commercial recording of natural, historic, or cultural subjects are covered under this Compatibility Determination (CD). This CD does not apply to legitimate news media activities.

Each request for this use will be considered, and if appropriate, will be issued a Special Use Permit by the refuge manager. Each request must be presented in writing with details of who, what, where, when, why, and how the commercial operation will be conducted. Each request will be evaluated on its own merit. The refuge manager will use professional judgment and ensure that the request will have no considerable negative impacts to natural, cultural, or visitor services, does not violate refuge regulations, and contributes to the achievement of the refuge purpose or the Refuge System mission. Special needs will be considered on a case-by-case basis and are subject

to the refuge manager's approval. Any approved Special Use Permit will outline the framework in which the use can be conducted and refuge staff will ensure compliance with the Permit.

Commercial photography is a popular enterprise on the refuge due to the scenic natural habitats and abundant wildlife in the area. The refuge staff anticipates that an increase in commercial photography will occur over the next few years as the refuge gains visibility and areas of natural habitat in the surrounding area decrease.

AVAILABILITY OF RESOURCES:

Permitting this use is within the resources available to administer our Visitor Services Program. Additional staff costs are incurred to review each request, analyze affected habitats and wildlife, coordinate with the outside entity and process a Special Use Permit, if necessary. Compliance with the terms of the Permit is within the regular duties of the Complex's Law Enforcement Officer. Anticipated costs for up to five requests are as follows:

- Refuge Biologist (GS-11) (review request) – 1 day/yr = $238
- Visitor Services Manager (GS-09) (review requests, coordinate with entity, process SUP) – 3 days/yr. = $589
- Refuge Manager (GS-12) (review and approval) – 1 day/yr. = $285
- Law Enforcement Officer (GS-09) (enforcement patrols) 1 day/yr. = $196
- Administrative Assistant (GS-06) (issue SUP) – 1 day/yr. = $145

ANTICIPATED IMPACTS OF THE USE:

For a complete analysis of the anticipated impacts of commercial photography, refer to chapter 5 of the CCP/EIS.

Commercial photography can result in positive or negative impacts to the wildlife resource. Visitors engaging in commercial photography are expected to use and stay on hiking and canoe trails or roads to access the interior of the refuge. To minimize disturbance to natural resources and insure public safety, the refuge has implemented restrictions on public entry such as closed areas, seasonally restricted areas, and daily hour restrictions. Facilities most utilized by refuge visitors engaging in commercial photography are roads, parking lots, trails, and boat launching ramps. Maintenance or improvement of these facilities will cause negligible to short-term minor impacts to localized soils and waters and may cause some wildlife disturbances and damage to vegetation.

Commercial wildlife and nature photography is expected to have negligible short-term, long-term or cumulative impacts on the economy of the towns or county in which the refuge lies based on findings regarding socioeconomic impacts (see appendix I in CCP). We would not expect this activity to considerably alter the demographic of economic characteristics of the local community. All proposed refuge actions will neither disproportionately affect any communities nor damage or undermine any businesses or community organizations. No adverse impacts are foreseen to be associated with changes in the community character or demographic composition.

Commercial filming, as with other uses, has the potential to disrupt cultural resources that are located in wetland areas adjacent to upland areas. Refuge visitors may inadvertently or even intentionally damage or disturb known or undiscovered cultural artifacts or historic properties. Impacts are expected to be negligible based on our observations of past visitor impacts from these uses.

A Section 7 evaluation has been conducted as part of this review to address the Delmarva fox squirrel, piping plover, red knot, and the State endangered bald eagle. It was determined that proposed activities would not likely affect the Delmarva fox squirrel. Areas near active bald eagle nests will not be open at any time for commercial photography and, therefore, are not expected to have any negative impacts on bald eagles (U.S. Fish and Wildlife Service 2007).

Commercial photography is expected to have negligible adverse short-term, long-term or cumulative impacts on secretive marsh and waterbirds, and waterfowl. To minimize waterfowl disturbance from this use, the refuge has designated approximately 3,000 acres as waterfowl sanctuaries that will be closed on a seasonal or annual basis.

Negligible adverse short-term, long-term or cumulative impacts on landbirds are expected. All visitors will be required to be on designated walking trails and access routes.

Impacts to fisheries from visitors engaged in commercial photography are expected to be temporary and minor. Use of boats and canoes will cause increased suspension of bottom sediments, which should not adversely affect

biological oxygen demand (BOD) for fisheries resources. Boat motors may also harm submerged or emergent vegetation, which may cause a negligible negative impact to protective cover for fisheries. Accidental introduction of invasive plants, pathogens, or exotic invertebrates attached to boats or canoes is a concern.

Commercial photography is expected to have negligible adverse short-term, long-term or cumulative impacts on mammals. The use was evaluated for its potential to benefit or adversely affect amphibians and reptiles or their habitats used for mating, reproduction, over-wintering, and foraging. Although most species that occur on the refuge are very common and widespread, there is concern for two species of turtle: eastern box and spotted, and amphibians everywhere are considered to be experiencing a general decline.

Impacts to invertebrates such as butterflies, moths, other insects, and spiders are expected to be negligible. Visitors participating in commercial photography are restricted to designated trail routes and interior roads, which minimizes disturbance to invertebrates.

Opportunities for commercial photography are available via new trails using existing and already maintained trail/road networks off of Slaughter Beach Road, Fowler Beach Road, Prime Hook Road, Deep Branch Road, and Broadkill Road. Using existing roads will minimize impacts to refuge resources. Moderate beneficial impacts are expected. Except as noted below, the refuge is open for this use in the following areas every day from one-half hour before sunrise to one-half hour after sunset. Some areas are seasonally restricted to minimize conflict among user groups and to minimize wildlife disturbance.

a) Designated beach dunes and overwash areas: Closed from March 1 through September 1.

b) Western Prime Hook Creek (from old shop ramp to Waples Pond): Closed every day during the deer and waterfowl hunting seasons, which typically starts on September 1 and ends in early February.

c) Deep Branch Road Trail (includes Goose & Flaxhole Ponds) and Eastern Prime Hook Creek (from old shop ramp to HQ ramp): Closed every day from September 1 through March 15.

d) Headquarters Area (includes Turkle & Fleetwood Ponds): Closed only for a maximum of two days for deer hunts.

e) The northern portion of Unit IV (includes trail overlooking Vergie's Pond): Closed from the Monday before Thanksgiving through March 15.

f) Hiking Trails on Fowler Beach Road, Prime Hook Road, and Slaughter Beach Road and Slaughter Canal: Closed except for Sundays from September 1 through the deer and waterfowl hunting seasons, which typically end in early February.

g) Roadside pulloffs and water control structures/fishing areas at Petersfield Ditch, Slaughter Canal & Cods Road: Open year round.

PUBLIC REVIEW AND COMMENT:

This compatibility determination is part of the refuge's draft Comprehensive Conservation Plan and Environmental Impact Statement. Public notification and review include a notice of availability published in the *Federal Register,* a 60-day comment period, and local media announcements.

DETERMINATION (CHECK ONE BELOW):

_____ Use is not compatible

__X__ Use is compatible, with the following stipulations

STIPULATIONS NECESSARY TO ENSURE COMPATIBILITY:

Each request must comply with 43 CFR Part 5, Public Law 106-206 of May 2000, 8 RM 16 (Refuge Manual).

To ensure compatibility with the National Wildlife Refuge System and refuge goals and objectives and to minimize or exclude adverse impacts as described above, the activity should be subject to the following stipulations:

(1) Only commercial photography in support of conservation, refuge purposes, the National Wildlife Refuge System Mission, and/or for education and interpretive purposes will be permitted.

(2) Permittee(s), designated representative, and associates will comply with all refuge regulations and conditions of the Special Use Permit as provided by the refuge manager. The Special Use Permit will detail who, what, where, when, why, and how the commercial operation will be conducted.

(3) The Refuge Manager will consider requests that include special access only if they demonstrate a means to enhance education, appreciation, and/or understanding of the natural resources and the National Wildlife Refuge System.

(4) Alterations to any vegetation are prohibited.

(5) Permittee will be required to minimize potential impacts to refuge visitors and natural and/or cultural resources within the refuge.

(6) Permittee is responsible for acquiring and/or renewing any necessary State and Federal permits prior to beginning or continuing their project.

(7) The refuge manager or designee can suspend the project, modify conditions, and/or terminate the project that is already permitted and in progress should unacceptable, unforeseen, or unexpected impacts or issues arise or be noted.

(8) Proper credit should be given to the refuge and the U.S. Fish and Wildlife Service for all commercial filming, including commercial recordings of images and sounds collected on the refuge.

(9) Permittee will clean up all sites of trash and litter to the satisfaction of the refuge manager.

(10) Permittee will provide the U.S. Fish and Wildlife Service with at least one free copy of all commercial products generated on the refuge.

The refuge shall also collect any costs incurred as a result of photography activities, including but not limited to administrative and personnel costs. All costs recovered shall be in addition to any use fee. Public Law 106-206 states that fees for commercial photography must be based on several criteria, including:

- The number of days the commercial photography or still photography takes place on federal land.
- The size of the film crew present on federal land.
- The amount and type of equipment present on federal land.

JUSTIFICATION:

Commercial photography has the potential to inspire and educate the public about the Refuge System, natural habitats, and wildlife. Wildlife photography is a priority wildlife-dependent use for the Refuge System through which the public can develop an appreciation for fish and wildlife (Executive Order 12996, March 25, 1996 and The National Wildlife Refuge System Administration Act of 1966, as amended by the National Wildlife Refuge System Improvement Act of 1997 (Public Law 105-57)). The Service's policy is to provide expanded opportunities for wildlife-dependent uses when compatible and consistent with sound fish and wildlife management, ensuring that they receive enhanced attention during planning and management.

Specific refuge regulations address equity and quality of opportunities for visitors and help safeguard refuge habitats. Impacts from this proposal, short-term and long-term, direct, indirect, and cumulative, are expected to be minor and are not expected to diminish the value of the refuge for its stated objectives.

Stipulations above will ensure proper control of the means of use and provide management flexibility should detrimental impacts develop. Allowing this use also furthers the mission of the National Wildlife Refuge System by providing renewable resources for the benefit of the American public while conserving fish, wildlife, and plant resources on the refuge.

Commercial photography is considered an economic use of a national wildlife refuge and is guided by the following policies:

16USC668dd, 50 CFR 27.71, Motion or Sound Pictures
The taking or filming of any motion or sound pictures on a national wildlife refuge for subsequent commercial use is prohibited except as may be authorized under the provisions of 43 CFR part 5.

16USC668dd, 50 CFR 27.97, Private Operations
Soliciting business or conducting a commercial enterprise on any national wildlife refuge is prohibited except as may be authorized by special permit.

16USC668dd, 50 CFR 27.86, Begging
Begging on any national wildlife refuge is prohibited. Soliciting of funds for the support or assistance of any cause or organization is also prohibited unless properly authorized.

16USC668dd, 50 CFR, Subpart A, 29.1 Allowing Economic Uses on National Wildlife Refuges
We may only authorize public or private economic use of the natural resources of any national wildlife refuge, in accordance with 16 U.S.C. 715s, where we determine that the use contributes to the achievement of the national wildlife refuge purposes or the National Wildlife Refuge System mission.

8 RM 16, Audio Visual Productions

5 RM 17, Commercial & Economic Uses on National Wildlife Refuges

43 CFR Part 5, Making Pictures, Television Productions or Sound Tracks on Certain Areas Under the Jurisdiction of the Department of the Interior

Public Law 106-206, Commercial Filming

This activity will not materially interfere with or detract from the mission of the Refuge System or purposes for which the refuge was established. In addition, this activity will fulfill one or more purposes of the refuge or Refuge System.

SIGNATURE:

Refuge Manager: _____ _____
(Signature) (Date)

CONCURRENCE:

Regional Chief: _____ _____
(Signature) (Date)

MANDATORY 10 YEAR RE-EVALUATION DATE: _____

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Exhibit 1

FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Prime Hook National Wildlife Refuge

Use: Commercially Guided Wildlife Observation

This exhibit is not required for wildlife-dependent recreational uses, forms of take regulated by the State, or uses already described in a refuge CCP or step-down management plan approved after October 9, 1997.

Decision criteria:	**YES**	**NO**
(a) Do we have jurisdiction over the use?	✔	
(b) Does the use comply with applicable laws and regulations (Federal, State, Tribal, and local)?	✔	
(c) Is the use consistent with applicable Executive orders and Department and Service policies?	✔	
(d) Is the use consistent with public safety?	✔	
(e) Is the use consistent with goals and objectives in an approved management plan or other document?	✔	
(f) Has an earlier documented analysis not denied the use or is this the first time the use has been proposed?		✔
(g) Is the use manageable within available budget and staff?	✔	
(h) Will this be manageable in the future within existing resources?	✔	
(i) Does the use contribute to the public's understanding and appreciation of the refuge's natural or cultural resources, or is the use beneficial to the refuge's natural or cultural resources?	✔	
(j) Can the use be accommodated without impairing existing wildlife-dependent recreational uses or reducing the potential to provide quality (see section 1.6D. for description), compatible, wildlife-dependent recreation into the future?	✔	

Where we do not have jurisdiction over the use ("no" to [a]), there is no need to evaluate it further as we cannot control the use. Uses that are illegal, inconsistent with existing policy, or unsafe ("no" to [b], [c], or [d]) may not be found appropriate. If the answer is "no" to any of the other questions above, we will generally not allow the use.

If indicated, the refuge manager has consulted with State fish and wildlife agencies. Yes ____ No ___✔___.

When the refuge manager finds the use appropriate based on sound professional judgment, the refuge manager must justify the use in writing on an attached sheet and obtain the refuge supervisor's concurrence.

Based on an overall assessment of these factors, my summary conclusion is that the proposed use is:

Not Appropriate _____ **Appropriate** ___✔___

Refuge Manager: _____ Date: _____

If found to be **Not Appropriate**, the refuge supervisor does not need to sign concurrence if the use is a new use.

If an existing use is found **Not Appropriate** outside the CCP process, the refuge supervisor must sign concurrence.

If found to be **Appropriate**, the refuge supervisor must sign concurrence:

Refuge Supervisor: _____ Date: _____

A compatibility determination is required before the use may be allowed.

JUSTIFICATION FOR A FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Prime Hook National Wildlife Refuge

Use: Commercially Guided Wildlife Observation

NARRATIVE:

The National Wildlife Refuge System Improvement Act of 1997 (P.L. 105-57) identifies six legitimate and appropriate uses of wildlife refuges: environmental education, interpretation, hunting, fishing, wildlife observation and wildlife photography. These priority public uses are dependent upon healthy wildlife populations. Where these uses are determined to be compatible, they are to receive enhanced consideration over other uses in planning and management.

Commercial tour guides provide the public with high-quality, safe, educational, and unique recreational opportunities. These visitor services are a valuable benefit to a segment of the American public that is not comfortable with, or for other reasons, chooses not to participate in unguided tours on the refuge.

Commercially guided tours will help increase public understanding of wildlife's needs and when people value something, they are motivated to action. When people understand the connections between land management and larger resource issues in their lives, they are in a better position to make wise resource decisions.

Commercially guided wildlife observation is not identified as a priority public uses of the National Wildlife Refuge System, is considered an economic use of a national wildlife refuge, and is guided by the following policies:

16USC668dd, 50 CFR 27.97, Private Operations
> Soliciting business or conducting a commercial enterprise on any national wildlife refuge is prohibited except as may be authorized by special permit.

16USC668dd, 50 CFR 27.86, Begging
> Begging on any national wildlife refuge is prohibited. Soliciting of funds for the support or assistance of any cause or organization is also prohibited unless properly authorized.

16USC668dd, 50 CFR, Subpart A, 29.1 Allowing Economic Uses on National Wildlife Refuges
> We may only authorize public or private economic use of the natural resources of any national wildlife refuge, in accordance with 16 U.S.C. 715s, where we determine that the use contributes to the achievement of the national wildlife refuge purposes or the National Wildlife Refuge System mission.

5 RM 17, Commercial & Economic Uses on National Wildlife Refuges

This activity will not materially interfere with or detract from the mission of the Refuge System or purposes for which Prime Hook NWR was established. In addition, this activity will fulfill one or more purposes of the refuge or the National Wildlife Refuge System.

COMPATIBILITY DETERMINATION

USE:

Commercially Guided Wildlife Observation

REFUGE NAME:

Prime Hook National Wildlife Refuge

ESTABLISHING AND ACQUISITION AUTHORITY(IES):

(1) Migratory Bird Conservation Act {16 U.S.C. 715d}

(2) Refuge Recreation Act {16 U.S.C. 460 K-1}

REFUGE PURPOSE(S):

(1) "…for use as an inviolate sanctuary, or for any other management purposes, for migratory birds…" {16 U.S.C. 715d; Migratory Bird Conservation Act}

(2) "…incidental fish and wildlife-oriented recreational development" {16 U.S.C. 460k-1; Refuge Recreation Act}

(3) "the protection of natural resources" {16 U.S.C. 460k-1; Refuge Recreation Act}

(4) "the conservation of endangered or threatened species…" {16 U.S.C. 460k-1; Refuge Recreation Act}

NATIONAL WILDLIFE REFUGE SYSTEM MISSION:

The mission of the Refuge System is to administer a national network of lands and waters for the conservation, management, and where appropriate, restoration of the fish, wildlife, and plant resources and their habitats within the United States for the benefit of present and future generations of Americans.

DESCRIPTION OF USE:

(a) What is the use? Is the use a priority public use?
The refuge will authorize commercially guided wildlife observation within the refuge, and will regulate such use through the implementation of a commercial wildlife guide management program, including issuance of Special Use Permits with conditions. Commercial means that clients pay a fee for the program and the intent of the permittee is to generate profit. Guiding also includes outfitting operations which may not provide an accompanying guide. Guiding does not include no-fee or not-for-profit guided tours conducted by non-profit groups, schools and colleges, or other agencies. This use is covered under the general wildlife observation compatibility determination.

This use also does not include tour bus or other road-based commercial tours which may stop at refuge-administered overlooks or landings.

This activity provides recreational, and often educational, opportunities for the paying public who desire a successful, quality experience, but who may lack the necessary equipment, skills, or knowledge to observe wildlife or otherwise experience the refuge. Commercial guiding for wildlife or other observation is an existing activity on the refuge, but it has not been consistently administered. This use is not a priority public use, but would be contributing to priority public uses.

(b) Where would the use be conducted?
The use would be conducted within the refuge's 10,132 acres, which lie between Slaughter Beach and the Broadkill River along the southeastern coastline of Delaware. In all four units, viewing areas will be highlighted along State roads (Slaughter Beach Road, Fowler Beach Road, Prime Hook Road, and Broadkill Road) in an interpretive auto tour route, where a visitor can access information about the refuge using advanced technology (radio, compact disc, cell phone, downloadable programming, etc.). Designated areas open for guided wildlife observation are as follows:

Unit I (Slaughter Beach Road to Fowler Beach Road): Wildlife observation and photography are the primary uses at designated areas at Fowler Beach, Slaughter Canal, and along the roadsides of Slaughter Beach Road and Fowler Beach Road. This area includes interpretive signs at Fowler Beach, information kiosks (one at Slaughter Beach and two on Fowler Beach Road), parking areas, and an unimproved boat ramp on Fowler Beach Road. Access to the Slaughter Canal is by boat only. We plan to provide access to existing interior roads and trails on the north side of Fowler Beach Road and south side of Slaughter Beach Road for wildlife observation and photography opportunities. A new parking area will be established on the north side of Fowler Beach Road.

Unit II (Fowler Beach Road to Prime Hook Road): Wildlife observation and photography are the primary uses at Slaughter Creek on Cods Road and roadside pull-offs along Prime Hook Road. The area includes two information kiosks on Prime Hook Road and parking areas. We plan to provide access to an existing interior road on the south side of Fowler Beach for wildlife observation and photography opportunities by adding a wheelchair accessible photography blind near a restored wetland area. Visitors can use the new parking area mentioned in the Unit I description. Access to the north side of Fowler Beach Road will be from the existing interior road and trail network.

Unit III (Prime Hook Road to Broadkill Beach Road): Wildlife observation, photography, environmental education, and interpretation are important uses in this area of the refuge. The majority of the public use infrastructure is located near the refuge headquarters. This area includes 5.1 miles of hiking trails (Blue Goose Trail, Photography Blind Trail, Dike Trail-wheelchair accessible, Black Farm Trail, Pine Grove Trail, and Boardwalk Trail-wheelchair accessible); canoe trail on Prime Hook Creek and the Headquarters Canal Ditch; Turkle and Fleetwood Ponds; Goose & Flaxhole Ponds; Petersfield Ditch; trailhead kiosks; informational kiosks (one in partnership with Delaware Division of Fish and Wildlife on Little Neck Road); highway direction signage; parking areas; restrooms; a photography blind; wheelchair accessible observation platform (Dike Trail); wheelchair accessible fishing pier (Fleetwood Pond); numerous interpretive signs and kiosk maps; Visitor Contact Station containing interpretive displays and various mounted animal species; four refuge boat ramps; roadside pull-offs along Broadkill Beach Road; refuge auditorium; an environmental education pavilion; wildlife observation and photography opportunities through special events, programs, and benches along hiking trails. The areas immediately surrounding the refuge office and associated trails provide opportunities for environmental education. We also participate in off-refuge events in Milton, such as the Horseshoe Crab-Shorebird Festival and the Youth Fishing Event.

We plan to enhance opportunities in this area by extending the trail network near the deer check station to provide additional parking and hiking opportunities; developing new facilities for environmental education and visitor services programs; and providing access to existing interior roads and trails on the south side of Prime Hook Road and near Goose Pond (off Deep Branch Road) for wildlife observation and photography opportunities.

Unit IV (Broadkill Beach Road to Broadkill River): Wildlife observation and photography are the primary uses in this area. This area includes roadside pull-offs along Broadkill Beach Road. We plan to reevaluate the trail and observation platform overlooking Vergie's Pond.

(c) When would the use be conducted?
Except as noted below, the refuge is open for wildlife observation, wildlife photography, environmental education, and environmental interpretation in the following areas every day from open one-half hour before sunrise to one-half hour after sunset. Some areas are seasonally restricted to minimize conflict among user groups and to minimize wildlife disturbance.

1) Designated beach dunes and overwash areas (Units I & II): Closed from March 1 through September 1 due to nesting State endangered least terns and American oystercatchers, and the potential for use by federally endangered piping plovers. Areas may be reopened if no nesting activity occurs or when nesting ends for the season.

2) Western Prime Hook Creek (from old shop ramp to Waples Pond) (Unit III): Closed every day during the deer and waterfowl hunting seasons, which typically starts on September 1 and ends in early February. Additional seasonal closures may apply through the second Saturday in May for hunting during the snow goose conservation order and/or turkey hunting.

3) Deep Branch Road Trail (includes Goose & Flaxhole Ponds) and Eastern Prime Hook Creek (from old shop ramp to HQ ramp) (Unit III): Closed every day from September 1 through March 15. Additional seasonal closures may apply through the second Saturday in May for hunting during the snow goose conservation order and/or turkey hunting.

4) Headquarters Area (includes Turkle & Fleetwood Ponds) (Unit III): Closed only for a maximum of two days for deer hunts.

5) The northern portion of Unit IV (includes trail overlooking Vergie's Pond): Closed from the Monday before Thanksgiving through March 15. Additional seasonal closures may apply through the second Saturday in May for hunting during the snow goose conservation order and/or turkey hunting.

6) Hiking Trails on Fowler Beach Road (Unit I), Prime Hook Road (Unit III), and Slaughter Beach Road and Slaughter Canal (Unit I): Closed except for Sundays from September 1 through the deer and waterfowl hunting seasons, which typically end in early February. Additional seasonal closures may apply through the second Saturday in May for hunting during the snow goose conservation order and/or turkey hunting.

7) Roadside pull offs and water control structures/fishing areas at Petersfield Ditch (Unit III), Slaughter Canal (Unit I) & Cods Road (Unit II): Open year round.

(d) How would the use be conducted?
Guided wildlife observation may involve the use of refuge boat ramps to access selected sites or routes. Often guides and clients use the same site, route, or one of several locations selected by the guide. Some guided programs may walk to sites/routes from parking lots or roadsides. Guided wildlife viewing operations have typically used existing refuge or other public observation sites. In addition to the observation activities, guides and clients may use refuge facilities for breaks, lunch, or other activities during the outing, and in accordance with refuge regulations.

The total number of wildlife observation guides and clients on the refuge is not known. A first step in establishing a commercial guiding program on the refuge will be to identify existing guides and outfitting businesses through a review of public records and outreach through news releases and special meetings. Until further information becomes available, the refuge manager will annually permit a maximum of three guides for each of the following uses: 1) commercially guided tours for canoeing/kayaking/boats (use of water trails); 2) commercially guided tours for birding or nature (use of upland trails); and 3) guided tours for continuing education. Each guide will be permitted to schedule three trips per year with a maximum of 25 people per trip. For guided tours for continuing education, more than 25 people may be permitted if they are confined to a bus tour. Organizations whose purpose supports refuge goals and objectives will also be able to use the refuge auditorium for meetings/workshops.

Administration of commercially guided wildlife activities will be conducted in accordance with commercial guide use stipulations (attached) developed to ensure consistency throughout the refuge; provide a safe, quality experience; protect resources; and to ensure compliance with pertinent Refuge System regulations and policies.

The guide use stipulations will address all aspects of the guided wildlife observation program including the number of permits to be issued, guide qualifications, permit cost, and selection methods. Commercial Guide Use Areas will be established based on factors such as refuge ownership, available suitable habitat, other refuge resources and users, and other pertinent issues.

Non-motorized boats enter refuge waters from access points on Slaughter Canal at Fowler Beach Road, at Waples Mill Pond on the Brumbley Family Campground, at the office boat ramp, at the ramp at the old maintenance facility, at suitable sites on Goose and Flaxhole Ponds, and at boat ramps at Turkle and Fleetwood Ponds. Slaughter Canal is tidal (Non-motorized boaters are encouraged to do their canoeing or kayaking within two hour window on either side of high tides for best access.) Tidal information is available on the State Division of Fish and Wildlife's web site.

At Fowler Beach, access for these activities will occur only on refuge owned lands on the sandy part of the beach from the toe of the dunes to the Delaware Bay (mean high water demarcation to mean low water demarcation). One parking lot with a dune crossover provides access to the beach. Access on the dune and adjacent marshes is prohibited.

In addition to published 50CFR regulations and State regulations, refuge-specific regulations also apply for Wildlife Observation & Photography, Environmental Education & Interpretation and are as follows:

1) All boats must be off the water at sunset.

2) Boat motor restrictions
   a) 30 horsepower motor restriction on Prime Hook Creek and Slaughter Canal
   b) Electric motors or manual propulsion only on Turkle & Fleetwood Ponds
   c) Manual propulsion only on Goose & Flaxhole Ponds
   d) Air thrust boats and jet skis are not permitted
   e) A "Slow No Wake" zone of one-half mile has been established on the Headquarters Ditch.

3) Areas may be closed on the refuge without warning.

4) Visitors must stay on the designated trail routes and areas.

5) Except as noted below, the refuge is open for wildlife observation, wildlife photography, environmental education, and environmental interpretation in the following areas everyday from open one-half hour before sunrise to one-half hour after sunset. Some areas are seasonally restricted to minimize conflict among user groups and to minimize wildlife disturbance.

   a) Designated beach dunes and overwash areas: Closed from March 1 through September 1 due to nesting State endangered least terns and American oystercatchers, and the potential for use by federally endangered piping plovers. Areas may be reopened if no nesting activity occurs or when nesting ends for the season.

   b) Western Prime Hook Creek (from old shop ramp to Waples Pond): Closed every day during the deer and waterfowl hunting seasons, which typically starts on September 1 and ends in early February. Additional seasonal closures may apply through the second Saturday in May for hunting during the snow goose conservation order and/or turkey hunting.

   c) Deep Branch Road Trail (includes Goose & Flaxhole Ponds) and Eastern Prime Hook Creek (from old shop ramp to HQ ramp): Closed every day from September 1 through March 15. Additional seasonal closures may apply through the second Saturday in May for hunting during the snow goose conservation order and/or turkey hunting.

   d) Headquarters Area (includes Turkle & Fleetwood Ponds): Closed only for a maximum of two days for deer hunts.

   e) The northern portion of Unit IV (includes trail overlooking Vergie's Pond): Closed from the Monday before Thanksgiving through March 15. Additional seasonal closures may apply through the second Saturday in May for hunting during the snow goose conservation order and/or turkey hunting.

f) Hiking Trails on Fowler Beach Road, Prime Hook Road, and Slaughter Beach Road and Slaughter Canal: Closed except for Sundays from September 1 through the deer and waterfowl hunting seasons, which typically end in early February. Additional seasonal closures may apply through the second Saturday in May for hunting during the snow goose conservation order and/or turkey hunting.

g) Roadside pull offs and water control structures/fishing areas at Petersfield Ditch, Slaughter Canal & Cods Road: Open year round.

6) Dog walking is not permitted on the refuge.

7) Bicycling is allowed only on roads open to public vehicular traffic.

8) The Visitor Contact Station is open weekdays from 7:30am to 4:00pm and seasonally on weekends.

9) The following activities are prohibited, including, but not limited to: ice skating, camping, roller blading, horseback riding, geocaching/metal detecting, off-road and mountain biking, off-road vehicles including ATVs, picnicking, dog walking, competitions or organized group events (e.g. cross country races), non-competitive organized events (e.g., weddings), operation of model boats and airplanes, swimming and sunbathing, waterskiing, personal watercraft (PWC), air thrust boats, soliciting of funds (per 50CFR 27.97 for Private Operations and per 50CFR 27.86 for Begging), and other activities identified in 50CFR Part 27.

10) All boaters would be required to operate their craft and possess all safety equipment in accordance with Delaware State and U.S. Coast Guard Regulations.

11) Beach access will occur only on refuge owned lands on the sandy part of the beach from the toe of the dunes to the Delaware Bay (mean high water demarcation to mean low water demarcation). One parking lot with a dune crossover provides access to the beach. Access on the dune and adjacent marshes is prohibited.

(e) Why is the use being conducted?
Wildlife observation is a compatible educational and recreational opportunities for visitors to enjoy the resource and to gain understanding and appreciation for fish and wildlife, wild lands ecology and the relationships of plant and animal populations within the ecosystem, and wildlife management. Based on apparent existing client demand, a significant number of the public are willing to pay for the additional expertise and local knowledge provided by commercial businesses and guides. The refuge provides excellent populations of watchable wildlife in a wild and scenic setting. It is expected that demand for guided wildlife observation will continue to increase, and with it, the number of interested commercial operators.

AVAILABILITY OF RESOURCES:

This program will increase overall costs of refuge operations, including but not limited to, development and review of policy and procedure, yearly administration of permits (inquiries, screening and selecting applicants, issuing permits), and enforcement of permit conditions. In the short-term, existing staff is adequate if shifts in priorities and assignments are made to accommodate a modest guiding program. However, the size and scope of the guiding program, and the number of permits that will be available, will have to be limited in balance with permit fees received. In the long-term, a comprehensive guiding program, when combined with other new initiatives requiring permits, will require additional administrative and/or other personnel as identified in the Comprehensive Conservation Plan. Existing facilities (launch ramps) and other infrastructure are currently sufficient to accommodate this use.

Permitting this use is within the resources available to administer our Visitor Services Program. Additional staff costs are incurred to review each request, coordinate with the outside entity and process a Special Use Permit, if necessary. Compliance with the terms of the Permit is within the regular duties of the Complex's Law Enforcement Officer. Anticipated costs are as follows:

- Refuge Biologist (GS-11) (review request) – 1 day/yr = $238
- Visitor Services Manager (GS-09) (review requests, coordinate with entity, process SUP) – 3 days/yr. = $589
- Refuge Manager (GS-12) (review and approval) – 1 day/yr. = $285
- Law Enforcement Officer (GS-09) (enforcement patrols) 1 day/yr. = $196
- Administrative Assistant (GS-06) (issue SUP) – 1 day/yr. = $145

ANTICIPATED IMPACTS OF THE USE:

For a more detailed analysis of the impacts of commercially guided wildlife observation, refer to chapter 5 of the draft CCP/EIS.

Commercially guided wildlife observation can result in positive or negative impacts to the wildlife resource. A positive effect of allowing visitor's access to the refuge will be the provision of additional wildlife-dependent recreational opportunities and a better appreciation and more complete understanding of the wildlife and habitats associated with Delmarva ecosystems. Each application will be evaluated on its own merit and stipulations will be adapted to individual requests to minimize impacts to vegetation and wildlife and ensure that the use is consistent with goals of the refuge and the Refuge System.

Visitors engaging in commercially guided activities are expected to use and stay on hiking and canoe trails or roads to access the interior of the refuge. Disturbance of refuge resources is the primary concern regarding commercially guided activities for wildlife observation. While field trip routes and observation sites are usually located in areas open to the public, disturbance caused by large groups could be more intense because the number of people, and desire to get close to wildlife, may be greater than what normally occurs during general public activities. This disturbance will displace individual animals to adjacent areas of the refuge. Commercially or recreationally, groups of six or more cyclists or groups of 15 or more pedestrian travelers will require a Special Use Permit.

Facilities most utilized by refuge visitors engaging in commercially guided wildlife observation are roads, parking lots, trails, and boat launching ramps. Maintenance or improvement of these facilities will cause negligible short term impacts to localized soils and waters and may cause some wildlife disturbances and damage to vegetation. Impacts from the construction of expanded facilities for visitor services programs that would accommodate commercially guided activities are expected to be negligible.

Commercially guided wildlife observation is expected to have negligible short-term, long-term or cumulative impacts on the economy of the towns or county in which the refuge lies based on findings of economic activity (see appendix I in CCP). No adverse impacts are foreseen to be associated with changes in the community character or demographic composition.

This activity would result in several minor beneficial impacts on the social communities near the refuge and in the state and region as a whole. In the case of commercial guiding, additional economic benefit would be gained by any local businesses providing guided wildlife observation opportunities.

Commercially guided wildlife observation is expected to have negligible adverse short-term, long-term or cumulative impacts on local or regional air and water quality. Localized increases in emissions from visitor's vehicles or boat motors would be negligible. The use of boats by these visitors has the potential to affect water quality negatively by increasing erosion, stirring up bottom sediments, or introducing pollutants into waterways. We do not expect emissions from vehicles or boat motors to substantially affect the water quality of the region.

Commercially guided wildlife observation is expected to have negligible adverse short-term, long-term or cumulative impacts on soils and vegetation. Negligible disturbance to vegetation will occur during the construction of new parking areas on Fowler Beach Road and on Broadkill Beach Road to facilitate wildlife observation/photography activities because existing interior roads and access routes will be used.

Disturbance factors resulting from public use are always considered for all listed species. The Delmarva fox squirrel and piping plover are listed as endangered by the U.S. Fish and Wildlife Service. Bald eagles, a State endangered species, occurs on the refuge and areas near active nests will not be open at anytime for commercially guided wildlife observation and, therefore, are not expected to have any negative impacts (U.S. Fish and Wildlife Service 2007).

Many of the impacts described for waterfowl, shorebirds, and secretive marsh and waterbirds are similar. Commercially guided wildlife observation is expected to have negligible adverse short-term, long-term or cumulative impacts on waterfowl. To minimize waterfowl disturbance from this use, the refuge has designated

approximately 3,000 acres as waterfowl sanctuaries that will be closed on a seasonal or annual basis. This use is expected to have negligible adverse short-term, long-term or cumulative impacts on secretive marsh and waterbirds, shorebirds, and landbirds. An increase in the number of hiking trails, particularly in or near wetland areas, has the potential to increase disturbance to secretive marsh and waterbirds.

Impacts to fisheries from visitors engaged in commercially guided wildlife observation is expected to be temporary and minor. Use of boats and canoes will cause increased suspension of bottom sediments, which should not adversely affect biological oxygen demand for fisheries resources. Boat motors may also harm submerged or emergent vegetation, which may cause a negligible negative impact to protective cover for fisheries. Accidental introduction of invasive plants, pathogens, or exotic invertebrates attached to boats or canoes is a concern, but the expectation is that impacts will be negligible.

Commercially guided wildlife observation is expected to have negligible adverse short-term, long-term or cumulative impacts on invertebrates and mammals. An increase in indirect impacts to mammals due to proposed expansions such as new trails is also expected. The use was evaluated for its potential to benefit or adversely affect amphibians and reptiles or their habitats used for mating, reproduction, over-wintering, and foraging. Although most species that occur on the refuge are very common and widespread, there is concern for two species of turtle: eastern box and spotted, and amphibians everywhere are considered to be experiencing a general decline.

Guided tour activities may conflict with other refuge users, including commercial or non-commercial tours that will likely use the same areas as independent wildlife viewers, kayakers and canoeists, and hunters and anglers during open seasons. Unregulated or inadequately regulated commercial guiding operations may adversely affect the safety of other refuge users, the quality of their experience, and the equity of opportunity. The refuge's visitor use programs would be adjusted as needed to eliminate or minimize each conflict and provide quality wildlife-dependent recreational opportunities.

PUBLIC REVIEW AND COMMENT:

This compatibility determination is part of the refuge's draft Comprehensive Conservation Plan and Environmental Impact Statement. Public notification and review include a notice of availability published in the *Federal Register,* a 60-day comment period, and local media announcements.

DETERMINATION (CHECK ONE BELOW):

____ Use is not compatible

__X__ Use is compatible, with the following stipulations

STIPULATIONS NECESSARY TO ENSURE COMPATIBILITY:

See attached stipulations.

JUSTIFICATION:

Allowing commercially guided wildlife observation on the refuge will not materially interfere with the purposes of the refuge or the mission of the Refuge System because:

1) Existing federal and state agency oversight and regulation of affected species and habitat is sufficient to ensure healthy populations. Disturbance to fish and wildlife will be local, short-term, and not adversely impact overall populations.

2) There are adequate state and federal enforcement officials to enforce state and federal regulations.

3) Qualifying standards for commercial operators will help ensure that the public is guided by competent individuals.

4) Restricting the number of guides and managing how guided activities are conducted will reduce adverse habitat effects, conflicts between competing guide services, and conflicts between guided operations and other refuge users.

5) Designated areas of operation (Guide Use Areas), operating requirements, and other regulation of guided activities will minimize conflicts with other refuge users.

6) Administrative (application) and Special Use Permit fees will help off-set costs to administer and provide oversight to this use.

7) Regulating and limiting the number of commercial operators as stated in the refuge commercial guide program stipulations will provide a safe, quality experience to individuals who want to enjoy the resources of the refuge. It will also increase opportunities for those who wish to observe wildlife and experience the scenic and wild nature of the refuge, but may lack the required equipment, knowledge, or expertise.

This activity will not materially interfere with or detract from the mission of the Refuge System or purposes for which the refuge was established. In addition, this activity will fulfill one or more purposes of the refuge or the Refuge System.

SIGNATURE:

Refuge Manager: _____ _____
(Signature) (Date)

CONCURRENCE:

Regional Chief: _____ _____
(Signature) (Date)

MANDATORY 10 YEAR RE-EVALUATION DATE: _____

ATTACHMENT:

Draft Stipulations

Commercial Wildlife Observation Guide Program Stipulations on Prime Hook National Wildlife Refuge

(Also applies to guided tours for continuing education)

The following stipulations apply to the special use permits issued for commercial guided recreational tours. Law enforcement and administrative monitoring of permit holders will continue for compliance with the following conditions, which are incorporated into all permits to minimize impacts on refuge lands and resources:

The refuge manager will designate "Commercial Wildlife Observation Guide Use Areas" on the refuge, based on factors such as refuge ownership, available suitable habitat, other refuge resources and users, and other pertinent issues. This will include all land and water acres within the refuge open to the public. For guided canoeing tours for wildlife observation, three guides will be permitted each year and each guide is allowed to conduct a maximum number of three guided tours per year. The same applies for terrestrial guided tours (for birding, interpretive nature walks, etc.). A maximum number of patrons for any guided trip is 25.

Qualified individuals (see below) may apply to conduct guided tours. If the maximum number of guides exceeds the recommended allowance for the refuge, guides will be selected by random drawing for a Special Use Permit valid for up to one year.

Administrative fee will be $100, non refundable and is comparable to fees issued by refuges in other regions. This fee is based on the salaries, plus 22 percent overhead, for a GS-13 Refuge Manager ($37.22 an hour at Step 1) and a GS-6 Administrative Assistant ($15.88 an hour at Step 1), plus a proportionate share of the average cost to operate the refuge (including construction cost, utilities, maintenance, equipment, vehicles, supplies, travel, and training), which is estimated to approximately $40.00. The staff is required to determine fair market value and cost recovery, and/or conduct competitive bids.

In addition to the administrative fee, the permit fee will be 5% of gross revenues or $50, whichever is greater (See Table 1).

Qualified individuals are defined as:

1. Licensed as a commercial guide by the state in which they operate, as applicable and must also be certified by the American Canoeing Association *(http://www.acanet.org/)* or similar certification.

2. Possess a current vessel operator license issued by the U.S. Coast Guard, as applicable. Minimum license shall be Operator Uninspected Passenger Vessel (OUPV). The license shall be valid for the area of operations and type(s) of vessel operated. This license applies to guides transporting patrons.

3. Possess a current CPR and First Aid training certificate issued by a recognized national organization

   The permittee must provide a copy of the appropriate documentation of current Red Cross First Aid and CPR certification for all guides.

4. Provide proof of insurance, including minimum coverage for general liability and comprehensive for all operations.

   The permittee agrees to hold the U.S. Government harmless from liability for any accident or injury to their clients or employees resulting from the activities the permit authorizes. The permittee must provide adequate, appropriate liability insurance: a Certificate of Insurance with adequate Comprehensive General Liability coverage, the minimum amount of liability being $300,000 per occurrence. The insurance certificate must name the U.S. Fish and Wildlife Service as additional insured, specify that the service or activity the permit authorizes is covered by the policy, and provide a telephone number for verification.

5. Certified as a "Certified Interpretive Guide" through the National Association for Interpretation *(http://www.interpnet.com)* and certified annually by the refuge manager through an orientation of current refuge news and information.

6. Otherwise required by state law.

Permittee must comply with the conditions previously mentioned and to all other Conditions of the Special Use Permit, including but not limited to the following to ensure compatibility:

1) The permittee will not advertise on refuge property or distribute leaflets via the refuge visitor contact station, refuge headquarters, etc. They may distribute leaflets only during the approved programs covered by the permit and only to those participants registered for that program.

2) All special use permits will expire on September 30, regardless of the date of issue. The permittee is responsible for accurate record keeping and shall provide the refuge manager with the following information by October 10 of each year:

    - Fee schedule for the year (charge per patron)
    - Number of guided or outfitted trips performed on the refuge
    - Number of individuals guided or outfitted
    - Date of each trip
    - Location of each trip, or general area of activity
    - Individual names and description of duties for all additional staff who assist with a trip on the refuge

3) A copy of a valid special use permit must be available for inspection on request by any law enforcement officer or refuge staff member, whenever an activity authorized by the permit is occurring. Storing permits in the glove box of a vehicle is acceptable; however, all guides must be knowledgeable about the permit and its conditions.

4) Violation of any special conditions of the permit or of any federal, state, local, or refuge regulations may result in a Notice of Violation (NOV) being issued or the revocation or cancellation of the permit without written or verbal warning. In that case, the permit holder will receive immediate notification by phone with follow-up notification by mail. The permit holders are responsible for the actions of their employees, agents, others working under their special use permit, and their clients.

5) Regardless of the reason for the revocation or cancellation of a permit, no refund will be made to the permit holder.

6) The refuge will issue permits on a year-to-year basis, and will not reissue them automatically on consecutive years.

7) Permit holders will provide all participants with relevant refuge information, including the regulations and conditions of the permit. The refuge will supply information to the permit holder, on request.

8) Permittees may be assisted by any number of individuals. These assistants must be named/authorized on the permit issued and possess any of the applicable state and Coast Guard licenses for duties conducted, as applicable. These assistants must also attend the required annual orientation by the refuge.

9) All boats must carry standard USCG-approved safety equipment.

10) Tours must begin and end during daylight hours only.

11) Groups will police their routes for litter, vandalism, etc., and report any problems to the refuge office.

12) All vessels and vehicles used in guide operations shall be marked with a guide identifier as required by the refuge.

(Note: Some stipulations may not apply to outfitters who do not accompany clients. Deviations will be noted in individual permits.)

Table 1. Current and Anticipated Commercial Recreational Activities at Prime Hook NWR

Refuge Use	Description	Compatible Use?	Special Use Permit Fee*	Max # Guides	Max # Trips per year	Max # Patrons	Expected Revenue for One Guide	Expected SUP Fee
Commercially Guided Tours for Canoeing or Kayaking	Interpretive guided tours on refuge waterways	Yes	$100 admin fee + 5% of revenues Or $50, whichever is greater	3	3 trips per guide outfitter	25 people per trip	$3,375 per year (based on full schedule of three trips, 25 patrons, & $45 per person)**	$168.75 (5% of revenues) + $100 admin fee = $268.75
Commercially Guided Tours for Birding or Nature	Interpretive guided birding trips; includes trips by non-profit organizations (e.g. DLITE, Bethany Chamber of Commerce)	Yes	$100 admin fee + 5% of revenues Or $50, whichever is greater	3	3 trips per guide outfitter	25 people per trip	$1,500 per year (based on full schedule of three trips, 25 patrons, & $20 per person)***	$75 (5% of revenues) + $100 admin fee = $175.00
Guided Tours for Continuing Education	Guided tours with or without fees, but sanctioned as continuing education from a recognized organization (includes bus tours, classes from Sussex Academy of Lifelong Learning, Elder Hostel)	Yes	Waived	Same as above	Same as above	Varies due to nature of tour (may allow more than 25 if confined to bus tour only)	Same as above	$0
Public Use of Refuge Auditorium	Use of auditorium restricted to organizations for meetings/ workshops whose purpose supports refuge goals & objectives	Yes	Waived	n/a	n/a	40 people maximum	n/a	$0

**Administrative fee of $100 is non refundable*
***Based on guided eco-tour by canoe at Coastal Kayak in Delaware*
****Based on guided birding trips by DLITE & Bethany Chamber of Commerce*

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Exhibit 1

FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Prime Hook National Wildlife Refuge

Use: Field Trails for Dogs

This exhibit is not required for wildlife-dependent recreational uses, forms of take regulated by the State, or uses already described in a refuge CCP or step-down management plan approved after October 9, 1997.

Decision criteria:	**YES**	**NO**
(a) Do we have jurisdiction over the use?	✔	
(b) Does the use comply with applicable laws and regulations (Federal, State, Tribal, and local)? **Field trials for dogs are prohibited except as may be authorized by special permit (50 CFR 27.91).**		✔
(c) Is the use consistent with applicable Executive orders and Department and Service policies?	✔	
(d) Is the use consistent with public safety?	✔	
(e) Is the use consistent with goals and objectives in an approved management plan or other document?		✔
(f) Has an earlier documented analysis not denied the use or is this the first time the use has been proposed?	✔	
(g) Is the use manageable within available budget and staff?	✔	
(h) Will this be manageable in the future within existing resources?	✔	
(i) Does the use contribute to the public's understanding and appreciation of the refuge's natural or cultural resources, or is the use beneficial to the refuge's natural or cultural resources?	✔	
(j) Can the use be accommodated without impairing existing wildlife-dependent recreational uses or reducing the potential to provide quality (see section 1.6D. for description), compatible, wildlife-dependent recreation into the future?		✔

Where we do not have jurisdiction over the use ("no" to [a]), there is no need to evaluate it further as we cannot control the use. Uses that are illegal, inconsistent with existing policy, or unsafe ("no" to [b], [c], or [d]) may not be found appropriate. If the answer is "no" to any of the other questions above, we will generally not allow the use.

If indicated, the refuge manager has consulted with State fish and wildlife agencies. Yes ____ No ___✔___.

When the refuge manager finds the use appropriate based on sound professional judgment, the refuge manager must justify the use in writing on an attached sheet and obtain the refuge supervisor's concurrence.

Based on an overall assessment of these factors, my summary conclusion is that the proposed use is:

Not Appropriate _____ **Appropriate** ___✔___

Refuge Manager: _____ Date: _____

If found to be **Not Appropriate**, the refuge supervisor does not need to sign concurrence if the use is a new use.

If an existing use is found **Not Appropriate** outside the CCP process, the refuge supervisor must sign concurrence.

If found to be **Appropriate**, the refuge supervisor must sign concurrence:

Refuge Supervisor: _____ Date: _____

A compatibility determination is required before the use may be allowed.

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Exhibit 1
Page 2

JUSTIFICATION FOR A FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Prime Hook National Wildlife Refuge

Use: Field Trials for Dogs

NARRATIVE:

The National Wildlife Refuge System Improvement Act of 1997 (P.L. 105-57) identifies six legitimate and appropriate uses of wildlife refuges; environmental education, interpretation, hunting, fishing, wildlife observation and wildlife photography. These priority public uses are dependent upon healthy wildlife populations. Where these uses are determined to be compatible, they are to receive enhanced consideration over other uses in planning and management. All other recreational uses are now considered general uses. As noted in the Appropriate Use Policy: "General public uses that are not wildlife-dependent recreational uses (as defined in the Improvement Act) and do not contribute to the fulfillment of refuge purposes, or goals, or objectives as described in current refuge management plans are the lowest priorities for refuge managers to consider. These uses are likely to divert refuge management resources from priority general public uses or away from the responsibilities to protect and manage fish, wildlife, and plants and their habitats. Therefore, both law and policy have a general presumption against allowing such uses within the Refuge System."

Field trials encourage practices and techniques that enhance the tradition and quality of the hunting experience and reduce the incidence of downed but un-retrieved game. Field trials typically involve concentrated numbers of participants and spectators, which have the potential to disturb wildlife and their habitats. Dog field trials are non-wildlife dependent uses. 50 CFR 27.91 states that "the conducting or operation of field trials for dogs on national wildlife refuges is prohibited except as may be authorized by special permit."

This activity will not materially interfere with or detract from the mission of the Refuge System or purposes for which Prime Hook NWR was established. In addition, this activity will fulfill one or more purposes of the refuge or the National Wildlife Refuge System.

COMPATIBILITY DETERMINATION

USE:

Field Trials for Dogs

REFUGE NAME:

Prime Hook National Wildlife Refuge

ESTABLISHING AND ACQUISITION AUTHORITY(IES):

(1) Migratory Bird Conservation Act {16 U.S.C. 715d}

(2) Refuge Recreation Act {16 U.S.C. 460 K-1}

REFUGE PURPOSE(S):

(1) "…for use as an inviolate sanctuary, or for any other management purposes, for migratory birds…" {16 U.S.C. 715d; Migratory Bird Conservation Act}

(2) "…incidental fish and wildlife-oriented recreational development" {16 U.S.C. 460k-1; Refuge Recreation Act}

(3) "the protection of natural resources" {16 U.S.C. 460k-1; Refuge Recreation Act}

(4) "the conservation of endangered or threatened species…" {16 U.S.C. 460k-1; Refuge Recreation Act}

NATIONAL WILDLIFE REFUGE SYSTEM MISSION

The mission of the Refuge System is to administer a national network of lands and waters for the conservation, management, and where appropriate, restoration of the fish, wildlife, and plant resources and their habitats within the United States for the benefit of present and future generations of Americans.

DESCRIPTION OF USE:

Field dog trials formally test dogs' scenting, marking, and retrieving ability in aquatic and upland habitats. Events typically last one to three days, and use dead frozen, live birds, or dummy birds. Live birds are usually certified disease free by a veterinarian. Larger events may involve 85 to 100 dogs, 150 to 200 vehicles, and nearly 200 people.

There is no area on the refuge conducive to this type of activity. Space is limited. This event is not a wildlife-dependent recreational use.

AVAILABILITY OF RESOURCES:

This activity is within the budget and staffing capabilities of the refuge to manage. The use would not require any special facilities or improvement to any existing facilities.

The following is a list of the approximate costs to the refuge required to administer this program:

• Refuge Personnel Costs		
• Administrative Time	(3 days @ 8hrs/day@$28/hr.)	$672
• Material Costs		$0
• **Total**		**$672**

ANTICIPATED IMPACTS OF THE USE:

Depending on the timing of the event, this activity may contribute to short-term disturbances of ground nesting birds and other wildlife. Numerous studies have confirmed that people on foot can cause a variety of disturbance reactions in wildlife, including flushing and displacement (Erwin 1989; Fraser et al. 1985), heart rate increases (MacArthur et al 1982), altered foraging patterns (Burger and Gochfeld 1991), and even, in some cases, diminished reproductive success (Boyle and Samson 1985). Based on this information, it is likely that field dog trials would have similar impacts. These studies and others have shown that the severity of the effects depends upon the distance to the disturbance and its duration, frequency, predictability, and visibility to wildlife (Knight and Cole 1991).

The most likely impact to the refuge resources would be during spring and early summer. Limited impacts to nesting birds could occur as described below, but would be relatively minor because the dog training would be limited to a confined area and would occur only a few days per season.

The presence of dogs may flush incubating birds from nests (Yalden and Yalden 1990), disrupt breeding displays (Baydack 1986), disrupt foraging activity in shorebirds (Hoopes 1993), and disturb roosting activity in ducks (Keller 1991). Despite thousands of years of domestication, dogs still maintain instincts to hunt and chase. Give the appropriate stimulus, those instincts can be triggered. Dogs that are unleashed or not under the control of their owners may disturb or potentially threaten wildlife. In effect, off-leash dogs increase the radius of human recreational influence or disturbance beyond what it would be in the absence of a dog.

Impacts to native vegetation could occur from movement of dogs and people over the landscape. Noxious weeds could be spread to other habitats through additional traffic. The short duration, infrequency, and restricted area of these events could result in minor impacts to resident wildlife but may have long-term impacts such as noxious weed spread and infestation.

The role of dogs in wildlife diseases is poorly understood. However, dogs host endo- and ectoparasites and can contract diseases from, or transmit diseases to wild animals. In addition, dog waste is known to transmit diseases that may threaten the health of some wildlife and other domesticated animals. Domestic dogs can potentially introduce various diseases and transport parasites into wildlife habitats (Sime 1999).

PUBLIC REVIEW AND COMMENT:

This compatibility determination is part of the Prime Hook draft Comprehensive Conservation Plan and Environmental Impact Statement. Public notification and review include a notice of availability published in the *Federal Register,* a 60-day comment period, and local media announcements.

DETERMINATION (CHECK ONE BELOW):

X Use is not compatible

____ Use is compatible, with the following stipulations

STIPULATIONS NECESSARY TO ENSURE COMPATIBILITY:

n/a

JUSTIFICATION:

Dog training is not listed as one of the six priority wildlife dependent recreational uses under the National Wildlife Refuge System Improvement Act of 1997, as amended. Dog training on the refuge is not necessary for the safe, practical, and effective conduct of existing refuge wildlife-dependent recreational uses. While most waterfowl and upland game hunters do employ dogs, training areas can be found elsewhere. Space is limited on the refuge to conduct this type of activity. The effects of dog training poses a minor threat to habitat and wildlife resources, and temporarily displace wildlife.

Dog training does not appreciably contribute to the public's understanding and appreciation of the refuge's natural and cultural resources, nor is the use beneficial to the refuge's natural or cultural resources.

Based on the analysis above, dog training has a negative impact on refuge habitat, displaces wildlife, and detracts staff and operational resources away from programs that contribute to the conservation and management of wildlife, therefore, this activity will materially interfere with or detract from the mission of the National Wildlife Refuge System or the purpose for which the refuge was established.

SIGNATURE:

Refuge Manager: _____ _____
(Signature) (Date)

CONCURRENCE:

Regional Chief: _____ _____
(Signature) (Date)

MANDATORY 10 YEAR RE-EVALUATION DATE: _____

LITERATURE CITED:

See CCP Bibliography.

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Exhibit 1

FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Prime Hook National Wildlife Refuge

Use: Commercial Forest Management

This exhibit is not required for wildlife-dependent recreational uses, forms of take regulated by the State, or uses already described in a refuge CCP or step-down management plan approved after October 9, 1997.

Decision criteria:	**YES**	**NO**
(a) Do we have jurisdiction over the use?	✔	
(b) Does the use comply with applicable laws and regulations (Federal, State, Tribal, and local)?	✔	
(c) Is the use consistent with applicable Executive orders and Department and Service policies?	✔	
(d) Is the use consistent with public safety?	✔	
(e) Is the use consistent with goals and objectives in an approved management plan or other document?	✔	
(f) Has an earlier documented analysis not denied the use or is this the first time the use has been proposed?	✔	
(g) Is the use manageable within available budget and staff?	✔	
(h) Will this be manageable in the future within existing resources?	✔	
(i) Does the use contribute to the public's understanding and appreciation of the refuge's natural or cultural resources, or is the use beneficial to the refuge's natural or cultural resources?	✔	
(j) Can the use be accommodated without impairing existing wildlife-dependent recreational uses or reducing the potential to provide quality (see section 1.6D. for description), compatible, wildlife-dependent recreation into the future?	✔	

Where we do not have jurisdiction over the use ("no" to [a]), there is no need to evaluate it further as we cannot control the use. Uses that are illegal, inconsistent with existing policy, or unsafe ("no" to [b], [c], or [d]) may not be found appropriate. If the answer is "no" to any of the other questions above, we will generally not allow the use.

If indicated, the refuge manager has consulted with State fish and wildlife agencies. Yes ✔ No _____.

When the refuge manager finds the use appropriate based on sound professional judgment, the refuge manager must justify the use in writing on an attached sheet and obtain the refuge supervisor's concurrence.

Based on an overall assessment of these factors, my summary conclusion is that the proposed use is:

Not Appropriate _____ **Appropriate** ✔

Refuge Manager: _____ Date: _____

If found to be **Not Appropriate**, the refuge supervisor does not need to sign concurrence if the use is a new use.

If an existing use is found **Not Appropriate** outside the CCP process, the refuge supervisor must sign concurrence.

If found to be **Appropriate**, the refuge supervisor must sign concurrence:

Refuge Supervisor: _____ Date: _____

A compatibility determination is required before the use may be allowed.

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Exhibit 1
Page 2

JUSTIFICATION FOR A FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Prime Hook National Wildlife Refuge

Use: Commerical Forest Management

NARRATIVE:

The use is commercial forest management, to include such actions as commercial timber thinning, salvage, and other silvicultural practices used to improve forest habitat conditions. It is not a priority public use of the National Wildlife Refuge System, under the National Refuge System Administration Act of 1966 {16 U.S.C. 668dd-668ee}, as amended by the National Wildlife Refuge System Improvement Act of 1997.

Commercial forest management allows the refuge the option to maintain and enhance necessary habitat for threatened and endangered species by promoting plant communities beneficial to these species, manage forest stands by manipulating stand composition in order to produce high quality habitats for trust resources, and manipulate forest stands to provide diverse plant successional stages ranging from regeneration to mature timber, which will support a variety of wildlife species. This will include promoting hard mast species and by assuring that adequate den and snag trees remain in the stands. These techniques may include harvesting under proper climatic conditions and placing buffer strips where necessary to protect water quality or other natural resources. Various silvicultural treatments will be used to accomplish these forest management objectives. Silvicultural decisions will be based upon the resources of concern and their habitat requirements as it relates to forest composition and structure. Silvicultural decisions should consider the age and vigor of the existing stands and the availability of desirable reproduction. When harvesting timber, we will be concerned with the promotion of diverse, vigorous stands of timber that benefit trust species. An important factor to consider when making silvicultural decisions is the availability of advanced oak regeneration.

The purpose of the use is to improve and maintain optimal habitat conditions for the endangered Delmarva fox squirrel (DFS) and other forest-dependent species over the long term. The primary goal of active forest management on the refuge will be to enhance and maintain habitat for focal species and associated communities identified in the refuge's CCP. These focal species include DFS, breeding black-and-white warbler, wood thrush, scarlet tanager, whip-poor-will, yellow-throated vireo, Kentucky warbler, migrating landbird species, resident reptiles, amphibians, and invertebrate communities.

Many upland forest habitat patches on the refuge now lack the optimal structure, composition or patch size required by designated focal species. Active forest management should improve and accelerate the development of desirable habitat structure, forest composition, and diversity to maintain and enhance forest ecological integrity. Active forest management actions can also maintain appropriate forest structure, age, and/or size class distribution on the landscape where desired. These actions will ensure that adequate habitat is always available for endangered species, forest interior breeding birds and other forest-dependent species.

Commercial forest management, including when necessary, the use of commercial silvicultural contractors and techniques, will contribute to the purposes, for which the Prime Hook NWR was established, the mission of the Refuge System, the enhancement of biological integrity, diversity, and environmental health, and to facilitate the ability of the refuge to meet its habitat and wildlife management objectives.

COMPATIBILITY DETERMINATION

USE:

Commercial Forest Management

REFUGE NAME:

Prime Hook National Wildlife Refuge

DATE ESTABLISHED:

April 8, 1963

ESTABLISHING AND ACQUISITION AUTHORITY(IES):

(1) Migratory Bird Conservation Act {16 U.S.C. 715d}

(2) Refuge Recreation Act {16 U.S.C. 460 K-1}

REFUGE PURPOSE(S):

(1) "…for use as an inviolate sanctuary, or for any other management purposes, for migratory birds…" {16 U.S.C. 715d; Migratory Bird Conservation Act}

(2) "…incidental fish and wildlife-oriented recreational development" {16 U.S.C. 460k-1; Refuge Recreation Act}

(3) "the protection of natural resources" {16 U.S.C. 460k-1; Refuge Recreation Act}

(4) "the conservation of endangered or threatened species…" {16 U.S.C. 460k-1; Refuge Recreation Act}

NATIONAL WILDLIFE REFUGE SYSTEM MISSION:

The mission of the Refuge System is to administer a national network of lands and waters for the conservation, management, and where appropriate, restoration of the fish, wildlife, and plant resources and their habitats within the United States for the benefit of present and future generations of Americans.

DESCRIPTION OF USE:

(a) What is the use? Is the use a priority public use?
The use is commercial forest management, to include such actions as commercial timber thinning, salvage, and other silvicultural practices used to improve forest habitat conditions. The use of commercial operators would constitute an economic use. It is not a priority public use of the National Wildlife Refuge System, under the National Refuge System Administration Act of 1966 {16 U.S.C. 668dd-668ee}, as amended by the National Wildlife Refuge System Improvement Act of 1997.

Forest management allows the refuge to maintain and enhance necessary habitat for threatened and endangered species by promoting plant communities beneficial to these species, manage forest stands by manipulating stand composition in order to produce high quality habitats for trust resources, and manipulate forest stands to provide diverse plant successional stages ranging from regeneration to mature timber, which will support a variety of wildlife species. This will include promoting hard mast species and by assuring that adequate den and snag trees remain in the stands. These techniques may include harvesting under proper climatic conditions and placing buffer strips where necessary to protect water quality or other natural resources. Various silvicultural treatments will be used to accomplish these forest management objectives. Silvicultural decisions will be based upon the resources of concern and their habitat requirements as it relates to forest composition and structure. Silvicultural decisions should consider the age and vigor of the existing stands and the availability of desirable reproduction. When harvesting timber, we will be concerned with the promotion of diverse, vigorous stands of timber which benefit trust species. An important factor to consider when making silvicultural decisions is the availability of advanced oak regeneration.

The purpose of the use is to improve and maintain optimal habitat conditions for the endangered Delmarva fox squirrel (DFS) and other forest-dependent species over the long term. The primary goal of active forest management on the refuge will be to enhance and maintain habitat for focal species and associated communities identified in the refuge's CCP. These focal species include DFS, breeding black-and-white warbler, wood thrush, scarlet tanager, whip-poor-will, yellow-throated vireo, Kentucky warbler, migrating landbird species, resident reptiles, amphibians, and invertebrate communities.

Many upland forest habitat patches on the refuge now lack the optimal structure, composition or patch size required by designated focal species. Active forest management should improve and accelerate the development of desirable habitat structure, forest composition, and diversity to maintain and enhance forest ecological integrity.

Active forest management actions can also maintain appropriate forest structure, age, and/or size class distribution on the landscape where desired. These actions will ensure that adequate habitat is always available for endangered species, forest interior breeding birds and other forest-dependent species.

(b) Where would the use be conducted?
The use would occur in areas requiring improved stand conditions for long-term mixed-hardwood forest health and diversity. These activities will be undertaken to create and enhance habitats for endangered DFS. The habitat requirements needed by priority breeding and migratory forested birds are similar to optimal forest stand conditions prescribed to meet the life history requirements for the DFS. The use will occur in appropriate areas gauged to the DFS habitat suitability model. Model parameters will be used as the baseline for forest habitat prescriptions.

Prescriptions will only be conducted after inventories document current forest composition and condition. Assessments will be conducted by professional foresters and wildlife biologists for all the treatment areas on the refuge. When refuge forest stands have been evaluated, site-specific management objectives will establish target forest conditions and potentially "trigger" treatment actions. Pre-treatment forest assessments will include the following information:

- canopy cover (% of stand)
- basal area
- stocking rate per acre
- vines in overstory (% of area)
- number of large trees (> 35 inch dbh) per acre
- mid-story canopy (% of stand)
- vines in midstory (% of area)
- understory canopy cover (% of area)
- ground cover occupancy
- regeneration of hard mast tree species (oaks & hickories) of inventory plot (% of total)
- number of logs of coarse woody debris) per acre
- number DFS "den" trees per 10 acre

(c) When would the use be conducted?
The use would occur at different times of the year at various locations, depending on individual site characteristics, stand conditions, spatial and temporal occupancy of resources of concern. It will also occur at times designed to minimize unwanted impacts on natural resources, e.g., erosion, soil compaction, or disturbance to focal species and resident wildlife. It is estimated that the frequency of entry into a stand would be every 5 to 15 years for reassessing stand conditions.

The use may be triggered when forest inventory data indicates conditions are outside the desired conditions (see table 1). Severe weather and insect outbreaks may also trigger management actions.

Table 1. Mixed hardwood forest community maintenance and enhancement prescriptions

Target Forest Conditions	Condition to Trigger Management Action
>80% canopy cover in the stand	< 80% canopy cover in the stand
Basal area 70 to 90 ft^2 / acre (16 to 20 m^2/ha)	Basal areas > 100 ft^2/acres (> 28 m^2 / ha)
60% to 80% stocking	> 100% stocking
Vines in overstory on 40%-60% of inventory (cruise) plots	Vines in overstory on < 30% of inventory (cruise) plots
Super-canopy trees on 10% to 20% of inventory (cruise) plots [= 4 to 6 super-canopy trees per acre]	Super-canopy trees < 5% of inventory (cruise) plots
Mid-story canopy cover on 30% to 60% of stand	Mid-story canopy on < 20% of stand
Vines in midstory on 50% to 70% of inventory (cruise) plots	Vines in midstory < 30% plots
Understory canopy cover less 30%	Understory canopy cover > 30% of stand
<30% ground cover occupancy average across inventory (cruise) plots	>30% ground cover occupancy average across inventory (cruise) plots
Regeneration of hard mast tree species (oaks and hickories) on 30% to 50% inventory (cruise) plots	Regeneration of hard mast tree species (oaks and hickories) on < 20% of inventory (cruise) plots
2 to 4 logs/acres that provide coarse woody debris	< 2 logs/acres providing coarse woody debris
4 to 6 cavity trees (snags) > 4 inches dbh/acres	< 4 cavity trees (snags) > 4 inch dbh/acres
1 to 4 large den trees or unsound cull trees per 10 acres	< 1 large den tree or unsound cull tree per 10 acres

(d) How would the use be conducted?
Guidelines for making timber sales are found in the Refuge Manual, sections 5 RM 17 and 6 RM 3, and they will be observed in all timber sales.

Timber stands would be inventoried and current conditions would be monitored and then compared to desirable stand conditions. Forest inventory data would also be used to design appropriate management prescriptions required to meet the habitat objectives of our CCP/HMP. It is anticipated that some site-specific forest management actions would require commercial harvest (Franklin et al 2007) thus improving management of forest habitats over the long term.

All technical specifications for forestry best management practices as described by Delaware Forest Service (2006) would be followed. Best management practice specifications are designated to meet the goals of Delaware's water quality standards and Federal Clean Water Act.

Collection of appropriate inventory data will help design the best forest management prescriptions that meet the objectives of CCP and HMP. Forest management contracts will use the necessary technical specifications required to insure compliance with the Delaware Forestry Best Management Practices Manual. These specifications, as well as additional refuge specific stipulations, will be incorporated in a special use permit issued to the selected contractor.

Table 2 below lists the forest endangered species and some priority migratory bird species identified as refuge management priorities which are directly linked to the habitat management of mixed hardwood forest communities dominated by oaks.

Table 2. Refuge Priority Focal Forest Species

Focal Species	Some Major Forest Structural Requirements
Delmarva fox squirrel	Both upland and bottomland forest habitats are required. Upland forest should contain a variety of nut-bearing hardwoods and seed-bearing trees; Mature forest stands should also contain closed canopies (>80%) and open understories (Dueser 1988). Understory vegetation comprised of shrubs can decrease habitat quality if shrub crown closure is greater than 30%.
Wood Thrush	Breeding: Mature deciduous or mixed (oak/pine) forest, late successional, mesic forest with a moderately dense shrub canopy, moist-soil, and leaf litter. Trees taller than 50 feet with fairly open canopy. Substrate moisture more important than canopy cover. Probability of occurrence increase with forest patch size to a maximum 500 ha (1,235 acres) but does occur in fragments as small as 25 acres.
Black-and-white warbler	Breeding: Area sensitive species that nests in mature and second growth moist deciduous and mixed hardwood forests. Highly sensitive to forest fragmentation requiring contiguous blocks greater than 740 acres (299 ha).
Scarlet Tanager and Yellow-throated vireo	Breeding: Mature deciduous forest, mixed swamp and floodplain forests and rich moist upland forests; prefers oak trees greater than 9 dbh, with relatively closed canopy and high diversity of shrub layer; minimum forest area needed to sustain viable populations from 40 acres. In Maryland, 50% occurrence is reached in forest patches of 15 ha (37 acres) bit 100 ha (250 acres) is suggested optimal patch size.

The approach to forest management will vary among different habitat types in the oak dominated Delmarva coastal plain mixed hardwood forest matrix. Management prescriptions will be based upon the inherent site capability (i.e., soil properties, moisture, hydrology, patch size, and surrounding landscape characteristics) of areas to grow certain tree species. It is anticipated that proactive management through the use of commercial forest management services will help make refuge forested habitats generally more resilient to disease and climate change stressors.

Generalized Forest Management Strategies to meet forest habitat objectives:

1) promote stands dominated by early seral stages at the refuge periphery

2) improve stands dominated of later seral stages in the refuge interior and along water courses

3) in managed stands, promote increased compositional and structural heterogeneity, including large-diameter coarse woody debris and snags

4) understand the natural disturbance regime inherent to the forest communities found on the refuge and work within the confines of seral pathways dictated by soil, climate, and hydrology of current refuge forest (~ 775 acres) community types that include
   - Southern red oak/heath forest
   - Mesic coastal plain oak
   - Northern coastal plain basic mesic hardwood forest
   - Mid-Atlantic mesic mixed hardwood forest
   - Successional sweetgum forest
   - Mid-Atlantic coastal plain loblolly

5) use techniques that emulate natural ecological disturbances (e.g., single tree mortality for multi-aged stands, stand (cohort) replacement in even-aged stands, etc.

6) use commercial and non-commercial forestry mechanical treatments, when and where appropriate

Additional details and more in-depth site-specific strategies will be developed once forest inventory and cruise data become available.

(e) Why is the use being proposed?
The use being proposed would assist in maintaining, enhancing, and creating optimal habitat for focal forest species. The refuge wishes to increase patch sizes, diversify species composition, reduce forest fragmentation, and improve forest health and integrity. Maintaining oak dominance in mixed-hardwood stands of the refuge will require using active management techniques, including but not limited to prescribed fire, thinning, and selective harvest. Oaks and acorns will be the foundation for managing refuge forest ecosystems as acorns are the most important food for DFS and other wildlife.

Performing the use on the Refuge Complex lands would be instrumental in addressing the following Delmarva Fox Squirrel recovery tasks, identified in the Recovery Plan (Moncrief, et al. 1993): (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.

Managing for mast will require using standard silvicultural tools, and a number of other vegetation-manipulation techniques (Vose et al 1999). Successful short-term and long-term management for optimizing mast production will require periodic forest habitat manipulations. General recommendations (Dellinger 1973) to promote mast production includes

1) periodic thinning to promote vigorous crowns and rapid growth of mast producers

2) managing for a diversity of mast-producing species, with a mixture of oaks consisting of one-third in the white oaks group, and two-thirds in the red oak group

3) maintaining 50% to 60% of management units in mast-producing stands

Mast-producing stands include oak species greater than 40 years old, sawtimber-size hardwood types with 50% of the basal area in oak, and any cover type with more than 30 square feet of basal area in oak and sawtimber (McShea & Healy 2002). The use of commercial forest management services would provide the best means to optimize long-term mast production on the refuge.

Thinning of stands via single-tree and group selection cuts to achieve prescription basal areas would accelerate the development of a structurally diverse forest in terms of species, size class, and growth forms (trees, shrubs, vines, and forbs) within a heterogeneous forest canopy. Thinning is also the best method to maintain canopy cover that would optimize the regeneration of shade intolerant tree species (e.g., oaks), to support the needs of refuge priority wildlife that are dependent on hard mast.

AVAILABILITY OF RESOURCES:

The refuge may use other Service personnel, contract the services of a state forester or private consulting forester, or use other federal personnel and partners. Forest habitat management funds are programmed through the Migratory Bird Program. Expense for sales funds, programmed through activity 6800, are used only for actual timber harvest costs, such as salaries, equipment, and supplies. Currently, the refuge does not receive any 6800 monies. There would be no construction of any new facilities or improvements on refuge property for this use.

Refuge staff would assume the management of contract development, forest administration, monitoring and forest resource database development and management. The use is not likely to be annually recurring due to the small acreage of total refuge forested habitats (less than 2,000 acres including bottomland and upland forest or potentially reforested areas). The expectation is that most refuge costs would be incurred for planning and conducting forest management during the years that such services would be used:

Forest inventories Pre-harvest planning Marking Timber	$5,000	(Professional Forester)
Contract Development & Administration	$2,500	(Refuge Managers)
Wildlife Inventory, Monitoring, Data Entry, and Analysis	$5,000	(Refuge Biologist)
Road Maintenance and Site Preparations	$2,500	(Refuge Maintenance Worker)
Total	**$15,000**	

ANTICIPATED IMPACTS OF THE USE:

For a more complete analysis of the impacts of forest management, refer to chapter 5 of the draft CCP/EIS.

The operation of heavy equipment for forest management over refuge roads and through natural habitats could impact soils, cause severe rutting, result in increased site erosion, or degrade near-by wetlands or water resources. All commercial forest management actions that have the potential to cause erosion or degrade water resources will be mitigated by following forestry management procedures required by Delaware's Forestry Erosion and Sedimentation Law (Delaware Code Title 3, Chapter 10, Subchapter VI) by adhering to Delaware's Forestry Best Management Practices Manual (2006).

Use of heavy equipment near rivers, creeks, ditches, ponds, and wetlands can result in increased run-off, sedimentation, and reduced shading of water courses, with concomitant increase in water temperatures. These factors may have detrimental effects on aquatic organisms, including fish, invertebrates, and amphibians. Poorly planned timber harvests can alter surface and ground water hydrology and water storage capacity. Maintaining forested buffers around all creeks, ditches, ponds, and other aquatic resources of concern will minimize impacts on water quality and aquatic resources.

Heavy equipment use required for timber harvesting operations may also result in localized impacts to vegetation and wildlife. Damage or destruction of understory vegetation, including rare plants and unique botanical communities are of concern. The use may also damage the litter layer, coarse woody debris, snags or cavity and den trees important for wildlife. Timber harvesting can also alter the moisture regimes in soil and on the forest floor in ways that affect plant and animals such as state rare plant species, invertebrates, amphibians, and small mammals.

Whole tree harvesting can result in a reduction of downed wood and snags in a forest ecosystem. Skidding operations can cause residual damage to trees remaining in the stand that can result in the introduction of disease and insects into an otherwise healthy forest. Harvesting trees may also leave the remaining trees more susceptible to wind throw or salt spray damage, altering plant and animal communities, facilitating the spread of invasive plants, disturbing wildlife temporarily, or displacing it over the long term.

Impacts will be mitigated by placing seasonal restrictions on harvesting to avoid disturbing wildlife at critical times of the year or damaging trees by making careful layouts of skid trails and conducting pre-harvest surveys to protect resources of concern prior to using mechanical harvesters.

In addition, the use could result in the temporary removal of vegetation. Establishment of weedy or undesirable vegetation would also be a possible impact in regenerating managed stands, whether natural or planted, and would require control through mechanical or chemical means. Direct adverse effects are of short duration as vegetation grows quickly during the growing season.

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.

Another method of forest management is prescribed burning, which 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.

Actions to increase patch sizes with a greater diversity of species composition and structure of existing forest stands, reducing forest fragmentation by reforestation of certain areas, and improving forest health and biological integrity of existing forest stands will have beneficial long-term impacts on focal forest management bird species.

Areas where forest management operations were occurring would be temporarily closed. Only a small proportion of the refuge would be closed at any one time so additional impacts on the public should be minimal.

The sociological aspects of forest management programs are complex, and vary widely across geographic boundaries. In many cases, members of the public see and hear only the negative aspects of forest management and associate forest management programs on refuges, especially the cutting of trees, 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. These concerns and issues would be addressed in environmental education and interpretation programs about the refuge's forest management program. Furthermore, forest management activities would have some direct beneficial impact on the socioeconomic environment of the region, as many of these techniques would require the contracted services of private timber companies or equipment companies.

Ultimately, the use of sound forest management techniques, including when necessary, the prudent use of commercial silvicultural contractors may provide the refuge the most cost-effective and safest method to increase the average forest age, size class, and acreage over the long term and expand different age classes represented across the refuge landscape. Habitat connectivity would increase along with riparian buffers around water courses and wetlands. Fragmentation of forest habitats would decrease, and the oak component of the refuge's mixed hardwood matrix would also increase. These are all anticipated desirable outcomes that would support the goals and objectives of the CCP and HMP.

Active forest management on the refuge will support all the goals as written in the CCP, especially Goal #1 (manage maritime habitats), Goal #2 (manage forested habitats), Goal #3 (protect wetland habitats) and Goal #4, manage early successional habitats). However, Goal #2 will reap the greatest benefits. In fact, Goal #2 will depend upon proactive habitat management actions in the form of commercial forest management. Proactive forest management will achieve refuge habitat objectives in a more efficient, suitable, and timely manner compared to relying on natural succession processes alone.

PUBLIC REVIEW AND COMMENT:

As part of the comprehensive conservation planning for the refuge, this compatibility determination will undergo public review, including a comment period of 60 days following the release of the draft CCP/EIS.

DETERMINATION (CHECK ONE BELOW):

_____ Use is not compatible

__X__ Use is compatible, with the following stipulations

STIPULATIONS NECESSARY TO ENSURE COMPATIBILITY:

Guidelines for making timber sales are found in the Refuge Manual, sections 5 RM 17 and 6 RM 3, and they will be observed in all timber sales.

An active refuge forest management program will be created based on sound silvicultural practices using an ecological forestry approach (Franklin et al 2007) to maintain, improve, and enhance refuge forested habitat.

Those contracted by the refuge will be required to follow the best management practices for timber harvest by the state of Delaware (Delaware Forest Service 2006).

The refuge will conduct forest inventories to establish the need for forest management on a specific tract or area within a tract.

The refuge will file for an Erosion and Sediment Control Harvest Permit with the Delaware Forest Service and have the state forester review our pre-harvest plan for concurrence with all commercial forest management actions.

Forest prescriptions will attempt to restore or mimic natural regimes and processes to achieve habitat objectives by recreating and /or maintaining desired forest conditions. Practices will focus on improving forest health, increasing tree growth and vigor, reducing stress, increasing mast production, promoting desirable species composition and facilitating the natural regeneration of desirable tree species throughout the refuge on appropriate sites.

Desired future conditions of the refuge's forests will be managed to enhance ecological and structural diversity where feasible and prudent by using a variety of silvicultural techniques and by retaining a diversity of vegetation and unique structural features.

Snags, live cavity and den trees, and large coarse woody debris (CWD) will be retained, as appropriate, to meet refuge objectives. During any silvicultural treatment, neither DFS den trees nor adjacent trees should be cut. The foliage of adjacent trees shades the bole of the den tree, thus keeping the den cooler. In order to promote additional den sites, trees interfering with crop tree crown development should not be felled but rather left standing and killed by girdling or by using systemic herbicides.

At the discretion of the refuge manager, the creation of snags, live cavity trees and/or CWD, or the removal of individual trees or groups of trees may occur on any areas of the refuge for specific wildlife management reasons or for public safety purposes.

Site specific timber harvesting will occur at times that are seasonally appropriate for each individual site, minimizing impacts on wildlife, e.g., no timber harvest during the bald eagle, or heron nesting seasons.

Where appropriate, the refuge will require contractors to leave tops, branches, and other wood debris on site.

Adaptive resource management will be used in assessing and modifying prescriptions to achieve wildlife habitat objectives in the most efficient and timely manner to expedite the achievement of desirable outcomes.

A pre-entry conference between the refuge forester and the designated permittee representative will be a requirement before the purchaser starts logging operations. The purpose of the pre-entry conference is to ensure that the purchaser completely understands what is expected and thus avoid misunderstanding or serious conflicts.

If requested, satisfactory scale tickets for timber products shall be submitted to the refuge.

Hardwood species will be cut so as to leave a stump not more than 12 inches high for saw timber. All stump heights are measured adjacent to the highest ground. In the case of swell-butted species or trees with metal objects in the butt, stumps may be higher.

Skidding is permitted only where designated on the sale map. The skidding of hardwood logs over 32 feet long may be prohibited in designated areas. Unnecessary damage to the residual stand will not be tolerated. The penalty for excessive skidding or other damage to residual trees will be assessed at $5.00 per inch dbh.

Ground level paint spot must remain visible after the tree has been cut. The logger may be required to cut and/or remove all marked trees.

Trees and tops shall not be left hanging or supported by any other tree and shall be pulled down immediately after felling.

Tops and logging debris shall be pulled back 20 feet from public roads and lopped within 150 feet of public roads.

All roads, rights-of-way, fields, openings, streams, and firebreaks must be kept clear of tops and debris. Permittee shall also repair all damage to same resulting from operations conducted under this permit.

No unmarked trees will be cut. Penalties will be assessed for cutting unmarked trees at $5.00 per inch of stump diameter up to 22 inches and $10.00 per inch of stump diameter for 22 inch and larger stumps.

Any of the penalties imposed will be charged against the performance deposit.

Loading of forest products on a public road, road shoulder, or afforestation area is prohibited.

Ownership of all products remaining on a sale area will revert to the Government upon termination of the permit.

The refuge staff shall have authority to temporarily close down all or any part of the operation during a period of high fire danger, wet ground conditions, or for any other reason deemed necessary. An equal amount of additional time will be granted to the permittee.

The Government accepts no responsibility to provide right-of way over private lands for materials sold under this contract.

The permittee and his employees will do all within their power to prevent and suppress forest fires.

The decision of the refuge manager shall be final in the interpretation of the regulations and provisions governing the sale, cutting, and removal of the timber covered by this permit.

When a timber sale area is adjacent to private land, all logging debris will be pulled back onto the refuge keeping damage to private property at a minimum.

JUSTIFICATION:

Forest management, including when necessary, the use of commercial silvicultural contractors and techniques, will contribute to the purposes, for which the refuge was established, the mission of the Refuge System, the enhancement of biological integrity, diversity, and environmental health, and to facilitate the ability of the refuge to meet its habitat and wildlife management objectives.

The use will not pose any significant adverse effects on refuge natural resources, interfere with the public use of the refuge, or cause an undue administrative burden. Commercial forest management on the refuge will not materially interfere with or detract from the mission of the National Wildlife Refuge System or the purposes for which the refuge was established as evidenced by the environmental assessment that shows this use will improve and advance our ability to achieve the goals and objectives set forth under the CCP.

SIGNATURE:

Refuge Manager: _____ _____
(Signature) (Date)

CONCURRENCE:

Regional Chief: _____ _____
(Signature) (Date)

MANDATORY 10 YEAR RE-EVALUATION DATE: _____

LITERATURE CITED:

See CCP Bibliography.

FINDING OF APPROPRIATENESS OF A REFUGE USE

603 FW 1
Exhibit 1

Refuge Name: Prime Hook National Wildlife Refuge

Use: Research by Non-Service Personnel. **Certain common research activities are explicitly covered under this determination. We reserve the right to make appropriateness findings for any specialized Research Project by Non-Service Personnel request on a case-by-case basis.**

This exhibit is not required for wildlife-dependent recreational uses, forms of take regulated by the State, or uses already described in a refuge CCP or step-down management plan approved after October 9, 1997.

Decision criteria:	**YES**	**NO**
(a) Do we have jurisdiction over the use?	✔	
(b) Does the use comply with applicable laws and regulations (Federal, State, Tribal, and local)?	✔	
(c) Is the use consistent with applicable Executive orders and Department and Service policies?	✔	
(d) Is the use consistent with public safety?	✔	
(e) Is the use consistent with goals and objectives in an approved management plan or other document?	✔	
(f) Has an earlier documented analysis not denied the use or is this the first time the use has been proposed?		✔
(g) Is the use manageable within available budget and staff?	✔	
(h) Will this be manageable in the future within existing resources?	✔	
(i) Does the use contribute to the public's understanding and appreciation of the refuge's natural or cultural resources, or is the use beneficial to the refuge's natural or cultural resources?	✔	
(j) Can the use be accommodated without impairing existing wildlife-dependent recreational uses or reducing the potential to provide quality (see section 1.6D. for description), compatible, wildlife-dependent recreation into the future?	✔	

Where we do not have jurisdiction over the use ("no" to [a]), there is no need to evaluate it further as we cannot control the use. Uses that are illegal, inconsistent with existing policy, or unsafe ("no" to [b], [c], or [d]) may not be found appropriate. If the answer is "no" to any of the other questions above, we will generally not allow the use.

If indicated, the refuge manager has consulted with State fish and wildlife agencies. Yes ____ No ✔.

When the refuge manager finds the use appropriate based on sound professional judgment, the refuge manager must justify the use in writing on an attached sheet and obtain the refuge supervisor's concurrence.

Based on an overall **generalized** assessment factors to **conduct Research by Non-Service Personnel,** my summary conclusion is that the described **generalized proposed** use is:

Not Appropriate _____ **Appropriate** ✔

Refuge Manager: _____ Date: _____

If found to be **Not Appropriate**, the refuge supervisor does not need to sign concurrence if the use is a new use.

If an existing use is found **Not Appropriate** outside the CCP process, the refuge supervisor must sign concurrence.

If found to be **Appropriate**, the refuge supervisor must sign concurrence:

Refuge Supervisor: _____ Date: _____

A compatibility determination is required before the use may be allowed.

JUSTIFICATION FOR A FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Prime Hook National Wildlife Refuge

Use: Research by Non-Service Personnel

NARRATIVE:

Research conducted by non-Service personnel is not identified as a priority public use of the National Wildlife Refuge System under the National Wildlife Refuge System Administration Act of 1966 (16 U.S.C. 668dd-668ee), as amended by the National Wildlife Refuge System Improvement Act of 1997. This use is not a priority public use of the Refuge System. However, research by non-Service personnel is often conducted by colleges, universities, federal, state, and local agencies, non-governmental organizations, and qualified members of the general public. Research on Prime Hook NWR would further the understanding of the natural environment and could be applied to management of the refuge's wildlife.

The refuge reserves the right at any time to find a specific request for a research project by non-Service personnel to be inappropriate or incompatible with the refuge's purposes, Service mission or the refuge's conservation management goals and objective established in the CCP and any stepped down management plan, based on each individual review and assessment of each project's research details.

Not all research may be appropriate. Some research may affect fish, wildlife, and plants in a manner neither consistent with refuge management plans nor compatible with refuge purposes or the Refuge System mission. Some research may interfere with or preclude refuge management activities, appropriate and compatible public uses, or other research. Some research may be appropriate off the refuge, but not on the refuge. For example, some natural and physical research may not be wildlife-dependent and may be accomplished successfully at locations off the refuge. Because not all research supports the establishing purposes of refuges or the Refuge System mission, we cannot define research as a refuge management activity. Therefore, we must evaluate each research proposal independently and may deny a request for a special use permit because we find the proposal to be inappropriate or incompatible.

Certain common research activities are evaluated explicitly in the Compatibility Determination. Any request for research would require issuance of a Special Use Permit issued by the Service. At the time of request, a determination will be made by refuge staff whether the research benefits the understanding of the natural environment and will contribute useful information to the Service and National Wildlife Refuge System. The entire refuge may be open and available for scientific research. An individual research project is usually limited to a particular habitat type, plant or wildlife species. On occasion research projects will encompass an assemblage of habitat types, plants or wildlife. The research location will be limited to those areas of the refuge that are absolutely necessary to conduct of the research project.

The timing of the research will depend entirely on the individual research projects approved design. Scientific research would be allowed to occur on the refuge throughout the year. An individual research project could be short term in design, requiring one or two visits over the course of a few days. Other research projects could be multiple year studies that require daily visits to the study site. The timing of each individual research project will be limited to the minimum required to complete the project. Certain common research activities are described explicitly in the Compatibility Determination.

The methods of the research will depend entirely on the individual research project that is conducted. The methods of each research project will be scrutinized well before it will be allowed to occur on the refuge. No research project will be allowed to occur if it does not have an approved scientific method, causes considerable negative impacts on wildlife and habitat, or compromises public health and safety. Certain common research activities are described explicitly in the Compatibility Determination.

No additional equipment, facilities, or improvements will be necessary to allow research by non-Service personnel. Staff time would be required to review research proposals and oversee permitted projects. We expect that conducting these activities will require less than one-tenth of a work-year for one staff member.

Non-Service organizations and personnel conducting research on the refuge will provide the Service with all data collected and/or reports. The research organization/agency or personnel in conjunction with the Service will retain the use and ownership of all data/reports.

The Service encourages approved research to further the understanding of the natural resources. Research by other than Service personnel adds greatly to the information base for refuge managers to make proper decisions. Disturbance to wildlife and vegetation by researchers could occur through observation, sampling, or accessing the study area. It is possible that direct mortality could result as a by-product of research activities.

Negligible impacts will occur when research projects which are previously approved are carried out according to the stipulations stated in the Special Use Permit issued for each project. Overall, however, allowing well designed and properly reviewed research to be conducted by non-Service personnel is likely to have very little impact on refuge wildlife populations. If the research project is conducted with professionalism and integrity, potential adverse impacts are likely to be outweighed by the knowledge gained about an entire species, habitat or public use.

COMPATIBILITY DETERMINATION

USE:

Research by Non-Service Personnel

REFUGE NAME:

Prime Hook National Wildlife Refuge

ESTABLISHING AND ACQUISITION AUTHORITY(IES):

(1) Migratory Bird Conservation Act {16 U.S.C. 715d}

(2) Refuge Recreation Act {16 U.S.C. 460 K-1}

REFUGE PURPOSE(S):

(1) "…for use as an inviolate sanctuary, or for any other management purposes, for migratory birds…" {16 U.S.C. 715d; Migratory Bird Conservation Act}

(2) "…incidental fish and wildlife-oriented recreational development" {16 U.S.C. 460k-1; Refuge Recreation Act}

(3) "the protection of natural resources" {16 U.S.C. 460k-1; Refuge Recreation Act}

(4) "the conservation of endangered or threatened species…" {16 U.S.C. 460k-1; Refuge Recreation Act}

NATIONAL WILDLIFE REFUGE SYSTEM MISSION:

The mission of the Refuge System is to administer a national network of lands and waters for the conservation, management, and where appropriate, restoration of the fish, wildlife, and plant resources and their habitats within the United States for the benefit of present and future generations of Americans.

DESCRIPTION OF USE:

(a) What is the use? Is the use a wildlife-dependent use?
The use is research or other ecological or cultural investigations not conducted by the U.S. Fish and Wildlife Service (Service) or a Service-authorized agent. Research is not a priority public use of the National Wildlife Refuge System under the National Wildlife Refuge System Administration Act of 1966 (16 U.S.C. 668dd-668ee), as amended by the National Wildlife Refuge System Improvement Act of 1997.

In accordance with 16 U.S.C. 668dd(d) and 50 C.F.R. Part 25, Subpart D, the refuge manager is responsible for reviewing applications for SUPs and determining whether to authorize a proposed use. Uses must be "appropriate," and if so, also found to be "compatible" with the refuge purposes, and those of the System, prior to be approved and undertaken. These decisions are based on the Service's best professional judgment, consistent

with Service regulations and policy, including the Policy on Maintaining the Biological Integrity, Diversity, and Environmental Health of the National Wildlife Refuge System (66 Fed. Reg. 3810 (2001); 601 FW 3).

Research is conducted by federal, state, and private entities, including the U.S. Geological Survey, state departments of natural resources, students and professors at state and private universities, and independent non-government researchers and contractors. This activity would allow permitted researchers access to the refuge's natural environment to conduct both short-term and long-term research projects.

The refuge issues from ten to twenty Special Use Permits (SUP) per year allowing research studies investigating biological, physical, and/or social issues and concerns to address refuge management information needs, or enhance understanding of trust resources. Specifically covered under this Compatibility Determination (CD) are the following research endeavors:

- Volunteer-based bird surveys, such as the Christmas Bird Count and Delaware Bird Atlas Project
- Migratory Bird Banding
- Anuran Surveys, such as conducted by DNREC or academic institutions
- Upland or wetland bird surveys
- Delmarva fox squirrel research and monitoring, such as conducted by DNREC
- Coastal Wetland Research, such as conducted by DNREC or academic institutions

Additional research permit requests will be considered on a case-by-case basis, as staff availability dictate, the value of the proposed research warrant, and the professional judgment of the refuge manager. The results of research should result in better knowledge of our natural resources and improve methods to manage, monitor, and protect the refuge's biological resources and public uses.

The refuge manager will always have the discretion to reevaluate the appropriateness and compatibility of any specific 'research by non-Service personnel' request at any time [603 FW 2.1 H(1), (2)]. A specific research project denial will be based on the refuge manager exercising sound professional judgment based on field experiences, knowledge of the refuge's natural resources, particularly its biological resources and available scientific information. When a refuge manager is exercising sound professional judgment, the refuge manager will use available information that may include consulting with others both inside and outside the Service.

When assessing the compatibility of a research project the refuge manager will use sound professional judgment to determine if the details of the project will materially interfere with or detract from the fulfillment of the System mission or purposes of the refuge. Inherent in fulfilling the System mission is not degrading the biological diversity, integrity or environmental health of the refuge.

Rationale for denials in appropriateness or compatibility will be consistent with the principles of sound fish and wildlife management, refuge administration and applicable laws. When a refuge manager is exercising sound professional judgment, and finds a specific research project to be inappropriate or incompatible, such a denial will be based on evidence that the details of a particular research project might lead to the impairment of our conservation mission, or detracts from fulfilling the refuge's purposes, or conflicts with the conservation goals or objectives in an approved refuge management plans, or is not manageable with the available budget or staff time, or is inconsistent with public safety, or conflicts with maintaining or restoring the biological integrity, diversity, and environmental health of the refuge's habitats involved in the research project.

The refuge manager will specify in writing the rationale, conclusions and decision when denying a specific research project request.

(b) Where would this use be conducted?
Sites for this use would be dependent on the particular study being conducted and could occur in a variety of habitat types. Access would be restricted by Special Use Permit to only the study sites needed to meet the objectives of the research.

Volunteer-based bird surveys such as the Christmas Bird Count and Delaware Breeding Bird Atlas are conducted in all habitats of the refuge, and often in areas otherwise closed to the public. Migratory bird banding is most often conducted in refuge wetlands, but may also be conducted in upland habitats such as forests or early

successional fields. Similarly, anuran surveys are most often conducted in wetlands, although the researcher may make observations from an upland location. Upland bird surveys would be conducted in any upland refuge habitat. Delmarva fox squirrely monitoring takes place in refuge forests. Wetland bird surveys and other wetland research may take place in refuge wetlands, whether salt marsh or impounded wetlands, or along the refuge shoreline.

(c) When would the use be conducted?
The timing of research will be dependent on the type and subject(s) of the research project. Research could potentially occur throughout the year. Time of year restrictions could be imposed to protect threatened or endangered species or to prevent conflicts with other refuge uses or management activities.

Certain volunteer-based bird surveys focus on specific seasons in the avian life cycle. For example the Christmas Bird Count is conducted during the winter, and the Delaware Breeding Bird Atlas is conducted during the spring and summer breeding season. Migratory bird banding may be conducted during the breeding or migration seasons, but also less frequently during the winter. Anuran surveys are most often conducted in the spring and early summer. Upland bird surveys would primarily be conducted in the spring and summer, whereas wetland bird surveys may also be conducted during migration and wintering periods as well. Delmarva fox squirrel research may be conducted at any time of the year, depending on specific monitoring objectives for a given survey. Wetland research may take place year-round.

(d) How would this use be conducted?
The mechanics of the research will depend entirely on the individual research project. Each research proposal will be carefully scrutinized for clear objectives, methods, and research approach before allowing it on the refuge. Research proposals that lack an approved study plan and protocol or compromises public health and safety will not be allowed. Draft proposals will be routed through the Regional Research Coordinator and Regional Biologist for review to ensure that protocols meet Service standards.

Any research study sites, sampling locations and transects can be temporarily marked by high visibility wooden or metal posts and must be removed when research ceases. Access to study sites is by foot, truck, vehicle, boat or canoe. Vehicle use is allowed on refuge roads, trails and parking lots normally open to the public or otherwise identified in a Special Use Permit (SUP).

Volunteer-based bird surveys such as the Christmas Bird Count and Delaware Breeding Bird Atlas, as well as other upland and wetland bird surveys, are conducted via field observations of birds during the season of interest. Migratory bird banding is conducted by trained and certified researchers, utilizing appropriate mist nets or other trapping devices. Birds are handled promptly and released. Anuran surveys are conducted via field observations. Delmarva fox squirrel research may include either carefully monitored trap-and-release efforts, or passive photo monitoring. Wetland research will involve several potential techniques. In-field measurements for vegetation and other physical characteristics will be taken. This may include the maintenance of permanent sampling equipment in the field, such as marking posts and surface elevation benchmarks. Some samples of sediments, water, and/or vegetation may be collected and removed from the wetland for further analysis (e.g., benthic core samples or water grab samples).

(e) Why is the use being proposed?
Research by non-Service personnel conducted by colleges, universities, federal, state, and local agencies, non-governmental organizations, and qualified members of the public furthers our understanding of the natural environment and improves the management of refuge natural resources. Much of the information research generated applies to management on and near the refuge, or supports the understanding and conservation of trust resource species.

The specific research activities described above represent common or recurring research projects that have been determined to have specific benefits for refuge resource decisions, and are conducted by organizations or individuals with appropriate qualifications.

The Service encourages and supports research and management studies on refuge lands that will improve and strengthen decisions on managing natural resources. The refuge manager encourages and seeks research that clearly relates to approved refuge objectives, improves habitat management, and promotes adaptive

management. Priority research addresses information on better managing the Nation's biological resources that generally are important to agencies of the Department of Interior, the National Wildlife Refuge System, and State Wildlife Agencies, that address important management issues, or demonstrate techniques for managing species or habitats.

Consideration may also be given to research for other purposes that may not relate directly to refuge-specific objectives, but contribute to the broader enhancement, protection, use, preservation or management of native populations of fish, wildlife and plants, and their natural diversity in the region or the Atlantic flyway. All proposals must comply with Service policy on compatibility.

Both the Refuge Manual and the Service Manual provide guidance on allowing research on refuges. The Refuge Manual (4 RM 6.2) lists three objectives that can be met by permitting research on refuges:

1) Promoting new information which will improve the quality of the refuge and other Service management decisions.

2) To expand the body of scientific knowledge about fish and wildlife, their habitats, the use of these resources, appropriate resource management and the environment in general.

3) To provide the opportunity for students and others to learn the principles of field research.

The Service Manual (603 FW 1.10D (4)) provides supplemental guidance in terms of the appropriateness of research on refuges, as follows: "We actively encourage cooperative natural and cultural research activities that address our management needs. We also encourage research related to the management of priority general public uses. Such research activities are generally appropriate. However, we must review all research activities to decide if they are appropriate or not as defined in section 1.11. Research that directly benefits refuge management has priority over other research."

The rationale for this conclusion is clearly stated in the preamble to that policy (71 Federal Regulation 36415):

> Not all research may be appropriate. Some research may affect fish, wildlife, and plants in a manner neither consistent with refuge management plans nor compatible with refuge purposes or the Refuge System mission. Some research may interfere with or preclude refuge management activities, appropriate off the refuge, appropriate and compatible public uses, or other research. Some research may be appropriate off the refuge, but not on the refuge. For example, some natural and physical research may not be wildlife-dependent and may be accomplished successfully at locations off the refuge. Because not all research support establishing purposes of refuges or the Refuge System mission, we cannot define research as a refuge management activity.

AVAILABILITY OF RESOURCES:

Refuge support for research may take the form of funding, in-kind services such as housing, the use of other refuge facilities, vehicles, boats, or equipment, the direct assistance of refuge staff in collecting data, providing historical records, conducting management treatments, or providing other assistance as appropriate. Generally, however, the bulk of the costs are incurred in staff time to review research proposals, coordinate with researchers, and write SUPs. In some cases, a research project may require only a few hours of staff time to review the proposal, coordinate with other reviewers, and write a SUP. In other cases, a research project may involve more significant staff time, because the refuge staff must coordinate with students and advisors and accompany researchers on site visits.

For projects conducted entirely by non-Service researchers, the following staff resources would be typical:

Proposal review, coordination, and SUP preparation –	Refuge Manager, 2 hours	$112
	Refuge Biologist, 8 hours	$283
	Total	**$395**

For the refuge to expend significantly more than this level of resources, the research would generally be required to have specific implications to our management. If the research was aimed at answering refuge-specific management questions, we would consider contributing additional resources. In this case, we might expect to contribute the following:

Proposal review, coordination, and SUP preparation –	Refuge Manager,	8 hours	$ 448
	Refuge Biologist,	16 hours	$ 566
Field assistance	Refuge Biologist,	160 hours	$5,659
	Maint. Worker,	40 hours	$ 961
Use of Facilities and Equipment			
	Trailer as quarters	30 days @ $12/day	$360
	Vehicle or boat	30 days @ $20/day	$600
	Total		**$8,594**

ANTICIPATED IMPACTS OF THE USE:

Short-term impacts:

Research activities may disturb fish and wildlife and their habitats. For example, the presence of researchers can cause waterfowl to flush from resting and feeding areas, cause disruption of birds on nests or breeding territories, or increase predation on nests and individual animals as predators follow human scent or trails. This is a potential impact of both volunteer-based bird surveys, other bird survey activities, and anuran surveys. Efforts to capture animals, such as for migratory bird banding and certain Delmarva fox squirrel monitoring techniques, can cause disturbance, injury, or death to groups of wildlife or to individuals. To wildlife, the energy cost of disturbance may be appreciable in terms of disruption of feeding, displacement from preferred habitat and the added energy expended to avoid disturbance.

The removal of vegetation or sediments by core sampling methods, a common method for use in wetland research, can cause increased localized turbidity and disrupt non-target plants and animals. Sampling activities associated with many types of research activities can cause compaction of soils and the trampling of vegetation. Installation of posts, equipment platforms, collection devices and other research equipment in open water may present a hazard if said items are not adequately marked and/ or removed at appropriate times or upon completion of the project. Research efforts may also discover methods that result in a reduction in impacts described above.

Long-term impacts:

Long term effects should generally be beneficial by gaining information valuable to refuge management. No long-term negative impacts are expected from the research activities described and the refuge manager can control the potential of long-term impacts through Special Use Permits. Permits for multi-year research projects are renewed annually, providing the opportunity for an analysis of any impacts before issuing a Special Use Permit renewal.

Cumulative impacts:

Cumulative impacts would occur if multiple research projects were occurring on the same resources at the same time or if the duration of the research is excessive. In particular, the refuge must consider the potential impacts of non-FWS research, in conjunction with any FWS-sponsored research also taking place. However, no cumulative impacts are expected because refuge manager can control the potential for cumulative impacts

through Special Use Permits, prohibiting multiple research projects from affecting any given area or species at one time. Managers retain the option to prohibit research on the refuge which does not contribute to the mission of the refuge system or causes undue disturbance or harm. Managers retain the right to revoke or deny renewal for any Special Use Permit if unanticipated short-term, long-term, or cumulative impacts are noted.

Ideally, any research project conducted on the refuge would positively contribute to one or more of the refuge goals and/or objectives. There may be short-term disturbance to plants and wildlife during field investigations -- this is unavoidable in most cases. We will conduct Intra-Service Section 7 Biological Evaluations for any proposal that could be anticipated to have an impact on any federally threatened or endangered species. We will pay particular attention to the joint Service-State Bald Eagle Protection Guidelines for Delaware. These guidelines provide distance and time-of-year restrictions for activities that could disturb nesting or roosting eagles. We will ensure that the refuge or any non-Service researchers obtain any special permits, including collection and banding permits, required by State or Federal law prior to issuing a SUP.

PUBLIC REVIEW AND COMMENT:

This compatibility determination is part of the Prime Hook Draft Comprehensive Conservation Plan and Environmental Impact Statement. Public notification and review included a notice of availability published in the Federal Register, a 60-day comment period, and local media announcements.

DETERMINATION (CHECK ONE BELOW):

____ Use is not compatible

__X__ Use is compatible, with the following stipulations

STIPULATIONS NECESSARY TO ENSURE COMPATIBILITY:

All researchers will be required to submit a detailed research proposal that follows Service Policy (Refuge Manual 4 RM 6). Researchers must give us at least 45 days to review proposals before the research begins. If the research involves the collection of wildlife, the refuge must be given 60 days to review the proposal. Researchers must obtain all necessary scientific collecting or other permits before starting the research. We will prioritize and approve proposals based on the need, benefit, compatibility, and funding required for the research.

The refuge may ask regional refuge biologists, other Service divisions, state agencies, or academic experts to review and comment on proposals. Researchers must possess all applicable state and federal permits for the capture and possession of protected species, for conducting regulated activities in wetlands, and for other regulated activities, as applicable to the approved research.

No more than six SUPs will be issued annually for approved research conducted by non-Service personnel. The SUP will list all conditions necessary to ensure compatibility, including stipulations regarding when, where, and how the research will be conducted. The SUPs will also identify a schedule for annual progress reports and the submittal of a final report or scientific paper. Managers retain the option to prohibit research on the refuge which does not contribute to the purposes of the refuge or the mission of the Refuge System, or which causes undo resource disturbance or harm.

Researchers will be required to submit a final report to the refuge upon completing their work. For long-term studies, we may also require interim progress reports. All reports, presentations, posters, articles or other publications will acknowledge the Refuge System and Prime Hook National Wildlife Refuge as partners in the

research. Non-Service organizations and personnel conducting research on the refuge will provide the Service with all data collected and/or reports. The research organization/agency or personnel in conjunction with the Service will retain the use and ownership of all data/reports.

Any research data collected under a SUP on the refuge shall be jointly owned by the Service and the researcher. The researcher will have the first opportunity for publication of results associated with the data, but appropriate credits to the United States Fish and Wildlife Service and the refuge shall be included in any formally published article, provided that the Service does not otherwise deem it appropriate to issue a disclaimer.

The refuge retains the right to revoke a SUP, or deny future renewal, if unacceptable impacts to refuge habitat or species are noted.

JUSTIFICATION:

The Service encourages research on national wildlife refuges to promote new information which will improve the quality of refuge and other Service management decisions, to expand the body of scientific knowledge about fish and wildlife, their habitats, the use of these resources, appropriate resource management, and the environment in general, and to provide the opportunity for students and others to learn the principles of field research.

In accordance with 50 CFR 26.41, research conducted by non-Service personnel, as described in this compatibility determination, will not materially interfere with, or detract from, the fulfillment of the National Wildlife Refuge System mission or the purposes for which the refuge was established.

SIGNATURE:

Refuge Manager: _____ _____
(Signature) (Date)

CONCURRENCE:

Regional Chief: _____ _____
(Signature) (Date)

MANDATORY 10 YEAR RE-EVALUATION DATE: _____

603 FW 1
Exhibit 1

FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Prime Hook National Wildlife Refuge

Use: Mosquito Management

This exhibit is not required for wildlife-dependent recreational uses, forms of take regulated by the State, or uses already described in a refuge CCP or step-down management plan approved after October 9, 1997.

Decision criteria:	**YES**	**NO**
(a) Do we have jurisdiction over the use?	✔	
(b) Does the use comply with applicable laws and regulations (Federal, State, Tribal, and local)?	✔	
(c) Is the use consistent with applicable Executive orders and Department and Service policies?	✔	
(d) Is the use consistent with public safety?	✔	
(e) Is the use consistent with goals and objectives in an approved management plan or other document?	✔	
(f) Has an earlier documented analysis not denied the use or is this the first time the use has been proposed?	✔	
(g) Is the use manageable within available budget and staff?	✔	
(h) Will this be manageable in the future within existing resources?	✔	
(i) Does the use contribute to the public's understanding and appreciation of the refuge's natural or cultural resources, or is the use beneficial to the refuge's natural or cultural resources?		✔
(j) Can the use be accommodated without impairing existing wildlife-dependent recreational uses or reducing the potential to provide quality (see section 1.6D. for description), compatible, wildlife-dependent recreation into the future?	✔	

Where we do not have jurisdiction over the use ("no" to [a]), there is no need to evaluate it further as we cannot control the use. Uses that are illegal, inconsistent with existing policy, or unsafe ("no" to [b], [c], or [d]) may not be found appropriate. If the answer is "no" to any of the other questions above, we will generally not allow the use.

If indicated, the refuge manager has consulted with State fish and wildlife agencies. Yes ✔ No _____.

When the refuge manager finds the use appropriate based on sound professional judgment, the refuge manager must justify the use in writing on an attached sheet and obtain the refuge supervisor's concurrence.

Based on an overall assessment of these factors, my summary conclusion is that the proposed use is:

Not Appropriate _____ **Appropriate** ✔

Refuge Manager: _____ Date: _____

If found to be **Not Appropriate**, the refuge supervisor does not need to sign concurrence if the use is a new use.

If an existing use is found **Not Appropriate** outside the CCP process, the refuge supervisor must sign concurrence.

If found to be **Appropriate**, the refuge supervisor must sign concurrence:

Refuge Supervisor: _____ Date: _____

A compatibility determination is required before the use may be allowed.

603 FW 1
Exhibit 1
Page 2

JUSTIFICATION FOR A FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Prime Hook National Wildlife Refuge

Use: Mosquito Management

NARRATIVE:

The use is mosquito and mosquito-borne disease management, which includes surveillance and, when warranted, chemical control interventions or the maintenance of current refuge biological mosquito control systems known as Open Marsh Water Management (OMWM). Mosquito and mosquito-borne disease management is not a priority public use of the National Wildlife Refuge System under the National Wildlife Refuge System Administration Act of 1966 (16 U.S.C. 668dd-668ee) as amended by the National Wildlife Refuge System Improvement Act.

Service interim *National Wildlife Refuge System Mosquito Management Guidelines* (USFWS 2005) states "when necessary to protect human, wildlife, or domestic animal health, the Service will reduce mosquitoes associated with health threats using an integrated pest management (IPM) approach, including when practical, compatible, non-pesticide actions that reduce mosquito production. Except in officially determined health emergencies, any procedure the Service uses to reduce mosquito production will meet compatibility requirements as found in 603 FW 2 and must give full consideration to the safety and integrity of non-target organisms and communities, including federally listed threatened and endangered species."

The Delaware Mosquito Control Section (The Section), under Service permits, has requested to conduct mosquito management on the refuge since its establishment in 1963. The Section of the Delaware Division of Fish and Wildlife, under the supervision of the Department of Natural Resources and Environmental Control, is mandated to *"take all necessary and proper steps and measures for the eradication of mosquitoes, including but not limited to source reduction methods that alter or eliminate habitats of immature mosquitoes, biological controls such as native fish stocking, and the application of insecticides by air or ground to control immature or adult mosquitoes, all done in order to effect nuisance relief, to protect public health, and to help avoid adverse impacts to local economies from severe mosquito infestations…"* (State of Delaware Mosquito Control's Enabling Statute: Delaware Code Title 16, Chapter 19).

COMPATIBILITY DETERMINATION

USE:

Mosquito Management

REFUGE NAME:

Prime Hook National Wildlife Refuge

DATE ESTABLISHED:

April 8, 1963

ESTABLISHING AND ACQUISITION AUTHORITY(IES):

(1) Migratory Bird Conservation Act {16 U.S.C. 715d}

(2) Refuge Recreation Act {16 U.S.C. 460 K-1}

REFUGE PURPOSE(S):

(1) "…for use as an inviolate sanctuary, or for any other management purposes, for migratory birds…" {16 U.S.C. 715d; Migratory Bird Conservation Act}

(2) "…incidental fish and wildlife-oriented recreational development" {16 U.S.C. 460k-1; Refuge Recreation Act}

(3) "the protection of natural resources" {16 U.S.C. 460k-1; Refuge Recreation Act}

(4) "the conservation of endangered or threatened species…" {16 U.S.C. 460k-1; Refuge Recreation Act}

NATIONAL WILDLIFE REFUGE SYSTEM MISSION:

The mission of the Refuge System is to administer a national network of lands and waters for the conservation, management, and where appropriate, restoration of the fish, wildlife, and plant resources and their habitats within the United States for the benefit of present and future generations of Americans.

The Improvement Act provides compatibility standards for refuge uses and directs the U.S. Fish and Wildlife Service (Service) to "ensure that the biological integrity, diversity, and environmental health of the Systems are maintained." In order to fulfill this mission, national policy and guidelines have been developed to provide refuge managers clear direction and procedures for making determinations regarding wildlife conservation and mosquito management on national wildlife refuge lands. Both interim guidelines and a draft policy (Federal Register/Volume 72, No. 198/Monday, October 15, 2007/Notice) describe the process we will follow to determine if and how to manage mosquito populations on lands administered within the Refuge System. The principles underlying both interim and draft policies have been incorporated into this Compatibility Determination (CD) and will be amended as required when final codified policy appears as part 601, chapter 7 of the Fish and Wildlife Service Manual.

DESCRIPTION OF USE:

(a) What is the use? Is the use a priority public use?
The use is mosquito and mosquito-borne disease management, which includes surveillance and, when warranted, chemical control interventions or the maintenance of extant biological mosquito control systems known as Open Marsh Water Management (OMWM). Mosquito and mosquito-borne disease management is not a priority public use of the National Wildlife Refuge System under the National Wildlife Refuge System Administration Act of 1966 (16 U.S.C. 668dd-668ee) as amended by the National Wildlife Refuge System Improvement Act of 1997.

(b) Where will the use be conducted?
The use will occur in areas specified in a refuge-issued annual special use permit, as needed, to protect human health and wildlife and domestic animal safety from mosquito-borne disease. Areas to be treated will vary in size and location based on population monitoring and threshold criteria for treatment, to be determined in a refuge specific mosquito management plan.

(c) When would the use be conducted?
Mosquito control will occur only as needed, and on an irregular and short-term basis when it is necessary to protect the health and safety of humans, wildlife, or domestic animals. Surveillance activities associated with this use will be conducted from April through October under the conditions of this compatibility determination, a refuge-specific mosquito management plan, and/or a special use permit, all in accordance with Service interim and final policies for mosquito management on National Wildlife Refuges, as well as Biological Integrity Diversity and Environmental Health (BIDEH) policy (USFWS 2001).

(d) How will the use be conducted?
On October 15, 2007, the Service published in the Federal Register its "Draft Mosquito and Mosquito-Borne Disease Management Policy Pursuant to the National Wildlife Refuge System Improvement Act of 1997." Until the draft policy is finalized, we will follow the "Interim Guidance for Mosquito Management on National Wildlife Refuges," prepared in spring 2005. This document provides refuges with interim guidance on addressing mosquito-associated health threats in a consistent manner. The guidance states that refuges will not conduct mosquito monitoring or control unless it is necessary and, when compatible. to protect the health of a human, wildlife, or domestic animal population. If there is a documented health emergency, the Service will work with local and state mosquito managers to minimize risks to human health, while at the same time protecting refuge resources.

Mosquito monitoring and control on the refuge will be managed under a mosquito management plan developed by refuge in conjunction with State officials. The plan will provide the specifics on how and when the refuge will allow monitoring and, if necessary, control of mosquitoes on refuge-owned lands, using predetermined threat levels and, or mosquito vector population densities. The Delaware Mosquito Control Section (DMCS), is responsible for monitoring larval and adult mosquitoes on the refuge. Additional details and restrictions on monitoring and control (generally access, timing and location) within refuge boundaries will be described in an annual special use permit issued to DMCS. Variation in annual permit restrictions are necessary to accommodate wildlife breeding, roosting and feeding activity; endangered species; administrative needs; public use management; research or monitoring protocols; and other conflicts that may arise.

The management plan will be developed and annual permit issued by the Service to ensure that there will be no significant adverse impacts on the refuge's wildlife and habitats. Treatment regimens may vary annually, depending on the current conditions of disease presence and mosquito abundance.

The purpose of monitoring is to detect changes in mosquito populations that indicate an increased risk to human or wildlife health. Because there is a documented history of mosquito-borne diseases in this area, the refuge will allow monitoring of mosquitoes on an annual basis, therefore a SUP will be issued annually before mosquito breeding season. The goal of early mosquito larvae monitoring is to rapidly detect relative and absolute changes in population size that can indicate an increased risk to human, wildlife, or domestic animal health. Mosquito monitoring on refuge will document composition to genus level, and estimate population size and distribution across refuge wetland habitats during the breeding season, using standard methods employed by mosquito control professionals.

In addition, the goal of surveillance for mosquito-borne disease is to monitor and test wildlife, especially birds and adult mosquitoes for pathogens. Such testing may include captive sentinel birds or other reservoir hosts for levels of disease activity (pathogens or antibodies). High levels of pathogenic activity would indicate higher health risks.

Federal and state public health representatives would officially identify a high risk for mosquito-borne disease based on documented mosquito vector population density and, or disease activity in humans or wildlife. In addition, the Secretary of the Interior has the authority to identify a high risk for mosquito-borne disease independent of other Federal or state public authorities. Such a high risk determination indicates an imminent risk of serious human disease or death.

High mosquito vector density and, or increased incidence of disease in humans or wildlife may warrant pesticide treatments to refuge lands to decrease vector populations and lower health risks. Early detection of pathogenic activity, combined with up-to-date mosquito vector population monitoring are the best management practices to allow for timely chemical intervention measures to occur. Timely intervention would reduce high disease risks to humans and reduce the use of chemicals that negatively impact wildlife resources.

In the absence of a health threat, we will allow the State to manage mosquitoes in such a way as to meet refuge statutory obligations to maintain and enhance the biological integrity, diversity, and environmental health of refuge lands. Therefore, we have evaluated the impacts of the mosquito control methods currently in use by DMCS.

Larvicides

Like other varieties of the natural soil bacterium, *Bacillus thuringiensis* (Bt), *Bacillus thuringiensis israelensis* (Bti) is a stomach poison that must be ingested by the larval form of the insect in order to be effective (Extoxnet 1996a). This soil bacterium contains crystalline structures containing protein endotoxins that are activated in the alkaline conditions of an insect's gut. These toxins attach to specific receptor sites on the gut wall and, when activated, destroy the lining of the gut and eventually kill the insect. The toxicity of Bt to an insect is directly related to the specificity of the toxin and the receptor sites. Without the proper receptor sites, the Bt will simply pass harmlessly through the insect's gut. Several varieties of Bt have been discovered and identified by the specificity of the endotoxins to certain insect orders. *Bacillus thuringiensis* var. *kurstaki*, for example, contains toxins that are specific to lepidopterans (butterflies and moths), while Bti is specific only to certain primitive dipterans (flies), particularly mosquitoes, black flies, and some chironomid midges. Bti is not known to be directly toxic to non-dipteran insects (Extoxnet 1996a).

Due to specificity of the effects of Bti on the insect order, diptera, this insecticide is deemed compatible for use, under the stipulations prescribed at the end of this CD and the Mosquito Management Plan. Bti is the preferred chemical control option and should be used under appropriate conditions.

Methoprene is an EPA toxicity class IV general use pesticide, considered slightly to practically nontoxic (EPA 2001). Methoprene is a synthetic mimic of a naturally produced insect hormone, juvenile hormone (JH). All insects produce JH in the larval stages, with the highest levels occurring in the insect's early developmental stages. As an insect reaches its final stage of larval development, the level of JH is very low. This low level of JH triggers the development of adult characteristics. When an insect is exposed to Methoprene, a hormonal imbalance in the development of the insect results, and it fails to properly mature into an adult. The insect eventually dies in the pupal stage. The most susceptible stages of development to Methoprene are the later instars (for mosquitoes, third and fourth instars). In mosquito control applications, Methoprene is applied to the larval breeding habitat. Methoprene is a non-specific contact insecticide that does not need to be ingested like Bti (Tomlin 1994). Larvae will continue to feed and may reach the pupal stage, but they will not emerge as adults.

Due to the potential adverse affects of Methoprene on non-target insects, Bti should be the first chemical of choice for use on the refuge. However, the refuge recognizes that Bti exhibits limited efficacy under certain conditions; under those conditions Methoprene would be the prudent alternative. Only formulations with short term residuals (5-10 days) may be used for larval mosquito control. Use of Methoprene products with long term residuals such as Altosid XR-G, 30-Day Briquettes, or XR Briquettes will not be permitted.

Mosquito control chemicals will be applied using handheld, backpack and aerial dispersal methods. DMCS may conduct mosquito surveillance using dip samples, light/CO2 traps, and landing rates. *Bacillus thurigiensis* and methoprene will be applied as specified in the product EPA label, the annual Service Pesticide Use Proposal, and the annual refuge special use permit.

Adulticides

Adulticides are inherently non-specific, i.e., they kill non-target species as well as mosquitoes. The most recent adulticides used on the refuge include the Naled products of Dibrom and Trumpet EC. Naled is a EPA Toxicity Class I (Highly Toxic) general use pesticide, having the signal word "Danger" on the specimen label (Amvac 2005). The EPA considers the active ingredient Naled, based on acute toxicity data, to be moderately to highly toxic to birds, moderately toxic to mammals, highly toxic to honey bees, moderately to very highly toxic to freshwater fish, and very highly toxic to freshwater aquatic invertebrates (EPA 2002). It is fast acting organophosphate adulticide licensed for controlling aphids, mites, flies, and mosquitoes. Naled is a cholinesterase inhibitor, a compound found in animals including mammals, birds, fish and other insects. Naled damages the nervous system, and at sufficiently high exposures, can result in respiratory paralysis and death (2005a).

It should be noted, that acute toxicity studies are conducted in a lab using chemical concentrations that are unlikely to be encountered during proper use in the field according to the pesticide label. Nevertheless, the acute toxicity data can be used to make general statements about the relative toxicity of various chemicals. For the purpose of comparison, the larvicide methoprene (also considered for compatibility in this document) ranks as a toxicity class IV, and is considered slightly to practically nontoxic (Extoxnet 1996). Methoprene is used in the production of various foods, including meat, milk, eggs, mushrooms, peanuts, rice, and cereals (Extoxnet 1996). It is practically nontoxic when ingested or inhaled and slightly toxic by dermal absorption. Methoprene is used in cattle feed to deter insect larvae from growing in cattle feces. Continued use of Methoprene is permitted on the refuge per this CD, while Naled is not.

EPA's Interim Reregistration Eligibility Decision (IRED) for Naled, published in 2002, evaluates the use of Naled for several purposes. The IRED evaluates the "risk" of various formulations and application techniques of Naled to humans as well as various wildlife species. While there are many definitions of the word risk, ***EPA considers risk to be the chance of harmful effects to human health or to ecological systems*** resulting from exposure to an environmental stressor. A stressor is any physical, chemical, or biological entity that can induce an adverse response. Stressors may adversely affect specific natural resources or entire ecosystems, including plants and animals, as well as the environment with which they interact *(http://epa.gov/riskassessment/basicinformation.htm#risk).*

EPA uses a process called "risk assessment" to characterize the nature and magnitude of health risks to humans (e.g., residents, workers, recreational visitors) and ecological receptors (e.g., birds, fish, wildlife) from chemical contaminants and other stressors that may be present in the environment.

At EPA, environmental risk assessments typically fall into one of two areas:

- *Human Health*
- *Ecological*

Risk assessment is, to the highest extent possible, a scientific process. In general terms, risk depends on the following factors:

- How much of a chemical is present in an environmental medium (e.g., soil, water, air),
- How much contact (exposure) a person or ecological receptor has with the contaminated environmental medium, and
- The inherent toxicity of the chemical.

Based on this, the risk assessor evaluates the frequency and magnitude of human and ecological exposures that may occur as a consequence of contact with the contaminated medium, both now and in the future.
This evaluation of exposure is then combined with information on the inherent toxicity of the chemical (that is, the expected response to a given level of exposure) to predict the probability, nature, and magnitude of the adverse health affects that may occur. In the ideal world, all risk assessments would be based on a very strong knowledge base (i.e., reliable and complete data on the nature and extent of contamination, fate and transport processes, the magnitude and frequency of human and ecological exposure, and the inherent toxicity of all of the chemicals). However, in real life, information is usually limited on one or more of these key data needed for risk assessment calculations. This means that risk assessors often have to make estimates and use judgment when performing risk calculations, and consequently all risk estimates are uncertain to some degree. For this reason, a key part of all good risk assessments is a fair and open presentation of the uncertainties in the calculations and a characterization of how reliable (or how unreliable) the resulting risk estimates really are *(http://epa.gov/riskassessment/basicinformation.htm#risk).*

Developing a risk assessment is often an iterative process, which involves researchers identifying and filling data gaps in order to develop a more refined assessment of the risk. This in turn may influence the need for risk assessors and risk managers to refine the scope of the risk assessment further triggering the need for more data or new assumptions.

As described in EPA's *"Risk Characterization Handbook,"* risk management is the process which evaluates how to protect public health. Examples of risk management actions include deciding how much of a substance a company may discharge into a river; deciding which substances may be stored at a hazardous waste disposal facility; deciding to what extent a hazardous waste site must be cleaned up; setting permit levels for discharge, storage, or transport; establishing national ambient air quality standards; and determining allowable levels of contamination in drinking water.

Risk assessment provides "Information" on potential health or ecological risks, and risk management is the "Action" taken based on consideration of that and other information, as follows:

- Scientific factors provide the basis for the risk assessment, including information drawn from toxicology, chemistry, epidemiology, ecology, and statistics - to name a few.
- Economic factors inform the manager on the cost of risks and the benefits of reducing them, the costs of risk mitigation or remediation options and the distributional effects.
- Laws and legal decisions are factors that define the basis for the Agency's risk assessments, management decisions, and, in some instances, the schedule, level or methods for risk reduction.
- Social factors, such as income level, ethnic background, community values, land use, zoning, availability of health care, life style, and psychological condition of the affected populations, may affect the susceptibility of an individual or a definable group to risks from a particular stressor.
- Technological factors include the feasibility, impacts, and range of risk management options.
- Political factors are based on the interactions among branches of the Federal government, with other Federal, state, and local government entities, and even with foreign governments; these may range from practices defined by Agency policy and political administrations through inquiries from members of Congress, special interest groups, or concerned citizens.
- Public values reflect the broad attitudes of society about environmental risks and risk management.

One purpose of an EPA risk assessment and re-registration analysis is to determine precautions that may be taken to reduce the level of risk to humans and the environment. In addition to stipulations on the use of Naled already determined in previous registration endeavors, the EPA in 2002 introduced three additional requirements designed to mitigate risk to non-target species. They are (EPA 2002):

- Reduce application rates for control of black fly from 0.25 to 0.1 lbs/ai/A, and reduce rates on peaches and almonds from 2.8 to 1.875 lbs/ai/A.
- Require buffer zones around permanent bodies of water to reduce runoff.
- Establish spray setbacks to reduce spray drift for agricultural uses.

Though these requirements largely target agricultural use of Naled, typically at higher concentrations than would be permitted for mosquito control, Naled at all permitted concentrations will continue to have a level of impact on non-target terrestrial invertebrates, if only in the short term. Despite the fact that a limited number of studies indicate a rebound of non-target insect abundance in a relatively short period of time, the impact of a short term loss of an important component of the food web is unknown. Other potential shifts in ecological process are not understood. Additionally, Wildlife Action Plans from numerous states express concern over the potential impacts of a range of mosquito control techniques, especially chemical control on non-target species, including Delaware (DDFW 2006), New Jersey (NJDFW 2008), Virginia (VDGIF 2005), New York (NYDEC 2005), Maryland (MDNR 2005), North Carolina (NRWRC 2005) Florida (FFWCC 2005), New Hampshire (NHFGD 2005), Rhode Island (RIDFW 2005), Maine (MDIFW 2005), Connecticut (CDEP 2005), Vermont (VDFW 2005), and Massachusetts (MEOEA 2006).

Despite the EPA's having gone through the risk assessment process, and having licensed the use of Naled for mosquito control, using specific tools, under specific conditions, the refuge manager must adhere to additional standards, policies and laws specifically governing the management of National Wildlife Refuges. They include:

- National Wildlife Refuge Improvement Act of 1997
- Biological Integrity, Diversity, and Environmental Health Policy (USFWS 2001)
- Appropriate Refuge Uses Policy (USFWS 2006a)
- Compatibility Policy (USFWS 2000)
- Mission of the National Wildlife Refuge System (USFWS 2006b)
- Prime Hook National Wildlife Refuge Purposes.

Within the context of refuge specific laws and policies, use of chemical pesticides, depending on circumstances, may materially interfere with and detract from the fulfillment of the Refuge System mission and the purposes of the refuge.

Due to the affects of adulticides on non-target terrestrial organisms, and the potential effects on ecological processes, adulticides including Naled, may only be used on lands owned and managed by Prime Hook National Wildlife Refuge if there is a documented public health emergency or as mandated by the Secretary.

Therefore, all further discussion of mosquito chemical control in this CD will be limited to Bti or Methoprene.

Open Marsh Water Management

The Delaware Mosquito Control Section, under Service permits, has controlled mosquitoes on the refuge since its establishment in 1963. Until 1995 Temephos (Abate) was the primary larvicide applied on Prime Hook marshes, while naled (Dibrom) and resmethrin (Scourge) were the primary adulticides used.

Today, DMCS's preferred method of control for mosquitoes is to use a source reduction technique of Open Marsh Water Management (OMWM). OMWM is a method for controlling salt-marsh mosquitoes using physical alternations of marsh habitat. Ponds and ditches are selectively excavated in order to create unsuitable environs for mosquito production while creating suitable habitat for larvivorous fishes. Such biological controls are effective in reducing mosquito production by 95% in treated areas (DNREC 2008).

Extensive OMWM systems have been installed on approximately 1,350 refuge acres from 1980 to 2002. The refuge participated in a pilot study beginning in 1980 to demonstrate OMWM efficacy was initiated by excavating a 6-acre treatment site parallel to a 6-acre control site. Four years later a 90 to 99% reduction in mosquito production was recorded by DMCS in the treatment site. An Environmental Assessment to conduct OMWM on the refuge was then completed in 1988 to treat 960 acres of salt marsh in Unit I and 430 acres in Unit IV. This work was completed in 1994 and 1,880 acres were removed from the mosquito pesticide spraying program. In 2001, DMCS returned to Unit I to excavate an additional 10.2 acres (3.2 acres of ponds and 7.0 acres of radial ditches) removing an additional 362 acres from the spray program.

The OMWM treated areas at the refuge were once grid ditched by the Civilian Conservation Corps (CCC) in the 1930's as a mosquito control project. The objectives of the two control methods differ in that grid ditching attempted to reduce the water table, thereby draining suitable mosquito breeding sites, while OMWM functions by creating reservoirs (maintaining or increasing water coverage) for mosquito eating fish. Grid ditching at that time likely did more damage to the marsh than OMWM. Nevertheless, OMWM does, to some measurable degree, alter the marsh hydrology and subsequently, the plant communities the marsh supports.

Most management options involve tradeoffs. In terms of Service Trust species, for example, a marsh receiving an OMWM treatment is likely to increasingly support beds of submerged aquatic vegetation, an important waterfowl food, and increased density and access to small fish by wading birds. In terms of tidal wetland or hydrologic function, ditching can alter the flooding regime and degree of saturation. OMWM eliminates net emergent marsh acreage by converting these areas to open water. Evapotranspiration rates are impacted. OMWM construction also introduces temporary bare areas which may increase the spread of invasive plant by creating areas of exposed soilsthat can be invaded by non-native plants. In some cases, marsh elevations have been raised in areas of sidecast material. As a result, marsh plant communities are altered. OMWM, therefore, alters the biological and structural integrity of the marsh, may diminish physical and biochemical tidal wetland functions and values, and therefore may not meet the criteria of the BIDEH policy.

Furthermore, preliminary data from marsh accretion monitoring at Forsythe NWR, New Jersey, where nearly all marshes were grid ditched in the 1930's, indicate that marshes with OMWM treatments and grid ditched marshes may be accreting at different rates (Kevin Holcomb, pers. comm.). The mechanism/s that would influence variable accretion rates within this system is not well understood, but is likely due to water movement across the marsh and rates of sediment deposition. Another likely factor relates to the ability of marsh vegetation to accumulate organic material (peat). It is important to determine if the structural or biological effects of OMWM treatments are detrimental to marsh accretion rates, and under what conditions, since the accretion process is vital for tidal marshes to persist in light of rising sea levels.

Despite the fact that OMWM appears to create a marsh that is less drained than a grid-ditched system, the refuge believes that BIDEH principles call for minimizing ditching or artificial pond creation in a saltmarsh. However, the refuge will continue to evaluate the merits of creating OMWM systems in formerly grid ditched marshes, and understanding the tradeoffs between allowing OMWM activity (e.g. reduced threats to human health, but potential impairment of marsh accretionary and hydrologic processes) and leaving marshes unaltered. Refuges in the Northeast will be installing wetland surface elevation monitoring stations inside and outside OMWM treatments, using Surface –Elevation Tables (SETs), and comparing marsh surface trajectories to local rates of sea level rise, to address some of the uncertainty regarding the potential effects of OMWM.

Additionally, the refuge has a concern regarding the potential detrimental effect of OMWM on secretive marsh birds of conservation concern. The Service is concerned about providing quality habitat for obligate saltmarsh passerines such as the Seaside Sparrow and Saltmarsh Sharp-tailed Sparrow, both of which are listed as "Birds of Conservation Concern" . Saltmarsh Sharp-tailed Sparrow is described as Vulnerable on the IUCN Red List. Seaside Sparrow is listed as a priority species in the Bird Conservation Region 30 list.

The Delaware Wildlife Action Plan (DNREC 2006) states, *Published reports indicate few effects from this (OMWM) management on an array of species and habitat measures. However, there was sufficient concern about OMWM impacts on black rail – a possible indicator species for Tidal High Marsh – to lead to a cessation of this practice in Maryland in the early 1990s. Circumstantial evidence from at least one site in Delaware supports this concern, and the issue warrants further study.*

The refuge is therefore concerned about potential negative impacts to secretive marsh birds, as well as the uncertainty of the effect of OMWM on marsh accretion rates (see CCP/EIS for further discussion of SLR). The refuge has concluded that while currently existing OMWM projects may be maintained as a non-pesticide alternative to mosquito population control, these existing OMWM projects may not be expanded nor any new projects initiated on refuge lands until the effect of OMWM on refuge marsh accretion is better understood. The refuge will also seek to support additional studies that address OMWM effects on obligate saltmarsh passerines. At least three to five years of additional research OMWM treatments will be conducted before decisions will be made to construct new OMWM treatment sites in previously grid-ditched marshes. Excavations in existing OMWM systems will be permitted for maintenance purposes when there are obvious, quantifiable problems associated with the mosquito control function of these systems, when OMWM systems have structurally failed, or when increased mosquito production levels are experienced.

The refuge values intact emergent wetlands with a high degree of functional integrity. Ultimately, as new research and monitoring sheds light on refuge marsh accretion rates and obligate salt marsh breeding bird health, the refuge may determine that filling extant grid ditches and OMWM systems, and restoring intact marsh, may be necessary to allow refuge tidal wetlands to keep pace with SLR.

Integrated Pest Management(IPM) Approach

We are incorporating an improved IPM approach to mosquito breeding problems and limiting chemical interventions, integrating the existence of multiple natural predator populations found in functional refuge wetland habitats, and using strategies to preserve natural control agents. There are two ways to mitigate anticipated negative impacts of IPM to natural mosquito predators:

- Reduce the use of adulticides
- Increase threshold values that trigger chemical intervention as a whole.

DMCS currently uses thresholds to determine how, when, and where to conduct mosquito control treatments. It is likely that these thresholds may require revision under the Mosquito Management Plan to bring them in line with refuge policies.

Implementing more effective pest management strategies for mosquito control can be achieved by using a tiered risk-assessment decision-making process that would reduce the use of adulticides until a documented high risk situation occurs (*Federal Register 2007*). In the past mosquito breeding data did not take into account the presence of natural predators. Balanced predator-prey populations can limit mosquito production and if vertebrate and invertebrate predator populations are adequate and in place to control mosquitoes, thresholds for chemical use should be higher, especially in low health risk situations (*Federal Register 2007*).

In summary, the refuge will not use adulticides solely for nuisance relief. Bti products will be employed over Methoprene products, when possible. By favoring the larvicide that would have the least adverse impacts on nontarget invertebrates, fewer disruptions to food webs critical for migratory birds and decrease lethal effects on natural mosquito predators, such as larval forms of odonates, hemipterans, and coleopterans will be experienced.

(e) Why is the use being proposed?

Who is Requesting the Use

DMCS, under Service permits, has conducted mosquito management on the refuge since its establishment in 1963. DMCS is under the Delaware Division of Fish and Wildlife and supervised by the Department of Natural Resources and Environmental Control. DMCS is mandated to *"take all necessary and proper steps and measures for the eradication of mosquitoes, including but not limited to source reduction methods that alter or eliminate habitats of immature mosquitoes, biological controls such as native fish stocking, and the application of insecticides by air or ground to control immature or adult mosquitoes, all done in order to effect nuisance relief, to protect public health, and to help avoid adverse impacts to local economies from severe mosquito infestations…"* (State of Delaware Mosquito Control's Enabling Statute: Delaware Code Title 16, Chapter 19).

Three other pertinent parts of the Mosquito Control's Enabling Statute (in State Code) include:

- "*Treat as nuisances all stagnant pools of water or other breeding places of mosquitoes to help protect the public's well-being and health.*"
- "*Enter upon land, whether privately-owned or not, for purpose of determining the breeding places of immature mosquitoes or occurrence of adult mosquitoes, and treat with proper means all such breeding places or adult mosquito populations wherever situated, doing no unnecessary damage.*"
- "*Control measures taken for eradication of mosquitoes shall be, to the extent practicable, not injurious to pets, livestock or wildlife.*"

The State's mandate to "take all necessary and proper steps and measures for the eradication of mosquitoes", comes in direct conflict with the laws and policies of the National Wildlife Refuge System which is designed to direct the conservation and management of the nation's limited biological resources, i.e. the National Wildlife Refuge Improvement Act of 1997, the Biological Integrity, Diversity, and Environmental Health Policy (USFWS 2001), Appropriate Refuge Uses Policy (USFWS 2006a), Compatibility Policy (USFWS 2000), the Mission of the National Wildlife Refuge System (USFWS 2006b), and the purposes for which Prime Hook National Wildlife Refuge was established. Based on these Service mandates, we have eliminated the use of adulticides on the refuge unless there is a documented public health emergency or as mandated by the Secretary. However, where and when appropriate, the refuge will actively cooperate with DMCS based on these directives and the sound professional judgment of the refuge manager, as directed by Compatibility Policy.

National Wildlife Refuge Mosquito Control Policy

The Service's interim National Wildlife Refuge System Mosquito Management Guidelines (USFWS 2005), state *"when necessary to protect human, wildlife, or domestic animal health, the Service will reduce mosquitoes associated with health threats using an integrated pest management (IPM) approach, including when practical, compatible, non-pesticide actions that reduce mosquito production. However, except in officially determined health emergencies documented by the State Dept. of Health, any procedure the Service uses to reduce mosquito production will meet compatibility requirements as found in 603 FW 2, must not materially detract from refuge purposes, and must give full consideration to the safety and integrity of non-target organisms and communities, including federally listed threatened and endangered species."*

Mosquito-borne Disease History in Delaware
There are two mosquito-borne viral diseases historically or currently endemic/enzootic on the Delmarva Peninsula, including Delaware: Eastern Equine Encephalitis (EEE), and West Nile Virus (WNV). Both are zoonotic diseases maintained in wildlife that only secondarily affect humans.

Eastern Equine Encephalitis
The more serious of the two diseases for humans is EEE, although it is relatively rare. Nationwide (Figure 1), the Center for Disease Control reports only 257 cases of neuroinvasive EEE over the period 1964-2009, although the mortality rate for those contracting the disease is high (Please refer to: *http://www.cdc.gov/ncphi/disss/nndss/casedef/arboviral_current.htm* for description of neuroinvasive EEE). The most recent EEE activity in humans in Delaware was in the 1970's, when 3 cases were identified in the state. There have been no confirmed human cases of EEE in Delaware since 1979 (DHSS 2009). However, a few mosquitoes, sentinels, or veterinary animals have tested positive for the EEE virus somewhere on the Delmarva Peninsula nearly every year since 2003, indicating that the virus is being maintained within the wildlife cycle (Appendix A).

Figure 1. Eastern Equine Encephalitis Virus Neuroinvasive Disease Cases Reported by State, 1964-2008

EEE is an encephalitis virus that routinely occurs in songbirds but for the most part is not fatal to wild birds. It is circulated by a difficult-to-control woodland mosquito species that feeds exclusively upon songbirds. Salt marsh or floodwater mosquitoes biting infected birds can then transmit the disease to humans or horses. The public health risk from EEE is greatest from early August through the first killing frost. It is not unusual to find a few positive tests for EEE in sentinel chickens, or to have EEE horse fatalities each year. It should be noted however that an effective vaccine is available for horses, though many horse owners choose not to have their animals vaccinated.

West Nile Virus
West Nile Virus (WNV) is a virus that mainly infects birds but is also known to infect skunks, squirrels, and bats. The main route of human infection is through the bite of an infected mosquito. The virus is transmitted through mosquito vectors with birds serving as amplifying hosts, developing sufficient viral levels to transmit the infection to other biting mosquitoes which go on to infect more birds. Robins and the American crow are the most common bird carriers. Primary WNV vectors in Delaware are *Culex pipiens* and the subspecies *C. quinquefasciatus* in fresh water, and *Culex salinarius* in saltmarsh/brackish-water.

For those humans that experience severe illness following transmission by an infected mosquito, WNV interferes with normal central nervous system functioning and causes inflammation of brain tissue, potentially resulting in death. Unlike some of the tick transmitted diseases, there is no scientific evidence indicating that people can be chronically infected with WNV. What remain in a person's body for long periods of time are antibodies

and "memory" white blood cells (T-lymphocytes) that the body produces to the virus. These antibodies and T-lymphocytes last for years, and may last for the rest of a person's life. Both antibodies and "memory" T-lymphocytes provide future protection from the virus. It is assumed that immunity will be lifelong; however, it may wane in later years (*http://www.cdc.gov/ncidod/dvbid/westnile/qa/transmission.htm*).

In areas where the virus is circulating, very few mosquitoes are infected with the virus. Even if the mosquito is infected, less than 1% of people who get bitten and become infected, will get severely ill. The chance you will become severely ill from any one mosquito bite is extremely small. Less than 1% of all (including people with asymptomatic infections) people who become infected with WNV will develop severe illness *http://www.cdc.gov/ncidod/dvbid/westnile/qa/cases.htm*). A study published by the CDC in 2009 in the journal, Emerging Infectious Diseases, calculated the prevalence of WNV in the US population to be approximately 1%, or approximately 3 million total infections during the period 1999-2008 (Planitzer et al 2009).

WNV was first recognized in the US in 1999. Delaware's first confirmed human case of WNV occurred in 2002. During 2003, 17 human cases were reported, of which two resulted in deaths. There were no human cases in 2004 and 2006,2 were reported in 2005, 1 in 2007 and 1 in 2008, for a total of 22 cases in 8 years. On the whole the US reported 29,532 cases during the same period, 2002-08, with a total of 1,144 deaths. As a comparison, Dushoff et al. (2006) estimated that the average number of deaths from seasonal flu, and associated complications in the U.S. was 41,400 / year (95% confidence interval: 27,100, 55,700) over the period 1979–2001.

These WNV numbers reflect both mild and severe human disease cases that have been reported to ArboNET by state and local health departments. ArboNET is the national, electronic surveillance system established by CDC to assist states in tracking WNV and other mosquito-borne viruses. The high proportion of neuroinvasive disease cases among reported cases of WNV disease reflects surveillance reporting bias. Serious cases are more likely to be reported than mild cases because mild cases can resemble other diseases, e.g. fever, headache, tiredness, and body aches. Also, the surveillance system is not designed to detect asymptomatic infections (*http://www.cdc.gov/ncidod/dvbid/westnile/surv&controlcasecount06_detailed.htm*). Therefore, as discussed above, the numbers reported in the US as a whole, 29,532, is considered well below the true number of humans exposed to the virus, which is calculated to be approximately 3 million. Additionally, multiple birds and horses tested positive during this timeframe (Appendix A).

Disease Surveillance

DMCS and the Division of Public Health have been conducting mosquito-borne disease surveillance and mosquito monitoring programs for the past 27 years in Delaware. Twenty-three sentinel chicken stations and 36 permanent adult mosquito traps monitor mosquito-borne disease activity throughout the state. Additional mobile mosquito traps are used when increased surveillance is warranted. Weekly blood samples are collected from the chickens and analyzed for the presence of EEE and/or WNV by the Division of Public Health laboratory.

Mosquito monitoring conducted by state mosquito experts indicates that 57 species of mosquitoes occur in Delaware of which 19 species pose disease-vector problems. These species include 11 floodwater species, 4 woodland species, and 4 predominantly urban species, i.e., mosquitoes that are mostly found in urban settings as container breeders, or in sewer catch basins, and storm water and waste water lagoons. All 19 species have been found to be WNV-positive, though not all have been found to be competent vectors of WNV (Sardelis 2001). Four species are also EEE vectors, with the common salt marsh mosquito *(Ochlerotatus sollicitans)* being a primary EEE vector. The common house mosquito *(Culex pipiens)* is the suspected primary WNV vector. These species are the target species for mosquito and mosquito-borne disease management on the refuge and are listed below:

Open Floodwater Species

Ochlerotatus sollicitans – Common saltmarsh mosquito (primary EEE vector)
O. cantator – Brown saltmarsh mosquito
O. taeniorhyncus – Black saltmarsh mosquito (EEE vector)
Aedes vexans – Floodwater mosquito (EEE vector)
Culex salinarius – Unbanded or "Little Sal" saltmarsh mosquito
Coquilletidia perturbans – Cattail or irritating mosquito (EEE vector)
Anopheles punctipennis – Mottled-wing mosquito or "Punkies"
A. quadrimaculatus – Common malaria mosquito or "Quads"
A. bradleyi – "Brads"

A. walkeri
Psorophora columbiae – Glades mosquito
P. ciliate – "Gallinipper"

Woodland Species
Ochlerotatus canadensis – Woodland pool mosquito
O. triseriatus – Eastern treehole mosquito
O. grossbecki
Psorophora ferox – White-footed woods mosquito

Urban Species
Aedes albopictus – Asian tiger mosquito or "Albies"
Ochlerotatus japonicus – Japanese mosquito
Culex pipiens – Common house mosquito

AVAILABILITY OF RESOURCES:

The administration of mosquito and mosquito-borne disease management on the Prime Hook NWR unit of the Coastal Delaware National Wildlife Refuge Complex, the following staffing costs are estimated:

Staffing Needs To Conduct Use Of Mosquito Management On PHNWR

Position	Involvement	FTE	Cost
Refuge Manager	General Oversight	0.05	$5,000
Wildlife Biologist	Field visits and reviews Mosquito Management Plan development and implementation, preparations of PUPS, SUPS, and Pesticide Use reporting, oversight of mosquito-borne disease monitoring, vector control activities, and field reviews of OMWM systems. Involvement in coordination and/or oversight of mosquito monitoring activities.	0.1	$6,750
Total FTES & Staffing Costs		**0.15 FTE**	**$11,750**

ANTICIPATED IMPACTS OF THE USE:

For a more complete analysis of the impacts of mosquito management, refer to chapter 5 of the CCP/EIS.

There are many potential negative impacts of mosquito management activities that pose threats to the biological integrity, diversity and environmental health of refuge lands and waters, and detract from the conservation of the refuge's resources of concern. Two forms of chemical mosquito control are permitted.

Bti *(Bacillus thuringiensis var. israelensis)* is a stomach poison that must be ingested by the larval form of the insect in order to be effective. Bti is an EPA toxicity class III general use pesticide and is practically non-toxic to animals (Kamarin 1997). The issue of Bti concentration is important with regard to impacts on nontarget organisms. Of particular concern is the potential for Bti to kill midge larvae. Chironomid (non-biting midge) larvae are often the most abundant aquatic insect in wetland environments and form a significant portion of the food base for other wildlife (Batzer et al. 1993; Cooper and Anderson 1996; Cox et al. 1998). Laboratory and field studies have shown that Bti is toxic to some larval chironomids, particularly those species which are filter feeders or grazers. Negative impacts on chironomid density/biomass could have deleterious effects on wetland/wildlife food webs and could also lower biodiversity.

In judging the potential for adverse ecological effects of Bti applications, one should consider the non-target aquatic organisms of concern that would be impacted from the potential loss of both mosquito and chironomid larvae. The refuge's mosquito management plan will apply this scientific information for creating the refuge's thresholds for treatment, types of control, and application plans.

The other form of chemical mosquito control is Methoprene, a contact insecticide that does not need to be ingested like Bti (Tomlin 1994). Methoprene products are more toxic than Bti products, killing a wider range of non-target larval insects. This makes Methoprene more likely to cause disruptions to invertebrate food webs. The use of Methoprene as a mosquito larvicide should have no direct adverse effects on populations of endangered birds, mammals, or fish.

Bti (EPA 1998) and Methoprene (EPA 2008) are non-toxic to vegetation; there may be indirect impacts via loss of insect pollinators. However, OMWM excavations have resulted in alteration of the physical structure of refuge salt marsh habitats. Although OMWM reduced the amount of chemicals used for mosquito control, there have been negative impacts to ecosystem function. Inappropriate spoil management has resulted in areas being converted to Phragmites and/or woody vegetation, while other areas can experience excessive draining and lowering of water tables. These conditions resulted in loss of high marsh zones with patches of desirable vegetation of *Spartina patens* being converted to less desirable plants like *Iva frutescens, Baccharis halimifolia,* and *Phragmites australis.*

Bti and Methoprene are non-toxic to birds at EPA approved application rates. The extent to which the use of Bti and Methoprene will limit the food resources for individual birds or local avian populations is unknown. IPM strategies will be designed to limit impacts to local invertebrate populations when the mosquito-borne disease risk to humans is low.

In giving full consideration to the protection and integrity of non-target organisms and communities, the greatest concerns the Service has with chronic mosquito chemical use is the potential degradation of biological integrity and diversity and disruption of vital food webs. Larvicides can adversely affect non-target insects, especially chironomids.

The Service's concerns that non-target effects of larvicides and other environmental contaminants could significantly reduce invertebrate populations that are key food resources for waterfowl, shorebirds, fish, and amphibians, have led to additional refuge-specific studies. These studies have provided staff with considerable information about dominant invertebrate taxa present in refuge salt marsh, impounded marsh areas, stable pond environments, and creek habitats from several years of invertebrate community studies (Pinkney et al.1998, Cook and Hill 2000, 2001, McGee et al 2003).

The refuge has no jurisdiction over mosquito control on lands outside the refuge boundary. It is likely that spray drift from mosquito control operations outside of the boundary will enter the refuge from the 3 neighboring barrier island communities. Since the State employs best management practices, and follows the EPA approved label, the Service expects impacts to refuge resources to be minimal.

The Service is proposing to implement a less detrimental pest management strategy for mosquito control that would prevent the use of adulticides until a documented high risk situation occurs. Adulticides (specifically Naled products) are EPA Toxicity Class I (Highly Toxic) general use pesticides. The EPA considers the active ingredient Naled, based on acute toxicity data, to be moderately to highly toxic to birds, moderately toxic to mammals, highly toxic to honey bees, moderately to very highly toxic to freshwater fish, and very highly toxic to freshwater aquatic invertebrates (EPA 2002). The prohibition of the use of adulticides, except in cases of declared health emergency or under the direction of the Secretary of the Interior, would decrease the potential effects on non-target organisms throughout the refuge, particularly invertebrates.

While the estimated increase in costs due to increasing adulticide use off-refuge is 24 percent, the Delaware Mosquito Control Section indicated the potential concern by residents and visitors in the 3 bayfront communities over increased use of pesticides in residential areas. The repeated adulticide applications to maintain mosquito populations at past levels could increase pesticides (adulticide) in the communities by 165 percent. Although DMCS projects a potential increase in adulticide use in populated areas 2.5 times the current rate, DMCS would still adhere to EPA approved application rates.

DMCS states that even with the above mosquito control it may not be able to decrease the adult mosquito population to the same level as with the application of adulticides on the refuge. The size of the resulting adult

mosquito population with the adjusted control measures is unknown. If the adult mosquito population reaches a certain criteria level, it is possible for quality of life and human health protection to decrease. To date, the criteria level has not been defined. It is unknown whether the mosquito population would reach a certain level, in any given year, which would impact the behavior of the surrounding community or its tourist industry. Potential risks to human health include EEE and WNV which are both enzootic/endemic within all areas of Delaware.

There are many potential negative impacts of mosquito management activities that pose threats to the biological integrity, diversity and environmental health of refuge lands and waters, and detract from the conservation of the refuge's resources of concern.

PUBLIC REVIEW AND COMMENT:

This compatibility determination is part of the draft CCP/EIS. Public notification and review include a notice of availability published in the *Federal Register,* a 60-day comment period, and local media announcements.

DETERMINATION (CHECK ONE BELOW):

_____ Use is not compatible

__X__ Use is compatible, with the following stipulations

STIPULATIONS NECESSARY TO ENSURE COMPATIBILITY:

General

- Except during declared human health emergencies where actions need to be taken quickly, we must give full consideration to the biological integrity of nontarget populations when considering compatible chemicals used for mosquito control or correcting faulty OMWM systems.

- Habitat manipulations for mosquito management such as draining or maintaining high water levels inappropriate for other wildlife are prohibited, as they conflict with habitat and wildlife management goals and objectives as stated in the CCP and EIS. Exceptions will be made during exigent circumstances, where the Secretary determines it is necessary to temporarily suspend, allow, or initiate any activity on the refuge to protect the health and safety of the public.

- Current mosquito population data obtained from on-refuge monitoring and consideration of the presence of natural mosquito prey species in mosquito breeding areas are necessary before the refuge will allow larvicide treatments for mosquito control on the refuge.

- Re-excavations of current OMWM systems will be allowed once historic and current mosquito breeding data has been evaluated and field reviews have been conducted to assess soil types and other factors that demonstrate probable cause for failure of these systems.

Who does the control?

- DMCS will assume all monetary costs and perform all activities associated with mosquito monitoring, disease surveillance and treatment. Service personnel may accompany DMCS personnel to examine exact locations of heavy mosquito breeding problems to ascertain presence of non-targets and/or mosquito predator species in these areas, as needed.

- Disease surveillance can be conducted adjacent to the refuge to identify existing health threats or document high risk disease situations. Disease surveillance adjacent to the refuge should be within flight range of vector species found on the refuge. DMCS will be responsible to monitor disease activity in reservoir hosts for pathogens or antibodies, and/or collect adult mosquito samples in same-genus pools for virus or any other monitoring it requires to substantiate a high risk disease situation on or near the refuge.

- In the event of a documented risk to human health, the Service will allow DMCS to control mosquitoes on the refuge, per Mosquito Management Plan Protocols, once established, using the least toxic alternatives, including the least toxic adulticides.

- Immediately after any pesticide application, additional mosquito population monitoring will be required to assess the effectiveness of the pesticide treatment(s).

- DMCS should only consider mosquito control treatment in developed areas where humans are present or at the source of nuisance complaints.

Risk Assessment and Mosquito Management Thresholds

- The refuge will collaborate with other Federal and state public health and vector control agencies to identify refuge-specific mosquito-borne disease health threat categories, with corresponding refuge responses. Responses will include intensifying surveillance activities or initiating chemical interventions based on local mosquito population numbers categorized into various threat levels based on disease risk assessments in a decision-making matrix.

- Action thresholds that trigger chemical interventions will incorporate various factors listed in Service Policy 601 FW 7, Exhibit 3 and will be developed with refuge staff, state mosquito control section, public human health services and vector control agencies. Thresholds must be genus and life-stage specific and be related to the refuge decision-making response matrix.

- Numerical action thresholds should be established in collaboration with Federal and State mosquito and public health agencies and identified in the mosquito management plan as shown in 601 FW 7, Exhibit 2.

- All decisions for chemical interventions to control mosquitoes will be based on meeting or exceeding predetermined mosquito abundance and, or disease thresholds.

- Populated areas located off-refuge should be considered for mosquito control treatment before refuge areas.

Chemicals used as Mosquito Control Agents

- The preferred control agents authorized for use are Bti products. Bti is preferred over Methoprene due to its higher insect target specificity, fewer negative impacts on natural mosquito predators, and much lower impacts on other non-target invertebrate species and communities.

- Use of Methoprene will be limited to situations in which Bti products are not sufficient for control of the larval stages present. Only formulations with short term residuals (5-10 days) may be used for larval mosquito control. Use of Methoprene products with long term residuals such as Altosid XR-G, 30-Day Briquettes, or XR Briquettes will not be permitted.

- Adulticides including Naled, may only be used on lands owned and managed by the refuge if there is a declared public health emergency, or as mandated by the Secretary.

Monitoring and Disease Surveillance

- The use of caged sentinel chickens on the refuge for reservoir host surveillance is discourageddue to the risk of spreading disease to wild birds.

Sensitive Areas

- Terms and conditions of the Special Use Permit will be subject to annual modification(s) if disturbance or other impacts are considered to interfere with or detract from the fulfillment of the purposes of the refuge or System mission.

Permits

- Mosquito control will be authorized if needed and requested by DMCS through a Special Use Permit. In addition to operational conditions, permit conditions will stipulate that all chemical use will be carried out in conformance with pre-approved Pesticide Use Proposals and Section 7 Endangered Species consultations.

JUSTIFICATION:

The refuge has worked cooperatively with DMCS to control mosquitoes on Prime Hook NWR since 1963. After a review of these activities, the refuge has determined that continuing some activities of the past would interfere with and materially detract from the mission of the refuge System and purposes of the refuge; and from conserving and protecting focal species and resources of concern as reflected in the refuge's new goals and objectives identified in the Comprehensive Conservation Plan and EIS.

Eliminating the use of adulticides during low disease risk situations, using Methoprene products conservatively, improves our Integrated Pest Management (IPM) mosquito strategy, reduces negative wildlife consequences and improves the protection and conservation of focal species.

Biological mosquito control in the form of OMWM (limited to existing maintenance) is a more permanent mosquito control technique than chemical interventions and significantly reduces mosquito production. With hundreds of acres of OMWM systems currently in place, significant reduction of mosquito production within most of the refuge's salt marsh habitats has been documented. Although OMWM reduced the amount of chemicals used for mosquito control, there have been negative impacts to ecosystem function and therefore needs to be evaluated before new areas are considered. Larviciding with BTI is the second most environmentally benign method of controlling mosquitoes, since a relatively small group of insects are susceptible to the toxin. However, the refuge recognizes that Bti exhibits limited efficacy under certain conditions; under those conditions Methoprene would be the prudent alternative.

The use of Bti and Methoprene may receive periodic compatibility review if future studies bring more information to light on the ecological impacts of mosquito control. In addition, new chemicals may become available that could be used on the refuge and would be evaluated at that time for potential use.

The stipulations above address the Service's laws and System policies to maintain, enhance, and restore biological integrity, diversity, and environmental health, as well as protect the public from unpredictable mosquito-borne health threats.

This activity will not materially interfere with or detract from the mission of the National Wildlife Refuge System or the purpose for which the Refuge was established.

SIGNATURE:

Refuge Manager: _____ _____
(Signature) (Date)

CONCURRENCE:

Regional Chief: _____ _____
(Signature) (Date)

MANDATORY 15 YEAR RE-EVALUATION DATE: _____

Appendix A. **Incidence of West Nile and EEE Virus' on the Delmarva Penninsula 2002-2008**

West Nile Virus 2008

State	Bird	Total Human Cases	Total Human Deaths	Mosquito	Sentinel	Veterinary
DE (statewide)	4	1	0		18	
MD (eastern shore)	0	1	0		0	
VA (eastern shore)	0	0	0		0	
DELMARVA	4	2	0		18	

Eastern Equine Encephalitis 2008

State	Bird	Total Human Cases	Total Human Deaths	Mosquito	Sentinel	Veterinary
DE (statewide)	0	0	0	0	3	0
MD (eastern shore)	0	0	0	0	0	0
VA (eastern shore)	0	0	0	0	0	0
DELMARVA	0	0	0	0	3	0

West Nile Virus 2007

State	Bird	Total Human Cases	Total Human Deaths	Mosquito	Sentinel	Veterinary
DE (statewide)	10	1	0	0	20	0
MD (eastern shore)	0	1	0	0	0	0
VA (eastern shore)	0	0	0	0	20	0
DELMARVA	10	2	0	0	20	0

Eastern Equine Encephalitis 2007

State	Bird	Total Human Cases	Total Human Deaths	Mosquito	Sentinel	Veterinary
DE (statewide)	2	0	0	0	2	0
MD (eastern shore)	0	0	0	1	0	0
VA (eastern shore)	0	0	0	0	0	0
DELMARVA	2	0	0	1	2	0

Appendix A. **Incidence of West Nile and EEE Virus' on the Delmarva Penninsula 2002-2008**

West Nile Virus 2006

State	Bird	Total Human Cases	Total Human Deaths	Mosquito	Sentinel	Veterinary
DE (statewide)	17	0	0	0	38	1
MD (eastern shore)	0	0	0	0	0	0
VA (eastern shore)	0	0	0	0	0	0
DELMARVA	17	0	0	0	38	1

Eastern Equine Encephalitis 2006

State	Bird	Total Human Cases	Total Human Deaths	Mosquito	Sentinel	Veterinary
DE (statewide)	0	0	0	0	0	0
MD (eastern shore)	0	0	0	0	0	0
VA (eastern shore)	0	0	0	0	0	0
DELMARVA	0	0	0	0	0	0

West Nile Virus 2005

State	Bird	Total Human Cases	Total Human Deaths	Mosquito	Sentinel	Veterinary
DE (statewide)	2	1 (2*)	0	0	4	0
MD (eastern shore)	1	0	0	1	0	0
VA (eastern shore)	0	0	0	0	0	0
DELMARVA	3	1 (2*)	0	1	4	0

Eastern Equine Encephalitis 2005

State	Bird	Total Human Cases	Total Human Deaths	Mosquito	Sentinel	Veterinary
DE (statewide)	0	0	0	0	2	1
MD (eastern shore)	0	0	0	0	0	0
VA (eastern shore)	0	0	0	0	0	0
DELMARVA	0	0	0	0	2	1

West Nile Virus 2004

State	Bird	Total Human Cases	Total Human Deaths	Mosquito	Sentinel	Veterinary
DE (statewide)	21	0	0	0	11	0
MD (eastern shore)	8	3	0	10	0	1
VA (eastern shore)	0	1	0	0	0	0
DELMARVA	29	4	0	10	11	1

Eastern Equine Encephalitis 2004

State	Bird	Total Human Cases	Total Human Deaths	Mosquito	Sentinel	Veterinary
DE (statewide)	0	0	0	0	4	4
MD (eastern shore)	1	0	0	0	0	1
VA (eastern shore)	0	0	0	0	0	0
DELMARVA	1	0	0	0	4	5

West Nile Virus 2003

State	Bird	Total Human Cases	Total Human Deaths	Mosquito	Sentinel	Veterinary
DE (statewide)	114	17	0 (2*)	0	34	63
MD (eastern shore)	12	6	1	23	0	45
VA (eastern shore)	7	0	0	0	0	1
DELMARVA	133	23	1 (3*)	23	34	109

Eastern Equine Encephalitis 2003

State	Bird	Total Human Cases	Total Human Deaths	Mosquito	Sentinel	Veterinary
DE (statewide)	0	0	0	0	8	0
MD (eastern shore)	0	0	0	10	0	4
VA (eastern shore)	0	0	0	0	0	0
DELMARVA	0	0	0	10	8	4

West Nile Virus 2002

State	Bird	Total Human Cases	Total Human Deaths	Mosquito	Sentinel	Veterinary
DE (statewide)	211	1	0	6	11	22
MD (eastern shore)	39	0	0	0	0	2
VA (eastern shore)	0	0	0	0	0	0
DELMARVA	250	1	0	6	11	24

Eastern Equine Encephalitis 2002

State	Bird	Total Human Cases	Total Human Deaths	Mosquito	Sentinel	Veterinary
DE (statewide)	0	0	0	0	0	0
MD (eastern shore)	0	0	0	0	0	0
VA (eastern shore)	0	0	0	0	0	0
DELMARVA	0	0	0	0	0	0

VA Data compiled From: *http://diseasemaps.usgs.gov/*

MD Data provided by Kimberly C. Mitchell, Maryland Dept of Health and Mental Hygiene

DE Data provided by William H. Meredith, Delaware Mosquito Control Section

(*) represents the number reported by the CDC

603 FW 1
Exhibit 1

FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Prime Hook National Wildlife Refuge

Use: Turtle Harvesting (Trapping)

This exhibit is not required for wildlife-dependent recreational uses, forms of take regulated by the State, or uses already described in a refuge CCP or step-down management plan approved after October 9, 1997.

Decision criteria:	**YES**	**NO**
(a) Do we have jurisdiction over the use?	✔	
(b) Does the use comply with applicable laws and regulations (Federal, State, Tribal, and local)?	✔	
(c) Is the use consistent with applicable Executive orders and Department and Service policies?	✔	
(d) Is the use consistent with public safety?	✔	
(e) Is the use consistent with goals and objectives in an approved management plan or other document?		✔
(f) Has an earlier documented analysis not denied the use or is this the first time the use has been proposed?	✔	
(g) Is the use manageable within available budget and staff?	✔	
(h) Will this be manageable in the future within existing resources?	✔	
(i) Does the use contribute to the public's understanding and appreciation of the refuge's natural or cultural resources, or is the use beneficial to the refuge's natural or cultural resources?		✔
(j) Can the use be accommodated without impairing existing wildlife-dependent recreational uses or reducing the potential to provide quality (see section 1.6D. for description), compatible, wildlife-dependent recreation into the future?		✔

Where we do not have jurisdiction over the use ("no" to [a]), there is no need to evaluate it further as we cannot control the use. Uses that are illegal, inconsistent with existing policy, or unsafe ("no" to [b], [c], or [d]) may not be found appropriate. If the answer is "no" to any of the other questions above, we will generally not allow the use.

If indicated, the refuge manager has consulted with State fish and wildlife agencies. Yes ____ No ✔.

When the refuge manager finds the use appropriate based on sound professional judgment, the refuge manager must justify the use in writing on an attached sheet and obtain the refuge supervisor's concurrence.

Based on an overall assessment of these factors, my summary conclusion is that the proposed use is:

Not Appropriate ____ **Appropriate** ✔

Refuge Manager: _____ Date: _____

If found to be **Not Appropriate**, the refuge supervisor does not need to sign concurrence if the use is a new use.

If an existing use is found **Not Appropriate** outside the CCP process, the refuge supervisor must sign concurrence.

If found to be **Appropriate**, the refuge supervisor must sign concurrence:

Refuge Supervisor: _____ Date: _____

A compatibility determination is required before the use may be allowed.

603 FW 1
Exhibit 1
Page 2

JUSTIFICATION FOR A FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Prime Hook National Wildlife Refuge

Use: Turtle Harvesting (Trapping)

NARRATIVE:

The National Wildlife Refuge System Improvement Act of 1997 (P.L. 105-57) identifies six priority uses of wildlife refuges; environmental education, interpretation, hunting, fishing, wildlife observation and wildlife photography. These priority public uses are dependent upon healthy wildlife populations. Where these uses are determined to be compatible, they are to receive enhanced consideration over other uses in planning and management.

Turtle harvesting has occurred on the refuge for many years by a small number of trappers. The activity is not a priority public use, but a general and economic activity, which could be used by the refuge as a management tool. Although some turtle harvesting is for recreation, it clearly has an economic value since the resulting animal is a natural resource that can be bought, sold, or bartered. In contrast, other consumptive uses such as hunting and recreational fishing do not result, due to federal or state law, in a commodity that can be bought or sold. The meat of snapping turtles is considered a delicacy, especially in soup.

COMPATIBILITY DETERMINATION

USE:

Turtle Harvesting (Trapping)

REFUGE NAME:

Prime Hook National Wildlife Refuge

ESTABLISHING AND ACQUISITION AUTHORITY(IES):

(1) Migratory Bird Conservation Act {16 U.S.C. 715d}

(2) Refuge Recreation Act {16 U.S.C. 460 K-1}

REFUGE PURPOSE(S):

(1) "…for use as an inviolate sanctuary, or for any other management purposes, for migratory birds…" {16 U.S.C. 715d; Migratory Bird Conservation Act}

(2) "…incidental fish and wildlife-oriented recreational development" {16 U.S.C. 460k-1; Refuge Recreation Act}

(3) "the protection of natural resources" {16 U.S.C. 460k-1; Refuge Recreation Act}

(4) "the conservation of endangered or threatened species…" {16 U.S.C. 460k-1; Refuge Recreation Act}

NATIONAL WILDLIFE REFUGE SYSTEM MISSION:

The mission of the Refuge System is to administer a national network of lands and waters for the conservation, management, and where appropriate, restoration of the fish, wildlife, and plant resources and their habitats within the United States for the benefit of present and future generations of Americans.

DESCRIPTION OF USE:

(a) What is the use? Is the use a priority public use?
The use is turtle harvesting (trapping), which is primarily an economic (commercial) activity. It is not a priority public use of the National Wildlife Refuge System under the National Wildlife Refuge System Administrative Act of 1966 (16 U.S.C. 668dd-668ee), as amended by the National Wildlife Refuge System Improvement Act of 1997. Turtle harvesting was deemed compatible in the past (1994) as a management tool to reduce snapping turtle predation of waterfowl, especially ducklings.

(b) Where would the use be conducted?
Turtle harvesting through trapping is an allowable and regulated practice by the Delaware Division of Fish and Wildlife which would be conducted in designated management zones of Prime Hook Creek and Slaughter Creek/ Canal. These areas have been historically trapped for turtles.

(c) When would the use be conducted?
The use had been conducted from June 16 through August 31 of each year, which reduced the potential conflict with refuge hunting activities in the fall and winter months. However, conflicts with kayaker/canoers and anglers remained, as Prime Hook Creek is a popular designation for outdoor enthusiast. The trapping season is considerably shorter than the season established by the Delaware Division of Fish and Wildlife from June 15 through May 15.

(d) How would the use be conducted?
Turtle harvesting follows Delaware State regulations with more restrictive season and refuge regulations issued through a refuge Special Use Permit (SUP). The refuge manager worked with officials of the Delaware Division of Fish and Wildlife to amend the special permit stipulations if warranted by physical conditions of the marsh and population dynamics.

Trappers were required to submit a weekly harvest report during the trapping season. The report would include data about trapping including the number of target and non-target species harvested, the refuge areas trapped, and remarks on the observation of wildlife or other noteworthy ecological information. However, the data is insufficient in determining population trends due to a lack of consistent methodologies. The trapping area is not of a representative size to compare population trends over the years.

(e) Why is this use being proposed?
In previous years, snapping turtle harvesting was considered compatible as a management tool at the refuge to reduce predation on young waterfowl, especially ducks. Some research has shown that the turtle predation has only minor impacts to local populations of waterfowl. Snapping turtles do not appear to be impacting waterfowl populations overall.

The State of Delaware currently has an unlimited harvest quota and an eleven month season which indicates the species as a whole is not in jeopardy in the State of Delaware. Harvesting of snapping turtles has also been a traditional pastime of the area for generations. No information is available on the carrying capacity of the local snapping turtle population or recommended harvestable surplus parameters that would sustain healthy populations of snapping turtles.

AVAILABILITY OF RESOURCES:

The financial resources necessary to provide and administer this use at historic levels are now available, and it is expect these resources would be available in the future. The refuge manager would provide overall administration to the program. A wildlife biologist would be required to evaluate turtle harvesting activity along with current and potential impacts on refuge resources. The biologist would also evaluate trapper data and compile reports. An administrative assistant would process permits. A refuge law enforcement officer would be required to check refuge trappers and ensure compliance with state and federal regulations.

Annual Costs:		
Refuge Manager (GS-12)	2 hrs @ $50/hr	$100
Wildlife Biologist (GS-11)	10 hrs @ $40/hr	$400
Law Enforcement Officer (GS-9)	40 hrs @ $30/hr	$1,200
Administrative Assistant (GS6)	10 hrs @ $20/hr	$200
	Total	**$1,900**

ANTICIPATED IMPACTS OF THE USE:

Direct impacts of turtle harvesting include mortality of captured individuals and on non-target species such as, other species of turtles. Historical refuge trapping records indicate that approximately 50 to 100 snapping turtles were removed each year and a decrease in snapping turtle populations was not observed. The State of Delaware has an 11 month season and an unlimited harvest quota of snapping turtles. Currently the Delaware Division of Fish and Wildlife does not feel the species is in jeopardy and therefore has no objections to the activity on the refuge (personal communications with Holly Neiterrider, DNREC 2009) especially with the abbreviated season

being proposed. No information is available on the carrying capacity of the local snapping turtle population or recommended harvestable surplus parameters that would sustain healthy populations of snapping turtles. No impact to endangered species is anticipated.

Indirect impacts may include displacing migratory birds resting and feeding in the marshes and are expected to be negligible due to the low number of permitted trappers. Conflict with priority wildlife-dependent recreational activities, particularly on Slaughter Canal and Prime Hook Creek. Affected user groups include canoers/ kayakers, anglers, wildlife observers, and photographers who will be using these same areas. .

Turtle harvesting in the proposed areas do not pose any threat to historic properties on and/or near the refuge.

Our findings indicate that there is insufficient knowledge pertaining to the target species, data, and associated research to assess cumulative impacts on wildlife resources or their habitats.

PUBLIC REVIEW AND COMMENT:

This compatibility determination is part of the draft Prime Hook CCP/EIS. Public notification and review include a notice of availability published in the *Federal Register,* a 60-day comment period, and local media announcements.

DETERMINATION (CHECK ONE BELOW):

_X_ Use is not compatible

____ Use is compatible, with the following stipulations

STIPULATIONS NECESSARY TO ENSURE COMPATIBILITY:

n/a

JUSTIFICATION:

The National Wildlife Refuge System Improvement Act of 1997 enumerated six wildlife-dependent recreational uses of refuges that are considered priorities for the Refuge System. All other recreational uses are now considered general uses. Appropriate Use Policy 603 FW1 states "General public uses that are not wildlife-dependent recreational uses (as defined in the Improvement Act) and do not contribute to the fulfillment of refuge purposes, or goals, or objectives as described in current refuge management plans are the lowest priorities for refuge managers to consider. These uses are likely to divert refuge management resources from priority general public uses or away from the responsibilities to protect and manage fish, wildlife, and plants and their habitats. Therefore, both law and policy have a general presumption against allowing such uses within the Refuge System."

The above-referenced activity is not a priority public use, but a general and economic activity, which could be used by the refuge as a management tool if warranted. Although some turtle harvesting is for recreation, it clearly has an economic value since the resulting animal is a natural resource that can be bought, sold, or bartered. In contrast, other consumptive uses such as hunting and recreational fishing do not result, due to federal or state law, in a commodity that can be bought or sold. The meat of snapping turtles is considered a delicacy, especially in soup (White, Jr. & White 2002).

Turtle harvesting provides a minimal benefit as a waterfowl management tool. Common snapping turtles have been historically thought to be detrimental to fish and waterfowl populations by predation; however, more studies are finding that their negative impact on waterfowl populations are exaggerated (White, Jr. & White 2002). Past studies of the eating habits of snapping turtles have reported the frequency of occurrence of waterfowl in the

stomach contents of these turtles to be low, ranging from 5.5% to 27% using small sample sizes (e.g., Pell, 1940; Lagler, 1943; Coulter, 1957; Hammer, 1969). Another study (Alexander 1943), which used a larger sample size, reported very low occurrence of birds, including the wood duck, in the stomach contents of snapping turtles. Coulter (1957) found that up to 13 percent of the estimated duckling population was taken by snapping turtles in Maine.

These previous studies only looked at the percent of waterfowl in the stomachs of turtles and not at the predation rate, or proportion of waterfowl ducklings preyed on by turtles. More current research conducted by Kenow et al. (2009) on the Upper Mississippi River found that the predation rate of snapping turtles on waterfowl, particularly ducklings, is minimal (2.9%) and that the predation rate of reptiles (14.2%) was lower than mammals (31.7%) and similar to that of fish (9.2%) and birds (11.7%). Abel (1992) reported attacks of snapping turtles on swan cygnets of seven to 15 pounds on Wisconsin lakes and concluded non-fatal attacks by these turtles likely cause injuries to many birds that later become infected or incapacitated.

Concerns have been raised about the effect of harvesting on snapping turtle populations and breeding size adults (Zappalorti 1995). Preliminary research in Maryland has shown that commercial harvest of snapping turtles may impact their population size structure, which could negatively affect their survivability due to life history characteristics of extended age to maturity, low annual fecundity, and low hatchling survival (Chesapeake Marshlands National Wildlife Refuge Complex Sixth Annual Science Meeting 2009).

Conclusion: Due to insufficient population data relating to the harvestable surplus of Delaware's snapping turtle population and numerous studies that support minimal predatory impacts to birds from snapping turtles, the use of turtle harvesting on the refuge is not justified as a management tool or economic use to support the refuge purpose, System mission, or refuge goals and objectives. Compatibility may be reconsidered in the future if 1) research provides new evidence that snapping turtle predation is a significant detriment to migratory birds or refuge trust resources and 2) the Delaware Division of Fish and Wildlife identifies parameters for the carrying capacity of our local snapping turtle population and a recommended harvestable surplus that sustains a healthy population of snapping turtles.

This activity will materially interfere with and detract from the mission of the Refuge System and purposes for which the refuge was established. In addition, this activity will not fulfill one or more purposes of the refuge or the Refuge System. This use is not consistent with any approved refuge management plan. The use of turtle harvesting is, therefore, determined to be not compatible with current information.

SIGNATURE:

Refuge Manager: _____ _____
(Signature) (Date)

CONCURRENCE:

Regional Chief: _____ _____
(Signature) (Date)

MANDATORY 10 YEAR RE-EVALUATION DATE: _____

LITERATURE CITED:

See CCP Bibliography.

COMPATIBILITY DETERMINATION

USE:

Federal Aviation Administration (FAA) Vortac Tower

REFUGE NAME:

Prime Hook National Wildlife Refuge

ESTABLISHING AND ACQUISITION AUTHORITY(IES):

(1) Migratory Bird Conservation Act {16 U.S.C. 715d}

(2) Refuge Recreation Act {16 U.S.C. 460 K-1}

REFUGE PURPOSE(S):

(1) "…for use as an inviolate sanctuary, or for any other management purposes, for migratory birds…" {16 U.S.C. 715d; Migratory Bird Conservation Act}

(2) "…incidental fish and wildlife-oriented recreational development" {16 U.S.C. 460k-1; Refuge Recreation Act}

(3) "the protection of natural resources" {16 U.S.C. 460k-1; Refuge Recreation Act}

(4) "the conservation of endangered or threatened species…" {16 U.S.C. 460k-1; Refuge Recreation Act}

NATIONAL WILDLIFE REFUGE SYSTEM MISSION:

The mission of the Refuge System is to administer a national network of lands and waters for the conservation, management, and where appropriate, restoration of the fish, wildlife, and plant resources and their habitats within the United States for the benefit of present and future generations of Americans.

DESCRIPTION OF USE:

This compatibility determination is for the continuation of an ongoing use. The Federal Aviaton Adminstration (FAA) Radar Tower, which is an air navigational aid known as Waterloo, Delaware VORTAC, is located in Tract 79c of the refuge. The tower was erected in 1957 and was operated by FAA under a lease agreement with the landowner, Island Farm, Inc. In 1968, the Service acquired the land from Island Farms, Inc. and has managed this facility with a Special Use Permit (SUP) that is renewed every five years.

The tower consists of a small building of approximately 1,400 square feet. The enclosed building houses electronic equipment which provides a signal beacon used for aircraft navigation. FAA personnel make infrequent trips to the site for on-site maintenance. The SUP authorizes FAA personnel to maintain and operate the buildings, roads, power lines, drains, and other components of the complete Waterloo, Delaware VORTAC that was in place on the ground when title to the land involved passed to the United States Government.

To help minimize environmental impacts and ensure compatibility with the purposes for which the refuge was established and the mission of the National Wildlife Refuge System, environmental stipulations are to be included in the SUP.

AVAILABILITY OF RESOURCES:

Adequate refuge personnel and base operational funds are available to manage this activity at current levels. Staff time primarily involves monitoring use to ensure compliance with permit stipulations. The FAA provides personnel to operate and maintain the tower. Refuge staff maintains the roadway leading from State Route 16 to the tower; however, snow removal is the responsibility of FAA. FAA maintains the grounds upon which the tower is located, using Service approved herbicides.

ANTICIPATED IMPACTS OF THE USE:

On-site visits by FAA personnel may disturb feeding geese during the period from October to March and may disturb nesting osprey from March to July. The birds are expected to habituate or return to feeding/nesting once the vehicle has passed. (Klein 1993). Impacts to natural resources from this activity at present levels are expected to be negligible.

PUBLIC REVIEW AND COMMENT:

This compatibility determination is part of the refuge's Comprehensive Conservation Plan and Environmental Impact Statement. Public notification and review include a notice of availability published in the *Federal Register*, a 60-day comment period, and local media announcements.

DETERMINATION (CHECK ONE BELOW):

_____ Use is not compatible

__X__ Use is compatible, with the following stipulations

STIPULATIONS NECESSARY TO ENSURE COMPATIBILITY:

1) The permittee is responsible for ensuring that all employees, party members, contractors, and any other persons working for the permittee and conducting activities allowed by this permit are familiar with and adhere to the conditions of the permit.

2) Fuel caches are prohibited.

3) The use of off road vehicles is prohibited.

4) No toxic materials will be used or stored on the facility site except as required for maintenance and operation of the permit facility and approved in advance by the refuge manager.

5) Permittee shall exercise reasonable care as determined by the refuge manager in using toxic materials if such materials are required for the proper and safe operation of the permitted site.

6) Only pesticides approved by the Service may be used. A pesticide use request must be submitted by March 1 of each year.

7) The access gate to the unit must be closed and locked during entry/exit from the refuge. The lock on the gate to the unit will be provided by the Service.

8) Vehicle speed limit shall not exceed 25 M.P.H. on Service lands.

9) The Service may regulate public access and egress to the general area in which this unit is located.

10) No new construction or any changes, above the physical base which was in place when the US Fish and Wildlife Service purchased the property, may occur without approval of the Regional Director.

11) The refuge manager may require permit modifications at any future time to ensure that the use and occupancy of the land is compatible with the purposes for which the refuge was established and the mission of the National Wildlife Refuge System.

12) Refuge staff will periodically monitor the site, and findings from these monitoring efforts will be used to determine what additional management actions, if any, are needed to ensure permitted activities remain compatible with the purposes for which the refuge was established and the mission of the National Wildlife Refuge System.

13) The permit may be terminated at any time by mutual agreement.

JUSTIFICATION:

This compatibility determination is a reevaluation of an existing use. After fully considering the impacts of this activity, as described previously in the "Anticipated Impacts" sections of this compatibility determination, this permit will not materially interfere with or detract from the mission of the Refuge System or the purpose for which the refuge was established.

This use is important to public safety and to national security as being an important link in the Nation's aircraft navigation system. The refuge will evaluate this compatibility determination if conditions under which the use is permitted change significantly, if there is significant new information regarding the effects of this use or upon renewal of the permit in five years.

SIGNATURE:

Refuge Manager: _____ _____
(Signature) (Date)

CONCURRENCE:

Regional Chief: _____ _____
(Signature) (Date)

MANDATORY 10 YEAR RE-EVALUATION DATE: _____

COMPATIBILITY DETERMINATION

USE:

Recreational Fresh & Saltwater Fishing & Crabbing

REFUGE NAME:

Prime Hook National Wildlife Refuge

ESTABLISHING AND ACQUISITION AUTHORITY(IES):

(1) Migratory Bird Conservation Act {16 U.S.C. 715d}

(2) Refuge Recreation Act {16 U.S.C. 460 K-1}

REFUGE PURPOSE(S):

(1) "…for use as an inviolate sanctuary, or for any other management purposes, for migratory birds…" {16 U.S.C. 715d; Migratory Bird Conservation Act}

(2) "…incidental fish and wildlife-oriented recreational development" {16 U.S.C. 460k-1; Refuge Recreation Act}

(3) "the protection of natural resources" {16 U.S.C. 460k-1; Refuge Recreation Act}

(4) "the conservation of endangered or threatened species…" {16 U.S.C. 460k-1; Refuge Recreation Act}

NATIONAL WILDLIFE REFUGE SYSTEM MISSION:

The mission of the Refuge System is to administer a national network of lands and waters for the conservation, management, and where appropriate, restoration of the fish, wildlife, and plant resources and their habitats within the United States for the benefit of present and future generations of Americans.

DESCRIPTION OF USE:

(a) What is the use? Is the use a priority public use?
The use is recreational fresh and saltwater fishing and crabbing, which is one of six priority public uses identified by Executive Order 12996 (March 25, 1996) and by the National Wildlife Refuge System Administration Act of 1966, as amended by the National Wildlife Refuge System Improvement Act of 1997 (Public Law 105-57).

Fishing for bait fish is permitted for recreational uses only, subject to regulations stated in Title 7 (Conservation) of the Delaware State Code. Recreational crabbing using collapsible traps is permitted from the shoreline only and the owner must be present.

(b) Where would the use be conducted?
The use would be conducted within the refuge's 10,132 acres, which lie between Slaughter Beach and the Broadkill River along the southeastern coastline of Delaware. Refuge waterways currently provide habitat for freshwater fish species such as largemouth bass, crappie, pickerel, and sunfish, for brackish water fish species such as white perch and striped bass, and for saltwater species, such as weakfish, flounder, striped bass, croaker, spot, and bluefish.

The refuge will open to public fishing in compliance with state and federal regulations. Below is a description of the specific areas open for each type of fishing opportunity. See Map 4-15 for an illustration of where fishing and crabbing would be conducted on the refuge.

Area	Type of Access
Fowler Beach	Shore only
Slaughter Canal	Boat & shore
Slaughter Creek	Shore only
Prime Hook Creek	Boat only (Shore only at HQ Canal)
Turkle & Fleetwood Ponds	Boat & shore
Goose & Flaxhole Ponds	Boat only
Petersfield Ditch	Shore only

(c) When would the use be conducted?
Fishing and crabbing would take place within the open fishing and crabbing seasons established by the Delaware Division of Fish and Wildlife. Fishing is practiced year-round except when waterways are frozen. Crabbing occurs primarily during the period from June through October. The refuge is open one-half hour before sunrise to one-half hour after sunset except night fishing is permitted at Fowler Beach. All boats must be off of the water at sunset. Fishing would be prohibited during designated seasonal closures, which are described in the following section.

(d) How would the use be conducted?
Fishing/crabbing will be conducted during the State of Delaware's fishing/crabbing seasons, in accordance with federal and state regulations. Federal regulations in 50 CFR pertaining to the National Wildlife Refuge System Administration Act, as well as existing, refuge-specific regulations will apply. However, the refuge manager may, upon annual review of the fishing program and in coordination with the Delaware Division of Fish and Wildlife, impose further restrictions on fishing, recommend that the refuge be closed to fishing, or further liberalize fishing regulations within the limits of state seasons and regulations. Fishing would be restricted if it becomes inconsistent with other, higher priority refuge programs or endangers refuge resources or public safety.

Crabbing will be conducted using only hand lines and collapsible traps. Collapsible traps must be fished from the shore only and the owner must be present. All other types of crabbing equipment are prohibited.

The refuge will consider crabbing along Prime Hook Road, Broadkill Road, and Fowler Beach Road in the future if visitor safety and adequate parking can be guaranteed.

Public access to the refuge can be gained from Route 1 along several State roads including Broadkill Beach Road, Deep Branch Road, Prime Hook Road, Cods Road, Fowler Beach Road, and Slaughter Beach Road. Anglers must access refuge lands from designated access points. Motorized or mechanized vehicles, such as off-road vehicles, are not allowed on refuge property.

A description of the fishing program is listed below and contains refuge-specific regulations:

In addition to published 50CFR regulations and State regulations, refuge-specific regulations also apply for Recreational Fishing and Crabbing and are below as follows:

1) No refuge-specific permits are required, except for night fishing at Fowler Beach.

2) No boat launching fees are required.

3) The refuge is open to fishing ½ hour before sunrise to ½ hour after sunset except night fishing is permitted at Fowler Beach. All boats must be off the water at sunset.

4) Catch and release regulations apply, including mandatory use of barbless hooks, for Turkle Pond, Fleetwood Pond, Goose Pond, Flaxhole Pond, and Prime Hook Creek.

5) Seasonal closures

   a) Designated beach dunes and overwash areas will be closed from March 1 through September 1 due to nesting State endangered least terns and American oystercatchers, and the potential for use by federally endangered piping plovers. Areas may be reopened if no nesting activity occurs or when nesting ends for the season.

   b) Western Prime Hook Creek (from old shop ramp to Waples Pond): Closed every day during the deer and waterfowl hunting seasons, which typically starts on September 1 and ends in early February. Additional seasonal closures may apply through the second Saturday in May for hunting during the snow goose conservation order and/or turkey hunting.

   c) Goose and Flaxhole Ponds and Eastern Prime Hook Creek (from old shop ramp to HQ ramp): Closed every day from September 1 through March 15. Additional seasonal closures may apply through the second Saturday in May for hunting during the snow goose conservation order and/or turkey hunting.

   d) Turkle and Fleetwood Ponds (in HQ Area): Closed only for a limited number of days for deer hunts.

   e) Slaughter Canal (boat access): Except for Sundays, closed from September 1 through the deer and waterfowl hunting seasons, which typically end in early February. Additional seasonal closures may apply through the second Saturday in May for hunting during the snow goose conservation order and/or turkey hunting.

   f) Water Control Structures at Petersfield Ditch & Slaughter Canal & Cods Road (shore only): Open year round.

6) Boats are not allowed at Slaughter Creek and Petersfield Ditch. Boats must be ported in by foot from the parking areas to Goose and Flaxhole Ponds.

7) Boat motor restrictions:

   a) 30 horsepower motor restriction on Prime Hook Creek and Slaughter Canal

   b) Electric motors or manual propulsion only on Turkle & Fleetwood Ponds

   c) Manual propulsion only on Goose & Flaxhole Ponds (includes float tubes)

   d) Air thrust boats and jet skis are not permitted

   e) A “Slow No Wake” zone of one-half mile has been established on the Headquarters Ditch.

8) Restriction of bank fishing (where permitted) to designated area off of state maintained highways at Petersfield Ditch, Slaughter Creek, and Slaughter Canal.

9) Access at Fowler Beach will only occur on refuge owned lands on the sandy part of the beach from the toe of the dunes to the Delaware Bay (mean high water demarcation to mean low water demarcation). One parking lot with a dune crossover provides access to the beach. Access on the dune and adjacent marshes is prohibited.

10) Crabbing will be conducted using only hand lines and collapsible traps. Collapsible traps must be fished from the shore only and the owner must be present. All other types of crabbing equipment are prohibited.

11) Areas may be closed on the refuge without warning.

12) A wheelchair accessible fishing pier on Fleetwood Pond is available for disabled anglers.

13) Camping and open fires are prohibited.

14) Harvest information is not required.

15) No check in/out required.

16) Dog walking is not permitted on the refuge.

17) Recreational gill netting, commercial fishing, and food fishing with equipment other than hook and line are prohibited on the refuge.

(e) Why is this use being proposed?
Fishing is one of the priority public uses defined by Executive Order 12996 (March 25, 1996) and the National Wildlife Refuge System Administration Act of 1966, as amended by the National Wildlife Refuge System Improvement Act of 1997 (Public Law 105-57). This legitimate and appropriate use of a National Wildlife Refuge is generally considered compatible, as long as it does not materially interfere with or detract from the fulfillment of the National Wildlife Refuge System mission or the purposes of the National Wildlife Refuge.

The Service intends to continue the tradition of wildlife-related recreation on the refuge by allowing fishing/crabbing in compliance with state regulations. By allowing this use to continue, anglers can experience this traditional recreational activity, gain a better appreciation of the refuge's high quality habitats, and become better informed about the refuge and the National Wildlife Refuge System.

AVAILABILITY OF RESOURCES:

Permitting the use of recreational fishing/crabbing is within the resources available to administer our Visitor Services Program with the current level of participation and to ensure that the use remains compatible with the refuge purposes. Additional funding for visitor services improvements can also come from challenge cost share projects, grant funds, and contributions. Compliance with fishing regulations is handled within the regular duties of the Station Law Enforcement Officer.

Facilities or materials needed to support this use include maintaining access roads, parking areas, and the wheelchair accessible fishing pier, upgrading some of the existing boat launching areas, providing fishing information in the public use brochure, maintaining the refuge's website with current refuge fishing information, maintaining regulatory and interpretive fishing program signs, and monitoring of the fisheries at Prime Hook Creek, Fleetwood Pond, Turkle Pond, Goose Pond, and Flaxhole Pond. Costs associated with the Public Fishing Program are estimated below. Costs associated with fisheries assessments and monitoring will be a one-time cost that may need to be conducted every five years and is not included in the annual cost of the fishing program below.

Item	**PROPOSED**	
	Staff Days	Cost
Planning	1	$300
Printing costs-handouts	0.25	$75
Law Enforcement	1.5	$360
Inquiries	1.5	$300
Facilities maintenance supplies*	0	$0
Fishing operations (youth fishing tournament)	1	$350
Total	**5.25**	**$1,385**

*Maintenance of parking lots, boat ramps, etc., is covered by deferred maintenance projects. Access roads and trails are already maintained for management access or other recreational uses.

ANTICIPATED IMPACTS OF THE USE:

For a more complete analysis of the impacts of recreational fresh and saltwater fishing and crabbing, refer to chapter 5 of the CCP/EIS.

Anglers are expected to use and stay on hiking and canoe trails or roads to access the interior of the refuge. Designated areas, such as fishing areas off of state maintained highways, are established to reduce impacts to refuge resources. Facilities most utilized by anglers are roads, parking lots, trails, and boat launching ramps. Maintenance or improvement of these facilities will cause negligible short-term impacts to localized soils and waters and may cause some wildlife disturbances and damage to vegetation.

Fishing activities directly related to refuge operations would generate an estimated $198.5 thousand in local output, 2.0 jobs, and $55.4 thousand in labor income in the local economy (see appendix I in CCP). Including direct, indirect, and induced effects, fishing activities would generate an estimated total economic impact of $277.8 thousand in local output, 2.3 jobs and $79.4 thousand in labor income. Recreational fishing and crabbing is expected to have negligible short-term, long-term or cumulative impacts on the economy of the towns or county in which the refuge lies. This activity would not considerably alter the demographic of economic characteristics of the local community. Additionally, Impacts on cultural resources are expected to be negligible based on our observations of past fishing impacts.

Recreational fishing and crabbing are expected to have negligible adverse short-term, long-term or cumulative impacts on local or regional air quality and vegetation.

Recreational fishing and crabbing are expected to have negligible adverse short-term, long-term or cumulative impacts on soils. Increased soil compaction will increase on heavily used shoreline areas for boat access in Goose and Flaxhole Ponds. To minimize impacts on bank erosion, no wake zones and a maximum motor restriction of 30 horsepower on Prime Hook Creek and Slaughter Canal will be posted.

Recreational fishing and crabbing are expected to have negligible adverse short-term, long-term or cumulative impacts on hydrology or water quality based upon staff observations of past fishing impacts. The use of boats by anglers has the potential to affect water quality negatively by increasing erosion, stirring up bottom sediments, or introducing pollutants into waterways. We do not expect emissions from vehicles or boat motors to substantially affect the water quality of the region.

Regarding state and Federally listed endangered species, impacts on the piping plover, American oystercatcher, common tern, Forster's tern, and least tern will be minimized through the seasonal closure of designated beach dunes and overwash areas from March 1 through September 1. A Section 7 Evaluation has been conducted as part of this review and it was determined that proposed activities would not likely affect the Delmarva fox squirrel.

During the period of September 1 – March 15, which is when most wintering and migrating waterfowl are on the refuge, adverse impacts to migrating and wintering waterfowl could result from unregulated human disturbance in optimum waterfowl habitats at the refuge. This conclusion is based on the role of disturbance as it relates to waterfowl life history requirements and behaviors such as feeding, flight, metabolic processes, molting, preening, and resting. Excess disturbance may negatively affect the ability of waterfowl to secure nutrients, thus disrupting molting processes and associated reproductive strategies. Adverse impacts to preening activities would be similar to those associated with the molting process. To minimize waterfowl disturbance from fishing and other recreational uses, the refuge has designated approximately 3,000 acres as waterfowl sanctuaries that will be closed to hunting and other recreational use on a seasonal or annual basis.

Recreational fishing and crabbing are expected to have negligible adverse short-term, long-term or cumulative impacts on shorebirds and landbirds.

Impacts on secretive marsh and waterbirds are expected to negligible. An increase in new fishing areas and associated hiking trails, particularly in or near wetland areas, have the potential to increase disturbance to secretive marsh and waterbirds. We anticipate that in the winter public use at these locations would be negligible.

A potential direct negative impact exists for wetland and open waterbird species (such as osprey, herons, and waterfowl) from lost fishing gear: specifically, hooks, lures, and litter, or becoming entangled in fishing line or hooks. Ingestion of lead sinkers is another source of concern throughout the region. The extent to which these bird species are impacted by fishing tackle currently is unknown. Discarded fishing line and other fishing litter can entangle migratory birds and marine mammals and cause injury and death

The activities described in this determination should have no long-term impact on mammal use of the refuge. In general, the presence of humans will disturb most mammals, which typically results in a temporary displacement without long-term effects on individuals and populations. We expect indirect impacts to mammals to increase

due to proposed expansions in public use activities such as fishing. Additionally, impacts to invertebrates such as butterflies, moths, other insects, and spiders are expected to be negligible.

Fishing, which is one of the six priority wildlife-dependent public uses, is a consumptive activity with additional direct effects on fisheries resources. Fishing has also been evaluated for its potential to benefit or adversely affect amphibians and reptiles or their habitats used for mating, reproduction, over-wintering, and foraging. Disturbance to basking or nesting turtles may occur where public use is concentrated at points where land and water interface.

Increasing fishing opportunities on the refuge would serve the demand for more fishing opportunities in Sussex County. The improved habitat quality resulting from ongoing habitat restorations on the refuge would likely result in improving water quality and increasing some fish populations. That could positively affect the fishing experience and fishing success.

Expanding fishing opportunities are expected to have adverse impacts on a certain segment of the public that does not desire any change in public use programs and regulations, or that may hold differing views on the course of action. In addition, while new visitors become familiar with those changes, violations could increase. Some conflict between wildlife observers, photographers, students, and other refuge users is expected to result in short-term moderate adverse impacts, which will be managed through seasonal closures. Fishing is also a relatively quiet form of wildlife-recreation that should have negligible impact on visitors participating in other activities such as wildlife observation or photography.

Minimal infrastructure, which includes the addition of two to three parking areas, enhancement of existing boat ramps, and placement of informational signs, is anticipated in support of this priority public use. There would be some minimal costs associated with these programs in the form of road maintenance, law enforcement, and boat ramp maintenance.

PUBLIC REVIEW AND COMMENT:

This compatibility determination is part of the refuge's Comprehensive Conservation Plan and Environmental Impact Statement. Public notification and review include a notice of availability published in the *Federal Register*, a 60-day comment period, and local media announcements.

DETERMINATION (CHECK ONE BELOW):

____ Use is not compatible

__X__ Use is compatible, with the following stipulations

STIPULATIONS NECESSARY TO ENSURE COMPATIBILITY:

The refuge will manage the fishing/crabbing program in accordance with Federal and State regulations and review it annually to ensure fisheries/wildlife and habitat goals are achieved and that the program is providing a safe, high quality fishing experience for participants. The refuge based these stipulations on our past Environmental Assessment on Fishing, 1986 Fishing Plan, draft CCP and Environmental Impact Statement, and refuge-specific regulations (See Description of Use section).

To ensure compatibility with refuge purposes and the mission of the Refuge System, fishing can occur on the refuge if the refuge-specific regulations highlighted in this document and following stipulations are met:

1) This use must be conducted in accordance with state and federal regulations (50CFR), and special refuge-specific regulations published in the Public Use Regulations brochures.

2) The fishing program will be reviewed annually to ensure that program contributes to refuge objectives in managing quality fisheries and recreational fishing and protecting habitats, and is subject to modification if on-site monitoring by refuge personnel or other authorized personnel results in unanticipated negative impacts to natural communities, wildlife species, or their habitats.

3) The refuge manager may, upon annual review of the fishing program and in coordination with the Delaware Division of Fish and Wildlife, impose further restrictions on fishing, recommend that the refuge be closed to fishing, or further liberalize fishing regulations within the limits of state seasons and regulations. Fishing may be restricted if it conflicts with other, higher priority refuge programs or endangers refuge resources or public safety.

4) Fishery assessments will be conducted in Turkle Pond, Fleetwood Pond, Goose Pond, Flaxhole Pond, and Prime Hook Creek to provide management recommendations if necessary (seasonal closures, stricter creel or size limits, etc.). Goose and Flaxhole Ponds will remain closed until these fishery assessments and contamination surveys are completed.

5) Closure of all side branches off Prime Hook Creek and freshwater ponds not specifically open to fishing.

6) Restriction of bank fishing (where permitted) to designated areas off of state maintained highways at Petersfield Ditch, Slaughter Creek, and Slaughter Canal.

7) Catch and release regulations will apply, including mandatory use of barbless hooks, for Turkle Pond, Fleetwood Pond, Goose Pond, Flaxhole Pond, and Prime Hook Creek.

8) Public outreach and education will be increased in order to minimize conflicts between user groups, help control aquatic invasive species, reduce fish introductions, and minimize disturbance to wildlife and habitat.

9) Refuge Law Enforcement Officer(s) will promote compliance with Refuge regulations, monitor public use patterns and public safety, and document visitor interactions. Refuge Law Enforcement personnel will monitor all areas and enforce all applicable state and federal regulations.

10) Designated seasonal closures must be followed to minimize conflict among user groups and minimize wildlife disturbance:

    a) Designated beach dunes and overwash areas will be closed from March 1 through September 1 due to nesting State endangered least terns and American oystercatchers, and the potential for use by federally endangered piping plovers. Areas may be reopened if no nesting activity occurs or when nesting ends for the season.

    b) Western Prime Hook Creek (from old shop ramp to Waples Pond): Closed every day during the deer and waterfowl hunting seasons, which typically starts on September 1 and ends in early February. Additional seasonal closures may apply through the second Saturday in May for hunting during the snow goose conservation order and/or turkey hunting.

    c) Goose & Flaxhole Ponds & Eastern Prime Hook Creek (from old shop ramp to HQ ramp): Closed every day from September 1 through March 15. Additional seasonal closures may apply through the second Saturday in May for hunting during the snow goose conservation order and/or turkey hunting.

    d) Turkle & Fleetwood Ponds (in HQ Area): Closed only for a limited number of days for deer hunts.

    e) Slaughter Canal (boat access): Except for Sundays, closed from September 1 through the deer and waterfowl hunting seasons, which typically end in early February. Additional seasonal closures may apply through the second Saturday in May for hunting during the snow goose conservation order and/or turkey hunting.

    f) Water Control Structures at Petersfield Ditch & Slaughter Canal & Cods Road (shore only): Open year round.

11) Changes outlined in the CCP dealing with closed and seasonally closed areas and fishing regulations, when approved, will be incorporated into their respective fishing program.

12) Recreational gill-netting, food fishing with equipment other than hook and line, and all commercial fishing are not permitted.

13) Crabbing will be permitted using only hand lines and collapsible traps. Collapsible traps must be fished from the shore only and the owner must be present. All other types of crabbing equipment are prohibited.

JUSTIFICATION:

Fishing is a priority wildlife-dependent use for the Refuge System through which the public can develop an appreciation for fish and wildlife (Executive Order 12996, March 25, 1996 and The National Wildlife Refuge System Administration Act of 1966, as amended by the National Wildlife Refuge System Improvement Act of 1997 (Public Law 105-57)). The Service's policy is to provide expanded opportunities for wildlife-dependent uses when compatible and consistent with sound fish and wildlife management and ensure that they receive enhanced attention during planning and management.

Fishing seasons and limits are established by the State of Delaware and adopted by the refuge. These restrictions ensure the continued well-being of overall populations of fish. Fishing does result in the taking of many individuals within the overall population, but restrictions are designed to safeguard adequate population and recruitment from year to year. Specific refuge regulations address equity and quality of opportunity for anglers, and help safeguard refuge habitat. Disturbance to other fish and wildlife does occur, but this disturbance is generally short-term and adequate habitat occurs in adjacent areas. Loss of plants or increases in water turbidity from boat motors is minor, or temporary, and is generally not concentrated since fishing pressure is well distributed.

Conflicts between anglers are localized and are addressed through law enforcement, public education, and continuous review and updating to State and refuge fishing regulations. Conflicts between other various user groups are further reduced by the establishment of seasonal area closures and by prohibiting recreational gillnetting, food fishing with equipment other than hook and line, commercial fishing, and crabbing with equipment other than hand lines and collapsible traps.

Stipulations above will ensure proper control of the means of use and provide management flexibility should detrimental impacts develop. Allowing this use also furthers the mission of the National Wildlife Refuge System by providing renewable resources for the benefit of the American public while conserving fish, wildlife, and plant resources on the Refuge.

This activity will not materially interfere with or detract from the mission of the Refuge System or the purpose for which the refuge was established.

SIGNATURE:

Refuge Manager: _____ _____
(Signature) (Date)

CONCURRENCE:

Regional Chief: _____ _____
(Signature) (Date)

MANDATORY 15 YEAR RE-EVALUATION DATE: _____

COMPATIBILITY DETERMINATION

USE:

Hunting

REFUGE NAME:

Prime Hook National Wildlife Refuge

ESTABLISHING AND ACQUISITION AUTHORITY(IES):

1. Migratory Bird Conservation Act {16 U.S.C. 715d}
2. Refuge Recreation Act {16 U.S.C. 460 K-1}

REFUGE PURPOSE(S):

1. "…for use as an inviolate sanctuary, or for any other management purposes, for migratory birds…" {16 U.S.C. 715d; Migratory Bird Conservation Act}
2. "…incidental fish and wildlife-oriented recreational development" {16 U.S.C. 460k-1; Refuge Recreation Act}
3. "the protection of natural resources" {16 U.S.C. 460k-1; Refuge Recreation Act}
4. "the conservation of endangered or threatened species…" {16 U.S.C. 460k-1; Refuge Recreation Act}

NATIONAL WILDLIFE REFUGE SYSTEM MISSION:

The mission of the Refuge System is to administer a national network of lands and waters for the conservation, management, and where appropriate, restoration of the fish, wildlife, and plant resources and their habitats within the United States for the benefit of present and future generations of Americans.

DESCRIPTION OF USE:

(a) What is the use? Is the use a priority public use?
The use is the public hunting of white-tailed deer, upland game (rabbit, quail, pheasant, and red fox), turkey, webless migratory birds (dove, woodcock, and snipe), and waterfowl (including coot) on the refuge. Hunting was identified as one of six priority public uses by Executive Order 12996 (March 25, 1996) and by the National Wildlife Refuge System Administration Act of 1966, as amended by the National Wildlife Refuge System Improvement Act of 1997 (Public Law 105-57).

Quality opportunities for hunting deer, waterfowl, upland game, and webless migratory birds, and turkey will be expanded, where possible, to include additional days and acres. Deer hunting would increase from 3,876 to 5,389 acres, waterfowl hunting from 1,723 to 3,455 acres, upland game & migratory bird hunting remains at 1,957 acres, and turkey hunting would expand from zero to 3,472 acres. For a detailed explanation of the history of the refuge's hunting program, refer to "Hunting Opportunities" in the "Refuge Visitor Services Program" section in Chapter 3 of the refuge's CCP and to the "Description of the Hunting Program" in the refuge's Hunting Management Plan.

(b) Where would the use be conducted?
The use would be conducted within the refuge's 10,132 acres, which lie between Slaughter Beach and the Broadkill River along the southeastern coastline of Delaware. A total of 5,389 acres would be open for deer hunting, 3,455 acres open for migratory bird hunting, 1,957 acres open for upland game hunting, and 3,472 acres open for wild turkey hunting. Forty percent of the refuge (3,455 acres) is open to migratory bird hunting, which is the maximum amount of land allowed by law (16 U.S.C. 668dd(d)(1)(A), National Wildlife Refuge System Administration Act; 16 U.S.C. 703-712, Migratory Bird Treaty Act; and 16 U.S.C. 715a-715r, Migratory Bird Conservation Act). Below is a description of the specific areas open for each type of hunting opportunity. See Map 4-16, 4-17, 4-18, 4-19 for an illustration of where hunting would be conducted on the refuge.

Area	Species	Acres	Seasons***
Regular Deer Hunt Area	Deer	3,939	Sept-Feb
Regular Waterfowl Hunt Area	Waterfowl & Dove	2,100*	Sept- Feb
Lottery Waterfowl Hunt Area	Waterfowl	1,338*	Sept-Feb
Lottery Deer Hunt Area	Deer	751	Nov & Jan
Non-Ambulatory Hunt Area	Deer & Waterfowl	16**	Sept-Feb
Lottery Non-Ambulatory Deer Hunt Area	Deer	682	Oct & Nov
Upland Game Hunt Area	Upland game & webless migratory birds (1,847 acres) except where designated as closed (110 acres)	1,957	Sept-Feb
Lottery Turkey Hunt Area	Turkey	3,471	Apr-May
Snow Goose Conservation Order	Snow Geese	Refuge-wide****	Late Jan - April

** A total of 3,454 acres is open to migratory bird hunting. This is the maximum amount of land allowed by law (40% rule). Lands purchased with Land and Water Conservation Funds do not apply.*
***Acres included as part of Lottery Waterfowl Hunt Area*
****Follow State hunting seasons that include seasonal closures and time restrictions (see hunting objectives and strategies in this section for more information)*
*****40% rule does not apply because taking of snow geese in the conservation order has been determined to be beneficial to the species.*

(c) When would the use be conducted?
The use would be conducted in designated areas of the refuge in accordance with federal and state regulations. Hunting would take place within the open hunting seasons established by the Delaware Division of Fish and Wildlife.

(d) How would the use be conducted?
Hunting will be conducted during the State of Delaware's hunting seasons, in accordance with federal and State regulations. Federal regulations in 50 CFR pertaining to the National Wildlife Refuge System Administration Act, as well as existing, refuge-specific regulations will apply. However, the refuge manager may, upon annual review of the hunting program and in coordination with the Delaware Division of Fish and Wildlife, impose further restrictions on hunting, recommend that the refuge be closed to hunting, or further liberalize hunting regulations within the limits of state seasons and regulations. We may restrict hunting if it conflicts with other, higher priority refuge programs or endangers refuge resources or public safety.

Seasonal closures to the general public will occur during the hunting season, which is typically a slower period of use due to weather conditions, and are highlighted below:

a) Western Prime Hook Creek (from old shop ramp to Waples Pond) (Unit III): Closed every day during the deer and waterfowl hunting seasons, which typically starts on September 1 and ends in early February. Additional seasonal closures may apply through the second Saturday in May for hunting during the snow goose conservation order and/or turkey hunting.

b) Deep Branch Road Trail (includes Goose & Flaxhole Ponds) and Eastern Prime Hook Creek (from old shop ramp to HQ ramp) (Unit III): Closed every day from September 1 through March 15. Additional seasonal closures may apply through the second Saturday in May for hunting during the snow goose conservation order and/or turkey hunting.

c) Headquarters Area (includes Turkle & Fleetwood Ponds) (Unit III): Closed only for a maximum of two days for deer hunts.

d) The northern portion of Unit IV (includes trail overlooking Vergie's Pond): Closed from the Monday before Thanksgiving through March 15. Additional seasonal closures may apply through the second Saturday in May for hunting during the snow goose conservation order and/or turkey hunting.

e) Hiking Trails on Fowler Beach Road (Unit I), Prime Hook Road (Unit III), and Slaughter Beach Road and Slaughter Canal (Unit I): Closed on Sundays from September 1 through the deer and waterfowl hunting seasons, which typically end in early February. Additional seasonal closures may apply through the second Saturday in May for hunting during the snow goose conservation order and/or turkey hunting.

The refuge will also evaluate the regular deer hunting area for the potential to incorporate hunting opportunities for non-ambulatory hunters.

Public access to the refuge can be gained from Route 1 along several State roads including Broadkill Beach Road, Deep Branch Road, Prime Hook Road, Cods Road, Fowler Beach Road, Turkle Pond Road, and Slaughter Beach Road. Hunters must access refuge lands from designated access points. No motorized or mechanized vehicles, such as off-road vehicles, are allowed off of designated roadways or parking areas on refuge property.

Boats would enter refuge waters from unimproved access points on Slaughter Canal at Fowler Beach Road and on Prime Hook Creek at either Waples Mill Pond on the Brumbley Family Campground, at the office boat ramp, or at the ramp at the old maintenance facility. All boaters are required to operate their craft and possess all safety equipment in accordance with Delaware State and U.S. Coast Guard Regulations.

The refuge will evaluate the future management of the Prime Hook Wildlife Area, which is managed and owned by the Delaware Division of Fish and Wildlife. In the past, refuge staff have issued hunting permits and collected fees for the Prime Hook Wildlife Area's eight waterfowl blinds through the refuge's waterfowl hunting permitting system. Currently, a contractor handles the collection of fees and issuance of permits. A formal agreement such as a MOU needs to be established if future cooperative management occurs. For more information about the partnership between the refuge and the Delaware Division of Fish and Wildlife as it relates to the Prime Hook Wildlife Area, refer to "Hunting Opportunities" in the "Refuge Visitor Services Program" section in Chapter 3 of the refuge's CCP and to the strategies section in the "Description of the Hunting Program-Objective 5.1" in the refuge's Hunting Management Plan.

Descriptions of each of the hunting programs are listed below and contain refuge-specific regulations:

General Regulations for All Hunting Programs

1) All hunters must have in their possession a signed and current refuge hunting permit. Except for lottery hunt areas, permits are available beginning in July through the hunting season. Permits are available at the refuge check station, refuge office, refuge website, or upon request from the refuge manager. For lottery hunts, a preseason lottery drawing will be conducted to issue permits and collect fees.

2) No permit fees are required except for lottery hunts for deer, turkey, and waterfowl. For these hunts, a $5.00 application fee for the preseason lottery drawing is required. In addition, a daily permit fee of $10.00 for turkey and deer hunting, and a $15.00 fee for waterfowl hunting are required. Everyone in the lottery drawing has an equal chance of being selected multiple times.

3) Vacancies remaining after the preseason lottery drawing is complete, will be available throughout the hunting season. For these vacancies, the daily permit fees plus a processing fee of $2-3 per hunt. Hunters will be allowed to claim only one permit per day to avoid someone from claiming all available vacancies at one time. The 50% discount on permit fees to Interagency Senior and Access passholders does not apply.

4) Non-ambulatory hunters (those hunters permanently confined to a wheelchair) must obtain an Interagency Access Passport, which provides a record of certified disability, to be eligible to receive a hunting permit for the designated non-ambulatory hunting areas.

5) Youth hunters aged 15 years and younger must obtain a free seasonal permit. Only hunters aged 16 years and older can apply or obtain a lottery hunt area permit.

6) The refuge will not provide permanent hunting structures except for non-ambulatory hunting activities. Hunting blinds/stands/steps must be portable and removed at the end of each day.

7) Hunters may not be on the refuge any earlier than two hours before the morning shooting time.

8) Areas may be closed on the refuge without prior warning.

9) The maximum permitted motor on refuge waterways is 30 horsepower.

10) No vegetation may be cut on the refuge (e.g., for shooting lanes, camouflaging, etc.).

11) The use of natural vegetation for camouflaging your blind is prohibited.

12) Practice or target shooting on the refuge is prohibited.

13) Overnight camping and open fires are prohibited.

14) No hunting is permitted in designated safety zones.

15) When requested by federal and State enforcement officers, hunters must display all game, hunting equipment, and ammunition for inspection.

16) Permits are non-transferable.

17) Individuals assisting non-ambulatory deer hunters in the non-ambulatory hunting area are not permitted to hunt; however, up to two individuals may hunt while assisting a non-ambulatory waterfowl hunter.

18) Submission of harvest information to refuge staff is not required.

19) For the Statewide youth hunts, all designated hunt areas will be open for waterfowl and deer hunting on a first-come, first-served basis.

20) All boaters are required to operate their craft and possess all safety equipment in accordance with Delaware State and U.S. Coast Guard regulations.

21) Non-toxic shot is required for all hunting except for lead slugs for deer/fox hunting.

22) The refuge manager will monitor, evaluate, and make necessary adaptations to the hunting program to ensure that the refuge is meeting resource management objectives and continuing to offer quality experiences. The refuge manager has the authority to extend or close hunting opportunities on the refuge within the established hunting seasons of the Delaware Division of Fish and Wildlife, while ensuring compatibility.

Regulations for Deer Hunting

1) Free-roam hunting is available on a first-come, first-served basis everyday during the State hunting seasons in the Regular Deer Hunting Area with the following restrictions:

   a) No access by canoe from Slaughter Creek on Cods Road.

b) The designated area north of Prime Hook Road will be seasonally closed from the Monday before Thanksgiving through March 15.

c) In the designated area along Prime Hook Creek, hunting is permitted during designated State deer hunting seasons on Tuesday, Thursday, and Friday.

i. Deer hunting will be closed on Fridays when it coincides with the opening days of a duck season.

2) For the lottery hunts in the Lottery Deer Hunt Areas, a limited number of permits (25-30) will be issued through a preseason drawing and hunters may choose their own hunting location anywhere within the hunt area on a first-come, first-served basis. Vacancies will be filled throughout the season. A contractor will administer the issuance of permits and collection of fees for the preseason drawing and vacant hunting opportunities. Firearms hunting will be open for one day during the November shotgun season and for one day during the January shotgun season. For the lottery hunts in the Lottery Non-Ambulatory Deer Hunt Area, hunters must choose from among eleven ground blinds during designated dates in October and November.

3) The refuge will participate in all State hunting seasons and bag limits except the October Antlerless deer season and the late handgun season. The refuge will consider participating in the October Antlerless Season only if an overabundance of deer arises, as determined by the Delaware Division of Fish & Wildlife and concurrence by the refuge, and conflicts with other user groups can be minimized.

4) No check-in or check-out is required except for the Non-Ambulatory Hunt Area.

5) Hunters must be out of the hunting areas one and one-half hours after the evening shooting time.

6) Wheelchair accessible blinds in the Non-Ambulatory Hunt Area are available for non-ambulatory hunters who possess an Interagency Access Passport on Tuesday, Thursday, and Friday on a first-come, first-served basis. Hunters must flip over a tag at the parking area to indicate that a blind is in use. Deer hunting on the entire refuge will be closed on Fridays when it coincides with the opening days of a duck season.

7) Opportunities for scouting will be allowed two weeks before the start of archery season and throughout the deer hunting season.

Regulations for Waterfowl Hunting

1) Free-roam hunting is available in the Regular Waterfowl Hunting Area on a first-come, first-served basis everyday during the hunting season until noon. No check-in or check-out is required except for the Non-Ambulatory Area. Zoned areas along the Broadkill River and Petersfield Ditch are also open to hunting.

2) For the lottery hunts (except early teal and resident Canada goose season) in the Lottery Waterfowl Hunt Area, a limited number of hunting parties for each day will be selected from a preseason drawing and required to hunt within a defined area around designated blind stakes (24 federal blind sites plus eight state hunting blinds). Hunting is permitted on Monday, Wednesday, and Saturday until noon during the hunting season. Hunting will be open on Fridays when it coincides with the opening days of duck season. Vacancies will be filled throughout the season. A contractor will administer the issuance of permits and collection of fees for both the preseason drawing and vacant hunting opportunities.

3) The refuge will participate in all State waterfowl hunting seasons unless otherwise restricted. This includes the duck seasons, early teal season, youth waterfowl hunt, resident Canada goose season, and snow goose season (early and snow goose conservation order).

a) Hunting during the early teal, resident Canada goose, and snow goose conservation order will be first-come, first-served in all designated areas, including the Lottery Hunt Area.

4) Snow geese may only be taken in the Lottery Hunt Area when the area is open for duck hunting or during the snow goose conservation order.

5) A maximum of three people are permitted for each blind stake in the lottery hunt areas.

6) Hunters must be out of the hunting areas by 1:00pm.

7) Only enrollees who complete the Young Waterfowler Training Program may participate in the mentored hunt in the Lottery Waterfowl Hunt Area. Only young waterfowl hunters may possess or discharge a weapon.

8) A wheelchair accessible blind in the Non-Ambulatory Hunt Area is available for disabled hunters who possess an Interagency Access Passport on Monday, Wednesday, and Saturday until noon on a first-come, first-served basis. Hunters must flip over a tag at the parking area to indicate that a blind is in use. Hunting will be open on Fridays when it coincides with the opening days of duck season.

9) Hunting dogs are permitted.

10) Opportunities for scouting will be allowed on Sundays immediately prior to each of the duck seasons.

11) The refuge has designated approximately 3,000 acres as waterfowl sanctuaries that will be closed to hunting and other recreational use on a seasonal or annual basis. These sanctuaries lie in the Unit II (~1,800 acres) and the southern half of the Unit III (~970 acres) managed impoundments. The northern portion of Unit IV (~230 acres), which contains a proposed trail and observation platform, will be closed from the Monday before Thanksgiving to March 15.

Regulations for Upland Game & Webless Migratory Bird Hunting

1) The refuge has adopted State hunting regulations and seasons for the Upland Game Hunting Area with the following restrictions:

   a) The hunting of squirrel is prohibited due to the presence of the endangered Delmarva fox squirrel on the refuge.

   b) Hunters must be out of the hunting areas one half hour after legal shooting hours.

   c) Dove hunting is open in the Upland Game Hunting Area except the designated area north of Prime Hook Road.

2) No check-in or check-out is required.

3) Hunting dogs are permitted.

4) Scouting is allowed during designated dates and times.

Regulations for Turkey Hunting

1) Hunting of turkey will be permitted in the designated Lottery Turkey Hunt Area in accordance with State hunting regulations and seasons. A limited number of hunters will be selected through a preseason lottery drawing and required to hunt in designated areas.

2) The refuge will collaborate with the Delaware Division of Fish & Wildlife to evaluate the status of the wild turkey population on the refuge and determine if it is sufficient to support hunting on the refuge.

3) Scouting is allowed during designated dates and times.

(e) Why is this use being proposed?

Hunting is one of the priority public uses defined by Executive Order 12996 (March 25, 1996) and the National Wildlife Refuge System Administration Act of 1966, as amended by the National Wildlife Refuge System Improvement Act of 1997 (Public Law 105-57). This legitimate and appropriate use of a National Wildlife Refuge is generally considered compatible, as long as it does not materially interfere with or detract from the fulfillment of the National Wildlife Refuge System mission or the purposes of the national wildlife refuge.

Sport hunting is a tool managers use to maintain wildlife populations at an acceptable level. In Delaware, the Division of Fish & Wildlife establishes hunting seasons and bag limits to meet population objectives and to offer people the opportunity to experience a traditional outdoor recreational activity. Game species population objectives are determined by a number of factors such as habitat limitations and landowner tolerances, and each year the seasons and bag limits are designed to remove the harvestable surplus without long-term negative impacts to the population. The ability to effectively manage game species populations depends in large part on the availability of land with quality habitat. Providing hunting opportunities on the refuge will aid the State in meeting its management objectives and preserve a wildlife-dependent priority public use long associated with this land.

The Service intends to continue the tradition of wildlife-related recreation on the refuge by allowing hunting in compliance with State regulations. By allowing this use to continue, hunters can experience this traditional recreational activity, aid the refuge and State in maintaining acceptable game species population levels, gain a better appreciation of the refuge's high quality wildlife habitats, and become better informed about the refuge and the National Wildlife Refuge System.

AVAILABILITY OF RESOURCES:

Administrative changes in the hunting program were implemented to ease the administrative burden on staff resources. Cost savings resulted from the phasing out the use of permanent hunting structures and eliminating the need to have staff conduct daily lottery drawings for permits. These changes reflect a decrease in an estimated 54 days of staff time to conduct the hunt or approximately $17,890. The benefit of these changes to hunters is a reduction in their cost to hunt. Therefore, the refuge proposes to eliminate permit fees to hunt on the refuge except for lottery hunts for deer, waterfowl, and turkey. For a detailed analysis of the cost of the hunting program, refer to the "Staffing and Funding" section in the refuge's Hunting Management Plan. Appendix I in the refuge's CCP, which is a report titled, "Regional Economic Impacts of Current and Proposed Management Alternatives for Prime Hook National Wildlife Refuge," contains a more robust analysis of the cost comparison of hunting programs between past and current management.

The Refuge Recreation Act requires that funds are available for the development, operation, and maintenance of the permitted forms of recreation. The permit fee ($10 for deer & turkey; $15 for waterfowl), preseason application fee ($5/hunter), and processing fee for permits acquired after the preseason drawing ($2-3 per hunt) are the minimal amounts needed to offset the cost of facilitating the preseason drawings and manage the lottery hunts. Due to the uncertainty in the level of hunter participation with these new program changes, permit fees may need to be adjusted (increased or decreased) and therefore will be evaluated annually. Preseason lottery drawings are administered by a contracted company that collects information, the required fees, conducts the drawing, and issues the permits. This reduces costs by over $3,000 and application and processing fees are being paid to the contractors for administering this permitting process. Refuge staff works with the contractor to provide the highest level of customer support. Signs for posting hunting areas, trails, etc. will have an initial, one-time cost. Maintenance of facilities used by hunters (roads, parking lots, trails, and boat launching ramps) will be addressed with the refuge's deferred maintenance budget. Below is a cost analysis and breakdown of each hunt.

		PROPOSED	
Program	**Staff Days**	**Cost**	**Recovery**
Big Game - Deer	18	$5,400	$1,790
Big Game - Turkey	3	$825	$300
Upland Game	2.5	$880	$0
Waterfowl	14.5	$5,360	$5,570
Other Migratory Birds	2.25	$600	$0
Total	**40.25**	**$13,065**	**$7,660**

Cost Breakdown for All Hunting Programs Combined:

Staff Time ($9,495) & Actual Expenditures ($3,570) = $13,065

Volunteer Contributions for All Hunting Programs Combined ($20.25 per hour):

48 hrs = $972

Recovery is the revenue generated by permit and application fees from hunters participating in refuge hunting activities. Regulations for the fee program allow the refuge to retain 80 percent of the total fees collected. Of the total recovery, the contractor administering the preseason lottery drawing will collect $2,870 in application fees. The refuge will receive 80% of the remaining balance of $4,790 ($3,832).

ANTICIPATED IMPACTS OF THE USE:

Hunting can result in positive or negative impacts to the wildlife resource. A positive effect of allowing visitors' access to the refuge will be the provision of additional wildlife-dependent recreational opportunities and a better appreciation and more complete understanding of the wildlife and habitats associated with Delmarva ecosystems. This can translate into more widespread and stronger support for the refuge, the National Wildlife Refuge System, and the Service. The following is a discussion of refuge-specific impacts, which are supported by a compilation of baseline information relative to the featured topic.

General Impacts of Public Use

Direct impacts are those impacts immediately attributable to an action. Indirect impacts are those impacts that are farther in time and in space. Effects that are minor when considered alone, but collectively may be important are known as cumulative effects. Incremental increases in activities by people engaged in the variety of allowed uses on the refuge could cause cumulative impacts. It will be important for refuge staff to monitor these activities to ensure wildlife resources are not impacted in a detrimental manner.

Impacts on Socioeconomic Environment

The USGS-Fort Collins Science Center estimated the direct and total economic impacts of refuge management activities, including hunting, in Sussex County. Refuge management activities of economic concern included refuge purchases of goods and services within the local community, refuge personnel salary spending, revenues generated by refuge Revenue Sharing, and spending in the local community by refuge visitors, including hunters. The economic impacts were estimated using the "Impacts Analysis for Planning" (IMPLAN) regional input-output modeling system. Refuge management activities directly related to refuge operations generate an estimated $3.3 million in local output, 30 jobs and $892.9 thousand in labor income in the local economy. Including direct, indirect, and induced effects, refuge activities would generate total economic impacts of $4.7 million in local output, 41 jobs and $1.29 million in labor income.

More specifically, overall hunting activities directly related to refuge operations would generate an estimated $93.8 thousand in local output, 0.8 jobs, and $26.9 thousand in labor income in the local economy. Including direct, indirect, and induced effects, overall refuge hunting activities generate an estimated total economic impact of $132.1 thousand in local output, 1.2 jobs and $38.5 thousand in labor income. A further breakdown of hunting activities on the refuge, including direct, indirect, and induced effects, reveals that big game hunting on the refuge generates an estimated total economic impact of $47.8 thousand in local output, 0.4 jobs, and $13.7 thousand in labor income. Waterfowl hunting on the refuge generates an estimated total economic impact of $82.3 thousand in local output, 0.8 jobs, and $24.3 thousand in labor income. Small game hunting on the refuge generates an estimated total economic impact of $2.0 thousand in local output, 0.02 jobs, and $500 in labor income.

In 2007, total labor income was estimated at $2.996 billion and total employment was estimated at 87,113 jobs for Sussex County (IMPLAN 2007 data). The estimated total economic impacts associated with refuge operations represent less than one percent of total income (0.04%) and total employment (0.05%) in the overall Sussex County economy. However, the estimated total economic effects of refuge operations play a larger role in the Prime Hook communities near the refuge such as Milton and Lewes where most of the refuge's public use related economic activity occurs.

Based on these findings, it is expected that hunting will have negligible short-term, long-term or cumulative impacts on the economy of the towns or county in which the refuge lies. This activity is not expected to considerably alter the demographic of economic characteristics of the local community. All refuge actions proposed would neither disproportionately affect any communities nor damage or undermine any businesses or community organizations. No adverse impacts are foreseen to be associated with changes in the community character or demographic composition.

This activity would result in several minor beneficial impacts on the social communities near the refuge and in the state and region as a whole. We expect public use of the refuge to increase, thereby increasing the number of days visitors spend in the area and correspondingly, the level of visitor spending in the local communities.

The "Recreation and Tourism" section in Chapter 3 of the refuge's CCP provides more information about national and statewide trends in the recreation of hunting.

Impacts on Cultural Resources

With a relatively small number of hunters dispersed across the refuge during the hunting season, impacts would be negligible on the refuge's cultural resources based on our observations of past hunting impacts. Refuge lands are vulnerable to looting, despite our best efforts at outreach, education, and law enforcement. Upland areas adjacent to wetland areas have been identified for high potential for cultural resources. In addition, refuge visitors may inadvertently or even intentionally damage or disturb known or undiscovered cultural artifacts or historic properties. The refuge will continue to enforce Federal and refuge-specific laws and regulations regarding cultural resources and continue outreach and educational efforts.

For compliance with section 106 of the National Historic Preservation Act, the refuge staff will provide the regional historic preservation officer a description and location of all projects, activities, routine maintenance and operations that affect ground and structures, details on requests for compatible uses, and the range of alternatives considered. That office will analyze those undertakings for their potential to affect historic and prehistoric sites, and consult with the State Historic Preservation Officer and other parties as appropriate. The State and local government officials will be notified to identify concerns about the impacts of those undertakings.

Impacts on Air Quality

Hunting is expected to have negligible adverse short-term, long-term or cumulative impacts on local or regional air quality. Localized increases in emissions from hunter's vehicles or boat motors would be negligible compared to current off-refuge contributions to pollutant levels and likely increases in air emissions in the Sussex County airshed from land development over the next 15 years. Any adverse air quality effects from refuge activities would be more than offset by the benefits of maintaining the refuge in natural vegetation. The hunting program would not violate EPA standards and would comply with the Clean Air Act.

Impacts on Soils

Hiking or walking can alter habitats by trampling vegetation, compacting soils, and increasing the potential of erosion. Soil compaction makes root penetration more difficult, making it harder for seedlings to become established. In moderate cases of soil compaction, plant cover and biomass is decreased. In highly compacted soils, plant species abundance and diversity is reduced in the long-term as only the most resistant species survive (Liddle 1975).

Using these baseline impacts, the refuge's hunt program has the potential to cause some soil compaction since off-trail foot travel occurs; however, hunting is expected to have negligible adverse short-term, long-term or cumulative impacts on soils. With a limited number of hunters dispersed across the refuge during the hunting season, impacts would be negligible based on our observations of past hunting impacts. Vehicles would continue to be confined to existing refuge roads and parking lots to minimize impacts outside of that developed footprint. Soil compaction will also occur in the immediate areas surrounding blind site stakes for waterfowl hunting in the Unit III Waterfowl Lottery Area. Impacts to bank erosion will be minimized through the use of no wake zones and a maximum motor restriction of 30 horsepower on Prime Hook Creek and Slaughter Canal.

To facilitate hunting, maintenance or improvement of facilities (parking areas, roads, trails, and boat ramps) will be needed, which are expected to cause negligible to minor short-term impacts to localized soils and waters. Negligible short-term disturbance to soils will occur during the construction of new parking areas on Fowler Beach Road and on Broadkill Beach Road to facilitate hunting.

Several rare peat bog communities have been located near Goose Pond and Flaxhole Pond and these areas are open to deer hunting. Sensitive hydric soils that support these rare plant communities are easily destroyed by trampling. Visitation to these sites will be kept to a minimum in order to protect damage to hydric soils and trampling of sensitive rare plants.

Impacts on Hydrology and Water Quality

Hunting is expected to have negligible adverse short-term, long-term or cumulative impacts on hydrology or water quality based upon staff observations of past hunting impacts. The hunting program would not violate federal or state standards for contributing pollutants to water sources and would comply with the Clean Water Act.

The use of boats by hunters has the potential to affect water quality negatively by increasing erosion, stirring up bottom sediments, or introducing pollutants into waterways. We do not expect emissions from vehicles or boat motors to substantially affect the water quality of the region since the majority of hunters are using air-cooled mud-motors instead of water-cooled two-cycle outboard motors due to the shallow water depth in the hunt areas. Localized increases in emissions from hunter's boat motors would be negligible compared to current off-refuge contributions of boaters to pollutant levels in the nearby Broadkill River and the Delaware Bay. Furthermore, the refuge posts no wake zones and imposes a maximum 30HP restriction on Prime Hook Creek and Slaughter Canal.

Non-toxic shot is required for all hunting except lead slugs for deer/fox hunting. Public outreach and education on littering and proper waste disposal will lessen potential negative water quality impacts.

Impacts on Vegetation

Repeated visitation to any particular locale at the refuge would continue to cause minor site-specific damage to vegetation. Repeated use of an aquatic area by boats equipped with go-devils can damage to emergent and submergent vegetation beds. Portions of or whole plants can be torn, sometimes by roots, and boat wakes contribute to erosion. Accidental introduction of invasive plants, pathogens, or exotic invertebrates attached to boats or trailers, or on shoes or clothing, is another source of direct minor impacts on vegetation. In places where unmarked paths are created by hunters and anglers, little used pathways will retain their dominant vegetation species, but on medium-use pathways some plant species will be replaced and heavily-used paths will often contain invasive species (Liddle and Scorgie 1980).

Using the information previously presented as a baseline and considering staff observations of past impacts, hunting is expected to have negligible adverse short-term, long-term, or cumulative impacts on vegetation. Disturbance to vegetation will increase due to an expected increase in deer and waterfowl hunters in new free roam hunting areas in upland and wetland habitats during all hunting seasons, particularly around blinds sites in the Unit III impoundments. The possibility for new trails to be developed from repeated hunter entry may occur. However, given the large expanse of both upland and wetland acreage, anticipated dispersal of hunters across hunting areas, the inherent nature of hunters to only travel as far as needed to find a hunting location, and knowing that most vegetative species will have already undergone senescence or become dormant, negligible impacts to vegetation from hunting is expected.

Furthermore, the phasing out and removal of all of the refuge's 130+ deer hunting stands and waterfowl hunting blinds will remove disturbance to impacted vegetation and soils and create a more aesthetically pleasing landscape for refuge visitors. Impacts to vegetation are also minimized by not permitting hunters to cut vegetation for shooting lanes or for use as camouflage. No natural vegetation is permitted for use as camouflage on the refuge. Impacts to vegetation are further minimized because permanent stand hunting, which often utilizes nails, wire, screws, or other methods for tree attachment is prohibited.

Hunting plays a role in how white-tailed deer, snow geese, resident non-migratory Canada geese, and mute swans impact vegetation. Canada goose herbivory during the growing season is a relatively new impact upon wetlands. In 2002, a research study conducted at neighboring refuges, Bombay Hook and Chincoteague NWRs, suggested that higher levels of use by geese may cause a long-term change in wetland community structure (Laskowski et al. 2002). Biomass of several species of vegetation was significantly adversely impacted by feeding resident Canada geese at both refuges. Resident geese directly damage agricultural resources by eating grain crops and trampling spring seedlings. Heavy grazing by geese can result in reduced yields and in some instances a total loss of the grain crop (Allen et al. 1985, Flegler et al. 1987). Lethal and nonlethal Canada goose control activities outlined under all strategies common to all alternatives would be expected to significantly decrease the number of injurious resident Canada geese in specific areas, thus reducing local impacts on vegetation. The long-term viability of migrant Canada goose populations would not be affected, however. Similarly, because mute swans are highly invasive of wetland habitats, and can consume large quantities of submerged aquatic vegetation, control of mute swans on the refuge will have a local beneficial impact on wetland vegetation communities.

Various light goose (snow goose) populations in North America have reached such high levels that they are damaging habitats on their Arctic and sub-Arctic breeding areas (Abraham and Jefferies 1997, Alisauskas 1998, Jano et al. 1998, Didiuk et al. 2001) as well as in some migration and wintering areas (Giroux and Bedard 1987, Giroux et al. 1998, Widjeskog 1977, Smith and Odum 1981, Young 1985). The increasing numbers of light-geese are viewed as a continental problem, but with real local adverse impacts on vegetation. Grubbing for rhizomes, especially in salt marshes, results in areas denuded of vegetation, typically referred to as eat-outs. Vegetation density at these eat-outs may return to previous normal levels after several years, if left alone. However, where eat-outs occur within salt marsh habitats, snow geese often return each winter to the same areas to feed. Such impacts have been observed at the refuge. It is also speculated that during the time snow geese are feeding in a salt marsh, much of the soil and sediment may be loosened and placed into suspension. In fact, recently analyzed water quality samples from refuge impoundments have found extremely high sediment concentration in the water during times of extensive snow goose browsing on the refuge. This material may then be washed away during high or flood tide periods. After several years of successive erosive eat-outs at the same location, the lower ground elevation may further prevent the return of vegetation, causing a more long-term impact to vegetation community on the site. Reducing snow goose numbers on the refuge will reduce adverse minor-to-moderate impacts of snow goose herbivory on salt marsh habitats.

Deer overabundance can affect native vegetation and natural ecosystems and has been well-studied (Tilghman 1989, Nudds 1980, Hunter 1990, Behrend et al. 1970). White-tailed deer selectively forage on vegetation (Strole and Anderson 1992), and thus can have substantial impacts on certain herbaceous and woody species and on overall plant community structure (Waller and Alverson 1997). Over-browsing by deer can decrease tree reproduction, understory vegetation cover, plant density, and plant diversity (Warren 1991). High densities of deer have also been recognized as vectors for spreading invasive species like Japanese stiltgrass. Thus, control of the white-tailed deer population on the refuge will have a moderate beneficial impact on the vegetation communities.

Impacts on Federal and State Endangered Species

Disturbance factors resulting from public use are always considered for all listed species. The Delmarva fox squirrel and piping plover are listed as endangered and threatened by the U.S. Fish and Wildlife Service and the red knot was designated as a candidate species in 2006 for possible listing. Several other species listed as endangered by the Delaware Division of Fish & Wildlife include American oystercatcher (, common tern, Forster's tern, least tern, and bald eagle (. Of these, the piping plover, red knot, American oystercatcher, common tern, Forster's tern, and least tern will not be impacted by hunting because they would be unlikely to use the refuge's forested habitats and/or their occurrence on the refuge is outside of the hunting season for deer, upland game, and waterfowl. A Section 7 Evaluation has been conducted as part of this review and it was determined that proposed activities would not likely affect the Delmarva fox squirrel or piping plover. Furthermore, the hunting of any squirrel species is prohibited on the refuge to further minimize impacts to this endangered species.

While the bald eagle is no longer a federally listed species, the refuge uses the National Bald Eagle Management Guidelines for bald eagle management to implement time-of-year restrictions for nesting eagles. The guidelines do not permit any activity within 330 feet of an active nest during the breeding season, particularly where eagles are unaccustomed to such activity (U.S. Fish and Wildlife Service 2007).

Hunting on or near Turkle Pond was an existing activity prior to nesting by bald eagles on the adjacent Horse Island. When bald eagles were listed as endangered, the Section 7 Evaluation conducted on the refuge concluded that this activity in Turkle Pond would not likely affect this species and the use was permitted. We will monitor use in Turkle Pond to determine if there is an impact on the eagle nest on Horse Island.

Impacts on Waterfowl

Below is a discussion of the generalized impacts of hunting on critical life history requirements of waterfowl, the use of sanctuaries to mitigate adverse impacts to waterfowl, and impacts of hunting through the harvest of waterfowl. Refuge-specific impacts of hunting on waterfowl are discussed in each of these sections.

Wintering Waterfowl – Waterfowl Habitats

Since the refuge consists of 80 percent wetlands, all recreational activity has the potential of impacting waterfowl, shorebirds, marsh birds, and other migratory bird populations feeding and/or resting near hunting area(s). Conflicts arise when migratory birds and humans are present in the same areas (Boyle and Samson 1985). Response of wildlife to human activities includes departure from the area (Owen 1973, Burger 1981, Korschgen et al 1985, Henson and Grant 1991, Kahl 1991, Klein 1993), use of suboptimal habitat (Erwin 1980, Williams and

Forbes 1980), altered behavior (Burger 1981, Korschen et al. 1985, Morton et al. 1989, Ward and Stehn 1989, Havera et al. 1992, Klein 1993), and increase in energy expenditure (Morton et al. 1989, Belanger and Bedard 1990). McNeil et al. (1992) found that many waterfowl species avoid disturbance by feeding at night instead of during the day.

During the period of September 1 – March 15, which is when most wintering and migrating waterfowl are on the refuge, adverse impacts to these birds could result from unregulated human disturbance in optimum waterfowl habitats at the refuge. This conclusion is based on the role of disturbance as it relates to waterfowl life history requirements and behaviors such as feeding, flight, metabolic processes, molting, preening, and resting. These daily waterfowl maintenance activities are costly from an energetic standpoint and require that waterfowl have undisturbed access to quality habitats with diverse food resources to meet their daily and seasonal energy requirements. Since these activities are critical to the survival of waterfowl, a discussion of their behaviors and metabolic processes is appropriate.

Feeding: Waterfowl have complex feeding strategies, which are conducted at optimum levels only in an environment void of disturbance. Feeding is the only activity that provides energy to birds, and the amount of time allocated to feeding is dependent upon relationships between energy-nutrient requirements and foraging strategies used in meeting these needs (King 1974). Feeding on readily available and easily consumed foods requires less time than feeding on dispersed food resources, foods which require searching (e.g. mobile invertebrates). or food that require complex foraging behavior (e.g., underground tubers) (Rapport 1980).

Generally, feeding periods for wintering waterfowl are early morning and late evening. Morton, et al., (1989) found that American black ducks spent an average of 4.49 hours per day feeding, with the majority of feeding activity occurring either during the first three hours after daylight, or the last three hours of the day, and then spent the remainder of the day engaging in resting, (4.54 hours) swimming, (1.83 hours), and engaging in other maintenance activities (balance of the day). This suggests that waterfowl, when undisturbed, prefer to feed early and late, and spend the remainder of the day in maintenance activities such as resting, preening, or courtship.

Mallards generally do not feed in water deeper than 40 cm (Thomas 1976), but prefer to feed in water depths of 10 cm or less (Fredrickson and Taylor 1982). This habitat type can be readily found within the refuge's impoundment complex. Accordingly, unregulated access to these habitats could adversely impact the feeding strategies of waterfowl using the refuge.

Flight: Many research projects have been conducted on the basic energy requirements of waterfowl, and these projects emphasize the importance of readily available food resources. As birds arrive in Delaware during fall migration, they need areas to rest and feed to replenish energy reserves. Migratory flight is often associated only with migration; however, it is important to recognize that approximately 90 percent of the migration period is spent in a stationary mode at successive stopover sites (Hedenstrom and Alerstam 1998). Birds at stopover sites spend their time resting and foraging as they rebuild protein and energy stores in preparation for their next migratory flight (McWilliams, et al 2004). It is also important to recognize that the cost associated with flight is a very expensive activity from a metabolic perspective and forcing birds into flight creates the need to replace lost energy reserves that could have been used for other maintenance activities. Protection is needed to allow waterfowl the opportunity to forage and replenish energy reserves depleted during migration to prevent the energetic expenditure associated with unnecessary flight.

Metabolic Processes: In addition to flight and along with rebuilding protein and energy stores, birds have basic energy maintenance requirements. These daily requirements, which include the energy costs of thermoregulation, maintenance of basal metabolic rate (BMR), and other activities, combine to account for 40-60 percent of the annual energy budget (Walsberg 1983). Thus, without reliable access to high quality food resources, waterfowl must either migrate to better habitats or suffer reduced fat reserves, which can result in below optimum body condition. As an illustration of the food resources required to maintain body condition, Magee (1996) found that, in waterfowl, the energetic cost of flight for one hour would require the equivalent energy reserves of enough foraging effort to consume 19.6 grams of corn (75 kernels) or 117.8 grams of amphipods (6,250 individuals) to replace lost energy reserves. And, from the standpoint of how fat deposition relates to reproductive potential, Heitmeyer (1985) discovered that hen mallards in the Mingo Basin of Missouri needed to reach a minimum weight threshold of 1,360 grams (>3 pounds) before leaving the wintering grounds to ensure there would be adequate fat reserves to initiate nesting activities upon arrival at the breeding grounds. At Chincoteague NWR, Morton et al (1989) found that wintering black ducks experienced reduced energy intake while doubling energy expenditure by increasing the time spent in locomotion in response to disturbance. Black

ducks used 10.4 times more energy in flight than at rest and used 1.8 times more energy in alert behavior or swimming than at rest, suggesting that human disturbance of wintering black ducks impaired their physiological condition, thereby reducing winter survival and/or nutrient reserves carried to the breeding grounds. Therefore, during migration stopovers, waterfowl must be afforded the time and opportunity to forage in high quality habitat to attain the desired body mass and fat depots, and replace lost energy reserves. To meet themetabolic demands of migration, waterfowl rely on many Federal, State, and private wetlands, including Prime Hook NWR, to rest, feed, and reacquire lost fatty deposits.

Molting: Feather molts are very costly from a metabolic standpoint, as waterfowl are converting from the alternate (summer) plumage to their basic (breeding) plumage. Most feathers are replaced during this period, as these birds are preparing for courtship rituals and pair bonding. Heitmeyer (1985) describes the prebasic molt of female mallards as extensive and intense, as these birds replace approximately 50 grams of feathers in a 6-7 week period, which requires a substantial amount of energy reserves. This increase in nutrient demand translates to the need for individual mallards to be afforded the opportunity for undisturbed foraging. Excess disturbance may negatively impact the ability of waterfowl to secure nutrients, thus disrupting molting processes and associated reproductive strategies.

Preening: Maintenance of feathers by preening has been previously correlated to molt activity and is undoubtedly influenced by molt chronology. Male mallards preen most often during autumn; but preening declines throughout early winter, which corresponds with declining molt activity (Combs 1987). Adverse impacts affecting preening activities would be similar to those associated with the molting process.

Resting: Resting appears to be a complementary activity to feeding, molting, and preening. As feeding declines from morning to afternoon, resting increases, which is necessary to allow birds to digest food consumed during previous periods of feeding (Paulus 1984b, Clark et al. 1986), and to rejuvenate muscle fibers that may have been damaged during periods of flight (McWilliams et al. 2004). The inability of waterfowl to rest may have a direct negative impact on the ability of waterfowl to digest foods and repair muscle fibers, thus impacting other necessary life history behaviors.

Waterfowl Sanctuaries

As discussed in the previous section, wintering waterfowl need access to areas that are free from human disturbance to complete seasonal and annual life cycle events. A disturbance can be characterized as an activity that causes an animal to deviate from behavior patterns that normally transpire without human influence. To explain further, a disturbance stimulus is produced when a human-related presence or object (e.g. birdwatcher, motorized vehicle) or sound (e.g. seismic blast or gunshot) occurs that causes changes to the natural behavioral patterns of animals (Frid and Dill 2002). Activities such as hiking, photography, jogging, hunting, fishing, boating, research and management activities, bicycling, and driving are among many types of disturbance that can and do occur on any National Wildlife Refuge. Because a disturbance free sanctuary is critical to waterfowl during the period of September 1 – March 15, it is important to understand that if unrestricted access is allowed to the entire refuge, the ability of the Prime Hook NWR sanctuary to meet the needs of waterfowl is reduced. The following sections discuss the values and functions of waterfowl sanctuaries and illustrate the impacts of disturbance on the ability of waterfowl to utilize habitats.

Disturbance is a primary factor influencing avoidance behaviors in waterfowl (Paulus 1984b, Heitmeyer 1985, Austin 1987) as ducks and geese are highly sensitive to motor traffic and human disturbance (walking, bird viewing, vehicular traffic) along roads during fall and winter (e.g., Bartelt 1987, Belanger and Bedard 1989, 1990, Bowles 1995, Dalhgren and Korschgen 1992, Gabrielson and Smith 1995, Heitmeyer 1985, Klein 1989, Knight and Cole 1991, 1995; Madsen 1985, Van Der Zande et al. 1980, Raasch 1996). Thus, when waterfowl are in areas adjacent to roads, they reduce time spent foraging and spend more time alert and vigilant to disturbance. For instance, a research study examining disturbance effects conducted on Mingo NWR in southeastern Missouri showed that mallards became alert at a mean distance of 213 meters (m), which is equivalent to 698 feet (ft), and flew from the site at a mean distance of 173 m (568 ft) in response to vehicle disturbance (Raasch 1996). In another study in Virginia, Pease, et al. (2005) described the responses of seven species of dabbling ducks to six different forms of disturbance and recorded whether the birds had: 1) no response; 2) alert response; 3) swam; and 4) flew. Analysis of the data from Virginia showed that 74.2 percent of birds responded (alert, swam, or flew) when birds were within 200 m (656 ft) of a human caused disturbance. As a result, when birds exhibit avoidance behaviors, swimming and flying activities increase while resting and feeding activities decrease (Combs 1987). This activity creates the need for additional foraging effort, which in turn influences seasonal movements and habitat selection. Areas that do not have regulations can cause increased human-wildlife interactions that can negatively affect the life history behaviors and metabolic processes of migratory waterfowl.

Laskowski et al. (1993) studied behavior of snowy egrets, female mallards, and greater yellowlegs on Back Bay NWR in Virginia within 91.4 meters of impoundment dikes used by the general public. The behavior of snowy egrets was recorded during August and September; mallards were monitored during migration in November and January; and greater yellowlegs behavior were observed during the northward shorebird migration. Researchers observed the behavior of birds during the typical public activities of walking, bicycling, and driving vehicles past the sample sites.

The study found that snowy egret resting behavior decreased and alert behavior increased in the presence of humans. Preening decreased when humans were present, but this change was not significant. Feeding, walk/swim, and flight behaviors were not related to human presence. Female mallards in November increased feeding, preening and alert behaviors in the presence of humans. Resting, walk/swim, and flight behavior were not influenced by human presence. In January, female mallard resting and preening behavior were not influenced by the presence of humans. However, feeding, alert, walk/swim, and flight behaviors were related to human presence. Greater yellowlegs increased alert behavior in the presence of humans. No other behaviors were affected. Maintenance behavior (combined feeding, resting, and preening) decreased when humans were present for all study species. In addition, this decrease was accompanied by an increase in escape behavior by each species. Maintenance behavior of mallards in January decreased in the presence of vehicles and combined disturbance. Escape behavior increased when vehicles or bicycles were present. Maintenance behavior of greater yellowlegs declined when bicycles and vehicles were present but was not influenced by pedestrian presence. Snowy egrets and female mallards increased movement between subplots and to areas within the study area but further from the disturbance.

The speed of vehicles has been identified as a factor that affects waterfowl response behavior. Objects that approach waterfowl quickly tend to frighten birds more often than objects that approach at lower speeds (Frid and Dill, 2002). Pease (2005), found that vehicles traveling more than 13 miles per hour but less than 30 miles per hour created the least amount of disturbance. As a contrast to speed, Pease noted that humans approaching waterfowl on foot had a greater disturbance impact than passing vehicles. Thus, research suggests that waterfowl are disturbed less by vehicles that pass at a moderate rate of speed, and more distressed by vehicles going very fast, very slow, or by humans on foot.

Non-motorized boating can affect refuge resources in a number of ways. Studies show that canoes and kayaks disturb wildlife (Bouffard 1982, Kaiser and Fritzell 1984 Knight 1984; Kahl 1991). The use of non-motorized boats can affect waterfowl broods, wintering waterfowl, shorebirds, raptors, and wading-birds. The low speeds associated with these boat types and their use primarily during the warmer months would mitigate those impacts, especially on wintering waterfowl and raptors. Canoeing/kayaking occur in areas frequented by shorebirds less often. Air thrust boats and jet skis are not permitted.

When birds leave the refuge because of human disturbance, high quality habitat is left unutilized for the duration of time that the birds are displaced. The length of time that a bird is displaced from a feeding site determines how much additional foraging effort will be required to replace lost food resources, which in turn impacts other maintenance activities such as molting, resting and preening. There are a number of research studies that examined how long it took waterfowl to return to habitats after being disturbed. For example, the return rate of mallards and Canada geese at Mingo NWR following vehicular disturbance indicated that two thirds of the birds were displaced after 25 minutes. At the Russell Lakes State Wildlife Area in Colorado, mallards flew from a pond during disturbances and did not return within 1 hour (George et al. 1991). In Wisconsin, only 15-56 percent of canvasbacks returned to foraging sites following disturbances (Kahl 1991), and staging snow geese populations in Quebec were found to be lower the day after they have been disturbed at a rate of less than two disturbances per hour, and that vehicular disturbance and unobstructed visual sight planes of approximately 400-500 m (1312 -1640 ft) are detrimental to waterfowl use and subsequent rates of return (Belanger and Bedard 1989). Thus, repeated disturbances (> 2 per hour), which could occur if unregulated access is permitted, can have serious detrimental impacts on the utilization of seasonal wetlands, which may ultimately cause birds to completely abandon a site, disperse to poorer quality habitat, and/or change feeding strategies.

Public use and access is important, but uses must be managed so that disturbance to wildlife is minimized and habitat utilization is not compromised. With these objectives in mind, it becomes necessary to recognize that disturbance to waterfowl early and late in the day can negatively impact biological processes such as feeding, flight, metabolic processes, molting, preening, and resting. For example, birds are feeding early in the morning

to obtain food resources, but are beginning to come to roost at sunset to begin a period of rest after returning from evening feeding. This period of rest is just as important as feeding because it permits the digestion of food prior to roosting and allows the repair of muscle fibers damaged during flight. Therefore, if measures to minimize or eliminate the cause of disturbance are not considered, the impacts from these activities can negatively affect the potential for wildlife to acquire the necessary resources needed to meet nutritional life history requirements throughout their annual life cycle (Raasch 1996, Fredrickson and Reid, 1988).

Providing waterfowl sanctuaries will minimize some of these impacts. Sanctuaries afford undisturbed access to waterfowl during biologically critical periods of the day. Havera et al. (1992) and Dahlgren (1988), in comprehensive literature reviews of human disturbances to migrating and wintering waterfowl, note that the use of sanctuaries (non-hunted areas) is the most common and effective solution to mitigating adverse disturbance impacts.

The use of sanctuaries as a management tool is an old concept. Bellrose (1954) wrote of the early 1900's when owners of duck lands found that providing non-hunted areas on their properties was of value in building and holding concentrations of waterfowl. A distinctive degree of sense of security constituted the principal factor governing duck use of areas that were all hunted, half hunted/half unhunted, or no hunting. Waterfowl numbers averaged 16 times more abundant per acre on half hunted/half unhunted areas than on areas that were completely hunted.

Other hunting measures that serve to mitigate adverse impacts to waterfowl:

1) provide adequate buffer areas and large enough sanctuaries to ensure full use by waterfowl;

2) provide "temporal respite" for ducks by limiting hunts to half days and/or use an intermittent hunt program (3-4 hunts/week); and

3) regulate hunter access limiting boat access and traffic to specific areas.

To minimize waterfowl disturbance, the refuge has designated approximately 3,000 acres as waterfowl sanctuaries. These areas will be closed to hunting and other recreational uses on a seasonal or annual basis. Given the dominant role of the refuge in the Atlantic Flyway migration corridor, this closed area system was established to provide waterfowl with a network of resting and feeding areas and to disperse waterfowl hunting opportunities on the refuge. These sanctuaries support policy 7 RM 3.6D. These sanctuaries lie in the Unit II (~1,800 acres) and the southern half of the Unit III (~970 acres) managed impoundments. The northern portion of Unit IV (~230 acres), which contains a proposed trail and observation platform, will be closed from the Monday before Thanksgiving to March 15 to also minimize disturbance to wildlife in this area. Waterfowl hunting will be terminated at noon in all hunting areas on limited hunting days to reduce disturbance to waterfowl feeding patterns, which in turn will result in high quality hunting experiences. Literature reviews of visitor use and its relationship to disturbance to waterbirds support the time restriction and are reflected in the hunting regulations of other refuges, particularly in the Southeast Region of the FWS (DeLong 2002).

Hunting is a priority, wildlife-dependent, consumptive activity with additional direct effects on waterfowl. General adverse impacts of waterfowl hunting are mortality, crippling and disturbance. Belanger and Bedard (1995) concluded that disturbance caused by waterfowl hunting to waterfowl resources can:

1) modify the distribution and use of habitats by waterfowl;

2) affect their activity budget and decrease their foraging time; and

3) disrupt pair and family bonds and contribute to increased hunting mortality.

The U.S. Fish and Wildlife Service annually prescribe frameworks, or outer limits, for dates and times when hunting may occur and the number of birds that may be taken and possessed. These frameworks are necessary to allow State selections of season and limits for recreation and sustenance; aid Federal, State, and tribal governments in the management of migratory game birds; and permit harvests at levels compatible with

population status and habitat conditions. Because the Migratory Bird Treaty Act stipulates that all hunting seasons for migratory game birds are closed unless specifically opened by the Secretary of the Interior, the Service annually promulgates regulations (50 CFR Part 20) establishing the frameworks from which States may select season dates, bag limits, shooting hours, and other options for each migratory bird hunting season. The frameworks are essentially permissive in that hunting of migratory birds would not be permitted without them. Federal annual regulations both allow and limit the hunting of migratory birds.

Migratory game birds are those bird species so designated in conventions between the United States and several foreign nations for the protection and management of these birds. Under the Migratory Bird Treaty Act (16 U.S.C. 703-712), the Secretary of the Interior is authorized to determine when "hunting, taking, capture, killing, possession, sale, purchase, shipment, transportation, carriage, or export of any bird, or any part, nest, or egg" of migratory game birds can take place, and to adopt regulations for this purpose. These regulations are written after giving due regard to "the zones of temperature and to the distribution, abundance, economic value, breeding habits, and times and lines of migratory flight of such birds, and are updated annually (16 U.S.C. 704(a)). This responsibility has been delegated to the U.S. Fish and Wildlife Service as the lead federal agency for managing and conserving migratory birds in the United States. Acknowledging regional differences in hunting conditions, the Service has administratively divided the nation into four Flyways for the primary purpose of managing migratory game birds. Each Flyway (Atlantic, Mississippi, Central, and Pacific) has a Flyway Council, a formal organization generally composed of one member from each State and Province in that Flyway. Prime Hook NWR is in the Atlantic Flyway.

The process for adopting migratory game bird hunting regulations, located in 50 CFR part 20, is constrained by three primary factors. Legal and administrative considerations dictate how long the rule making process will last. Most importantly, however, the biological cycle of migratory game birds controls the timing of data-gathering activities and thus the dates on which these results are available for consideration and deliberation. The process of adopting migratory game bird hunting regulations includes two separate regulations-development schedules, based on "early" and "late" hunting season regulations. Early hunting seasons pertain to all migratory game bird species in Alaska, Hawaii, Puerto Rico, and the Virgin Islands; migratory game birds other than waterfowl (e.g. dove, woodcock, etc.); and special early waterfowl seasons, such as teal or resident Canada geese. Early hunting seasons generally begin prior to October 1. Late hunting seasons generally start on or after October 1 and include most waterfowl season not already established. There are basically no differences in the processes for establishing either early or late hunting seasons. For each cycle, Service biologists and others gather, analyze, and interpret biological survey data and provide this information to all those involved in the process through a series of published status reports and presentations to Flyway Councils and other interested parties. Though not as detailed as that for waterfowl, relevant data are collected and summarized for migratory bird species such as dove, woodcock, etc. Bird monitoring data are available through the Service's Division of Migratory Bird Management Website (*http://www.fws.gov/migratorybirds/*; accessed February 2012).

Because the Service is required to take abundance of migratory birds and other factors into consideration, the Service undertakes a number of surveys throughout the year in conjunction with the Canadian Wildlife Service, State and Provincial wildlife-management agencies, and others. To determine the appropriate frameworks for each species, several factors are considered such as population size and trend, geographical distribution, annual breeding effort, the condition of breeding and wintering habitat, the number of hunters, and the anticipated harvest. After frameworks are established for season lengths, bag limits, and areas for migratory game bird hunting, migratory game bird management becomes a cooperative effort of State and Federal Governments. After Service establishment of final frameworks for hunting seasons, the States may select season dates, bag limits, and other regulatory options for the hunting seasons. States may always be more conservative in their selections than the Federal frameworks but never more liberal. Season dates and bag limits for National Wildlife Refuges open to hunting are never longer or larger than the State regulations. In fact, based upon the findings of an environmental assessment developed when a National Wildlife Refuge opens a new hunting activity, season dates and bag limits may be more restrictive than the State allows.

National Environmental Policy Act (NEPA) considerations by the Service for hunted migratory game bird species are addressed by the programmatic document, "Final Supplemental Environmental Impact Statement: Issuance of Annual Regulations Permitting the Sport Hunting of Migratory Birds (FSES 88-14)," filed with the Environmental Protection Agency on June 9, 1988. A Notice of Availability is published in the Federal Register on June 16, 1988 (53 FR 22582), and our Record of Decision on August 18, 1988 (53 FR 31341). Annual NEPA

considerations for waterfowl hunting frameworks are covered under a separate Environmental Assessment in which the FONSI is published generally in August of that hunt year. Further, in a notice published in the September 8, 2005, Federal Register (70 FR 53376); the Service announced its intent to develop a new Supplemental Environmental Impact Statement for the migratory bird hunting program. Public scoping meetings were held in the spring of 2006, as announced in a March 9. 2006, Federal Register notice (71 FR 12216). More information may be obtained from Chief, Division of Migratory Bird Management., US Fish and Wildlife Service, Department of the Interior, MS MBSP-4107-ARLSQ, 1849 C Street, NWR, Washington, DC 20240.

At Prime Hook NWR, the impacts of hunting of waterfowl are negligible when compared to the State's total waterfowl harvest. For example, from 1987 to 2009, the average annual waterfowl harvest at the refuge is 2.6 percent of Delaware's total waterfowl harvest (Table 1.1). Furthermore, in 2009, the refuge's harvest of ducks was only 3.4 percent of Delaware's total duck harvest, 0.96 percent of the Atlantic Flyway's duck harvest, and 0.01 percent of the entire United States' duck harvest (Table 1.2; Raftovich et al. 2011). Also in 2009, the refuge's harvest of geese (Canada and snow geese combined) was only 0.82 percent of Delaware's total goose harvest, 0.04 percent of the Atlantic Flyway's goose harvest, and 0.01 percent of the entire United States' goose harvest. (Table 1.2; Raftovich et al. 2011).

The impacts of waterfowl hunting at the refuge are also negligible when compared to long-term trends in duck and goose populations at the refuge and across the state. Through monthly aerial surveys from October through November, the Delaware Division of Fish and Wildlife is able to evaluate long-term trends in duck and goose populations. The surveys give fairly accurate information about geese, but duck populations such as wood ducks and sea ducks are almost impossible to count. Furthermore, these surveys do not cover the entire state, but only the primary waterfowl habitat in Delaware, which is approximately the eastern half of the state. These figures represent the numbers of ducks and geese at the time of the survey, but do not reflect an actual annual estimate for the waterfowl population in Delaware due to the transitory nature of birds migrating through the State during the fall and winter months.

Based on the findings of these monthly surveys from 1987 to 2009, the average annual waterfowl harvest at the refuge is only 1.8 percent of the estimated peak waterfowl survey findings on the refuge (Table 1.1). During an individual season, the percent of the refuge's harvest on statewide and refuge populations may range greatly depending on the timing of refuge hunting activity and peak waterfowl migration. For example, during the 2009-2010 hunting season, the refuge harvested between 0.19 percent and 1.5 percent of the State's estimated monthly duck population and between 0.02 percent and 0.11 percent of the State's estimated monthly goose population (Table 1.3). Refuge hunters harvested between 0.31 percent and 6.15 percent of the refuge's estimated monthly duck population and between 0.09 percent and 1.48 percent of the refuge's estimated monthly goose population (Table 1.3).

Table 1.1. Waterfowl harvest and aerial survey estimates on Prime Hook NWR compared to statewide harvest. Waterfowl includes geese and ducks.

Year	Statewide Waterfowl Harvest*	Refuge Waterfowl Harvest	Refuge Waterfowl Survey**	Refuge Hunter Visits
1987	63,360	1,202	21,243	1,206
1988	62,160	771	21,814	826
1989	61,480	578	64,822	333
1990	59,510	1,241	49,611	1,065
1991	63,410	1,625	55,792	1,178
1992	46,600	1,155	55,238	1,291
1993	46,850	1,421	86,087	962
1994	53,290	2,053	155,096	1,604
1995	45,540	1,572	71,131	1,024
1996	44,170	1,980	104,447	1,630
1997	71,070	3,116	191,446	1,904

Year	Statewide Waterfowl Harvest*	Refuge Waterfowl Harvest	Refuge Waterfowl Survey**	Refuge Hunter Visits
1998	118,560	2,964	193,617	1,530
1999	96,410	1,987	224,693	1,403
2000	94,610	2,047	134,156	1,250
2001	76,210	2,679	107,919	1,683
2002	95,170	1,936	102,690	1,330
2003	88,800	2,546	203,615	1,486
2004	73,190	1,573	69,737	1,422
2005	71,740	1,624	111,544	1,301
2006	64,630	2,389	132,088	1,750
2007	81,620	2,989	44,086	1,850
2008	107,120	1,634	90,875	1,253
2009	86,600	1,934	79,263	1,453

**Statewide waterfowl harvest data from: http://www.flyways.us/regulations-and-harvest/harvest-trends*

*** Waterfowl estimates were derived from peak numbers found during aerial surveys. Zone 7 was used to estimate waterfowl numbers for the refuge, which covers the area from Big Stone Beach to the Broadkill River and east of Route 1. Only one survey was conducted in 2007 (October 2007) which may not have reflected the peak. (http://www.fw.delaware.gov/Hunting/Pages/Waterfowl%20Surveys.aspx)*

Table 1.2. Comparison of waterfowl harvest at Prime Hook NWR to State, Flyway, and United States harvest in the 2009 hunting season.

Waterfowl Harvest Area	Ducks	Geese
Prime Hook NWR	1,609	325
Delaware*	46,800	39,800
Atlantic Flyway*	1,680,100	922,200
United States*	13,139,800	3,327,000

**Harvest estimates from (Raftovich et al. 2011)*

Table 1.3. Comparison of duck and goose (Canada & snow geese) harvest at Prime Hook NWR to State waterfowl surveys during the 2009-2010 hunting season.

Month	Refuge Duck Harvest	Refuge Duck Population Estimates*	Statewide Duck Survey Results*	Refuge Goose Harvest	Refuge Goose Population Estimates*	Statewide Goose Survey Results*
Oct 2009	67	21,457	36,042	9	10,512	44,372
Nov 2009	406	30,548	63,516	104	18,734	92,604
Dec 2009	697	46,675	76,100	115	32,588	247,922
Jan 2010	439	7,141	28,688	97	6,565	102,229

** Waterfowl estimates were derived from peak numbers found during aerial surveys. Zone 7 was used to estimate waterfowl numbers for the refuge, which covers the area from Big Stone Beach to the Broadkill River and east of Route 1. (http://www.fw.delaware.gov/Hunting/Pages/Waterfowl%20Surveys.aspx)*

Impacts of refuge hunting on snow geese and resident Canada geese are negligible. For resident Canada geese, hunters averaged 8.8 birds per year from 2001 to 2006 (Table 1.4). For snow geese in the late season (late January into March), hunters averaged 16.0 birds per year from 2001 to 2006 (Table 1.5). From 2000 to 2009,

refuge hunters harvested between 0.04 percent and 0.43 percent of the refuge's estimated monthly snow goose population (Table 1.5).

Table 1.4. Resident Canada Goose Harvest in Prime Hook National Wildlife Refuge.

Year	Resident Canada Goose Harvest	Refuge Hunter Visits
2001	14	33
2002	6	15
2003	10	13
2004	14	10
2005	0	0
2006	9	2

Table 1.5. Snow Goose Harvest and Aerial Survey Estimates at Prime Hook National Wildlife Refuge.

Year	Total Snow Goose Harvest*	Hunted in Late Season**	Snow Goose Harvested in Late Season**	Refuge Hunter Visits in Late Season**	Refuge Snow Goose Survey***
2000	174	No	n/a	n/a	96,112
2001	242	Yes	37	42	67,840
2002	48	Yes	7	9	72,200
2003	118	Yes	33	24	124,500
2004	121	Yes	3	5	55,330
2005	36	Yes	4	8	86,627
2006	73	Yes	12	12	132,088
2007	130	No	n/a	n/a	30,500
2008	56	No	n/a	n/a	84,520
2009	43	No	n/a	n/a	27,000

** Includes snow geese harvested in February / March when applicable*

*** Late season includes late January to mid-March*

**** Snow goose estimates were derived from peak numbers found during aerial. Zone 7 was used to estimate snow goose numbers for the refuge, which covers the area from Big Stone Beach to the Broadkill River and east of Route 1. Only one survey was conducted in 2007 (October 2007) which may not have reflected the peak. (http://www.fw.delaware.gov/Hunting/Pages/Waterfowl%20Surveys.aspx)*

Migratory bird hunters may also disturb migratory birds and other wildlife as they travel to and from their hunting sites or when retrieving downed birds. Depending on the location and the number/species of migratory birds in the area, a disturbance can be temporary with displaced birds moving to nearby backwaters, or major in the case of motoring through a large flock of snow geese. For some species like bald eagles and other predators, migratory bird hunting creates a readily available food source due to birds lost or wounded.

Direct disturbance to waterfowl occurs during white-tailed deer hunting seasons, as hunters flush deer through wetlands, creeks, and open water habitats. Dogs running at large during upland game hunting seasons will also flush wintering waterfowl resting and feeding in both wetland and upland areas. The ingestion of lead sinkers or lead shot is another concern; however, the impacts are lessened on refuge lands due to regulations requiring the use of non-toxic shot for upland hunting, except for slugs for deer hunting.

Expanded hunting opportunities for deer and waterfowl will cause disturbance to waterfowl in refuge impoundments, Prime Hook Creek, and refuge salt marshes. On Prime Hook Creek, deer hunting will occur on Tuesday, Thursday, and Friday during the hunting seasons. On refuge impoundments in Unit III and Prime Hook Creek, waterfowl hunting will occur on Monday, Wednesday, and Saturday during the hunting season. If the opening day of any duck season is Friday, waterfowl hunting will be open and deer hunting will not occur. Impacts to waterfowl will be decreased from current management by changing the end of shooting time from 3:00pm

to noon. Participating in the early teal, resident Canada goose, and snow goose conservation order will cause direct impacts to increase but will be negligible based on current refuge harvest contributions to statewide and national harvests. Free roam areas for deer and waterfowl hunting (jump shooting) will provide hunters greater access and also increase the potential for waterfowl disturbance. These disturbances are mitigated by creating sanctuary areas where no waterfowl hunting occurs.

Proposed waterfowl hunting in Units I and IV salt marshes have the potential to increase adverse impacts and disturbance on refuge wintering American black ducks. Zoned hunting areas have been established in Unit IV to limit hunter numbers, thereby minimizing wildlife disturbance. Since black ducks are a focal species of conservation concern, monitoring and the evaluation of impacts of increased recreational use of salt marsh habitats will be required to identify and respond to unacceptable impacts.

Impacts to Shorebirds

Disturbance to shorebirds has been well documented. Pfister et al. (1992) investigated human disturbance as a factor that might limit the capacity of appropriate staging areas to support migrating shorebirds. Results indicate that adverse impacts from human disturbance will be greater on shorebird species using the front side of beach habitats and that the local abundance of impacted species may be reduced by 50 percent. Such disturbance is implicated as a potential factor in long-term declines in shorebird abundance during migration periods at disturbed sites.

Disturbance to shorebirds becomes very crucial during incubation or nesting periods. Direct adverse impacts of displacement caused by human disturbance during nesting periods include egg exposure to temperature extremes, predation of eggs when the nest is vacated by the adult, and predation at a later time due to predators following human trail or scent (Korschgen and Dahlgren 1992). Protection of nesting colonial shorebirds is easier than protection of solitary nesters, like the American oystercatcher and piping plover, because much larger beach areas must be protected, managed, and patrolled. Public education, active protection methods (small fences around nests, signs, wardens), legal measures (beach use regulations, active enforcement patrols), and well-advertised closures of portions of the beach are management actions that often successfully reduce the adverse impacts of human disturbance when shorebirds are most vulnerable. Protection of nesting colonies using fences and wardens has markedly decreased reproductive losses of least tern colonies in New Jersey (Burger 1995).

Based on these findings and past observations of impacts on shorebirds by refuge staff, disturbance by refuge hunters to shorebirds is expected to be negligible since most shorebird species have completely passed through Delaware by peak hunting season in November through January. Some hunting occurs when these species may be migrating before and after this peak hunting time. Shorebirds using refuge marsh habitats that are also open to hunting may be disturbed by hunters traveling in these areas or by their gunshots; however, established sanctuaries provide disturbance-free areas for migrating birds during the hunting season.

A direct beneficial impact for shorebirds is derived from seasonal closures to hunting and other public use. Minimizing human disturbance will increase nesting and foraging opportunities on overwash habitats which will subsequently increase shorebird nesting productivity. Seasonal closures of designated beach dunes and overwash areas from March 1 through September 1 are in place to minimize disturbance to nesting shorebirds such as least terns, American oystercatchers, and, potentially, piping plovers.

Indirect beneficial impacts on shorebirds are obtained by educating hunters about special beach closures with news releases and other outreach mechanisms to engage the public to understand the needs of nesting shorebirds. Public awareness and appreciation of the refuge's efforts to conserve and protect shorebirds could inspire some to volunteer or support refuge needs in the conservation and protection of critical habitats required to protect continental and hemispheric shorebird resources in perpetuity in other ways.

Impacts to Landbirds

Disturbance to landbirds has been well documented. Pedestrian travel can influence normal behavioral activities, including feeding, reproductive, and social behavior and the location of recreational activities impacts species in different ways. Miller et al. (1998) found that nesting success was lower near recreational trails, where human activity was common, than at greater distances from the trails. A number of species have shown greater reactions when pedestrian use occurred off trail (Miller et al. 1998). For songbirds, Gutzwiller et al. (1997) found that singing behavior of some species was altered by low levels of human intrusion.

Some other species, such as wood thrush, will avoid areas frequented by people, such as developed trails and buildings, while other species, particularly highly social species such as tufted titmouse, Carolina chickadee, or Carolina wren, seem unaffected or even drawn to a human presence. When visitors approach too closely to nests, they may cause the adult bird to flush exposing the eggs to weather events or predators.

Disturbance to these non-hunted migratory birds could have regional, local, and flyway effects. Regional and flyway effects would not be applicable to species that do not migrate such as most woodpeckers, and some songbirds including cardinals, titmice, wrens, chickadees, etc. We expect disturbance to non-hunted landbirds, such as feeding and resting, to increase due to an expected increase in deer hunters in new free roam hunting areas. However, the direct, indirect, and cumulative impacts of hunting on these non-hunted landbirds are expected to be negligible because the deer, upland game, and waterfowl hunting seasons are during the fall and winter months which do not coincide with the critical nesting periods of most bird species. Turkey hunting, which does occur during the nesting season of many non-hunted landbird species in April and May, is expected to have negligible impacts because hunter numbers are limited to less than five and are scattered over 3,472 acres.

Direct impacts to hunted landbirds such as quail, woodcock, and snipe are expected to remain stable since no increase in upland game hunting is expected. Hunting of resident game species such as quail does not have any regional impact on their respective populations due to their restricted home ranges. Delaware Division of Fish & Wildlife periodically reviews populations of all harvested resident species, and has determined that populations are adequate to support hunting efforts throughout the State. The refuge contributes negligibly to the State's total harvest for resident game species. For example, the number of quail taken per year has been no more than 14 per year on the refuge in recent years (Table 1.6).

Table 1.6. Number of upland game, small game, and webless migratory birds harvested and hunter visits on Prime Hook NWR.

Year	Dove Harvest	Snipe Harvest	Woodcock Harvest	Quail Harvest	Rabbit Harvest	Refuge Hunter Visits*
1996	110	0	0	5	83	126
1997	77	0	0	0	117	169
1998	30	0	0	0	46	112
1999	90	0	0	0	98	123
2000	13	0	0	0	29	81
2001	6	0	0	0	65	128
2002	58	0	0	0	163	114
2003	13	0	0	0	79	81
2004	12	0	0		75	53
2005	6	0	0	0	257	129
2006	20	0	0	14	115	106
2007	22	0	0	11	145	178
2008	0	0	1	10	176	171
2009	0	0	6	1	163	149

**Hunter visits include all species combined; majority are hunting rabbits*

For migratory birds such as mourning dove, an estimated 36,300 birds were harvested in Delaware during the 2009 season (Table 1.6; Raftovich et al. 2011) when none were taken on the refuge. (Table 1.7). Similarly, very few snipe and woodcock were harvested (Table 1.7). Direct, indirect, and cumulative impacts on these species on the refuge are negligible. See Impacts to Waterfowl for a description of how the Federal and State migratory bird hunting frameworks are established.

Table 1.7. Comparison of mourning dove, woodcock, and snipe harvest at Prime Hook NWR to State, Flyway, and United States harvest in the 2009 hunting season.

Harvest Area	Dove	Woodcock	Snipe
Prime Hook NWR	0	6	0
Delaware*	36,300	200	0
Eastern Management Unit*	7,639,200	63,300	43,600
United States*	17,354,800	238,400	83,500

**Harvest estimates from (Raftovich et al. 2011); Estimates for snipe are from the Atlantic Flyway*

Turkey hunting is proposed only if a huntable population is found to exist on the refuge. This will be determined through coordination with the Delaware Division of Fish & Wildlife. Currently, turkey hunting occurs in other areas of Delaware.

The hunting of deer can be a beneficial impact to landbirds. The reduction of the vegetation's physical structure and diversity due to overbrowsing by deer also can negatively impact landbirds. Casey and Hein (1983) have found greatly reduced bird species diversity in areas with long term, high density populations of deer. These changes were mainly attributed to habitual landscape alteration with pronounced browse line and sparse cover caused by overbrowsing.

Impacts on Secretive Marsh and Waterbirds

Resident waterbirds tend to be less sensitive to human disturbance than migrants, and thus will be less impacted by disturbance from public use on the refuge. However, wading birds have been found to be extremely sensitive to disturbance in the northeastern U.S. and may be adversely impacted by disturbance from public use on the refuge (Burger 1981). The impacts of intrusion through public use are generally negligible for this group of birds, but can vary by species and between years (Gutzwiller and Anderson 1999).

Disturbance to secretive marsh birds and waders from hunting would start in September and usually end in January, unless hunting is allowed during the snow goose conservation order into mid-April. This disturbance may have direct effects on migrating and wintering secretive marsh birds and waders. However, these birds would receive added benefits from the establishment of new sanctuary areas or zones, where 3,000 acres would be protected from hunting activities that cause disturbances to secretive marsh and waterbirds.

Impacts on Fisheries

Impacts to fisheries from visitors engaged in hunting are expected to be temporary and negligible. Increased deer and waterfowl hunting on Prime Hook Creek and Unit III impoundments will cause increased suspension of bottom sediments from boat motors. However, since hunting occurs during the fall and winter months, this sediment suspension should not adversely affect biological oxygen demand (BOD) for fisheries resources. Early season hunters may harm submerged or emergent vegetation by accessing small ditches, which may cause negligible adverse impacts to protective cover for fisheries based on past observations of these impacts from refuge staff. Effects on interjurisdictional fishes are expected to be unlikely from hunting because the majority of the refuge will experience minimal, transitory use by hunters.

Impacts on Mammals

In general, the presence of humans will disturb most mammals, which typically results in indirect negligible short-term adverse impacts without long-term effects on individuals and populations.

Adverse impacts on resident game populations from hunting would be negligible. The Delaware Division of Fish and Wildlife periodically reviews populations of all harvested resident species and has determined that populations are adequate to support hunting efforts throughout the State. Hunter visits and harvest of upland and small game such as rabbit on the refuge have been relatively low (Table 1.6) and impacts are expected to be negligible. The refuge does not allow hunting of eastern gray squirrel to minimize conflicts with endangered Delmarva fox squirrel.

Overall impacts from hunting on non-hunted mammals, such as voles, moles, mice, shrews, and bats, are expected to be negligible. Since small mammals are less active during winter when hunting season occurs, and since these species are mostly nocturnal, hunter interactions with small mammals are very rare. Vehicles are restricted to roads and harassment or taking of any wildlife other than legal game species is not permitted. Impacts of hunting to migratory bat species would be negligible. Except for some species of migratory bats, these species have very limited home ranges and hunting would not affect their populations regionally. These species are in torpor or have completely passed through Delaware by peak hunting season in November through January. Some hunting occurs during September-October and March-April when these species are migrating; however, hunter interaction would be commensurate with that of non-consumptive users.

The Delaware Division of Fish and Wildlife recently finalized a new statewide 10-year deer management plan (Rogerson 2010). The plan was created with input from a 22-member advisory group, a public phone attitude survey, a mail survey to hunters, comments solicited from the general public, and technical reviews from deer experts outside the division. The resulting plan identifies population objectives based on habitat capability and societal tolerances.

Prime Hook NWR is located in the State's deer management zone 9, which encompasses the northeastern coastal portion of Sussex County (Rogerson 2010). The Division of Fish and Wildlife manages deer populations, in part, through recreational hunting. Based on their monitoring programs, the Division of Fish and Wildlife adjusts hunting levels in terms of season length, sex ratio in the harvest, and number of hunters (tag availability) to move population levels toward desired objectives. Of course, other factors such as disease, severe weather, predation, and automobile collisions influence mortality are taken into account by annual monitoring.

Delaware deer herd statistics indicate that the deer density in zone 9 was estimated in 2009 at 22.5 deer per square mile with a variability of plus or minus 20.75 percent (Rogerson 2010). This is a decrease of 58 percent from the 2005 estimated density of 39.2 deer per square mile (Rogerson 2010). The total Statewide post-hunting season deer population in 2005 was estimated at 37,563 deer, while in 2009 it was estimated at 31,071 deer, a 17.3 percent Statewide reduction. Major land use changes over the last 100 years have created a deer herd that exceeds normal deer densities of 10 to 20 deer per square mile.

High deer numbers are associated with crop damage, reduction of some forest understory species, and reduction of reforestation seedling survival, which all impact habitat that is important for a variety of wildlife. White-tailed deer hunting is the single most important public use on the refuge that would impact mammals, including deer, and other forest-dependent wildlife. It serves both as a wildlife-dependent recreational use and a method to reduce and stabilize deer densities. This benefits other mammals, including the endangered Delmarva fox squirrel.

Based on a nationwide survey of all states (Krausman 1992), deer populations are effectively controlled with hunting and habitat manipulation in many areas where they were overpopulated. In a 10-year study in northwestern Pennsylvania examining the impacts of varying densities of deer on deer health and habitat, starvation mortality resulted when densities reached higher than 25 deer per square kilometer (247 acres). Also, no prevention or control of epizootic hemorrhagic disease exists to date except by keeping populations below the carrying capacity of their habitats. Such breakouts have occurred on the refuge in the past. Based on these considerations, it is anticipated that hunting would have short-term and long-term minor-to-moderate beneficial impacts on deer health and quality and habitat condition.

Hunting resident game species on the refuge, such as deer, will result in negligible impacts on their populations because of their restricted home ranges. The refuge contributes negligibly to the State's total harvest for resident game species (figure 1.1 and tables 1.8 and 1.9). For example, since 1999, deer harvest at the refuge has ranged from 0.8 percent to 1.5 percent of Delaware's total deer harvest each year. The current harvest level of deer on the refuge (107) has a negligible impact on the Statewide deer population of 31,071 deer (Table 1.9). Given the low numbers of animals harvested from the refuge in respect to the total Statewide harvest and deer population, no cumulative impacts to local, regional, or Statewide populations of white-tailed deer are anticipated from allowing hunting of the species on the refuge. Additional information on the status of the Delaware deer herd and the Delaware hunting program can also be found in the refuge Hunt Plan (appendix C).

Figure 1.1. Delaware annual deer harvest, 1954 – 2008/09 seasons. ***(Source: Rogerson (2010)***

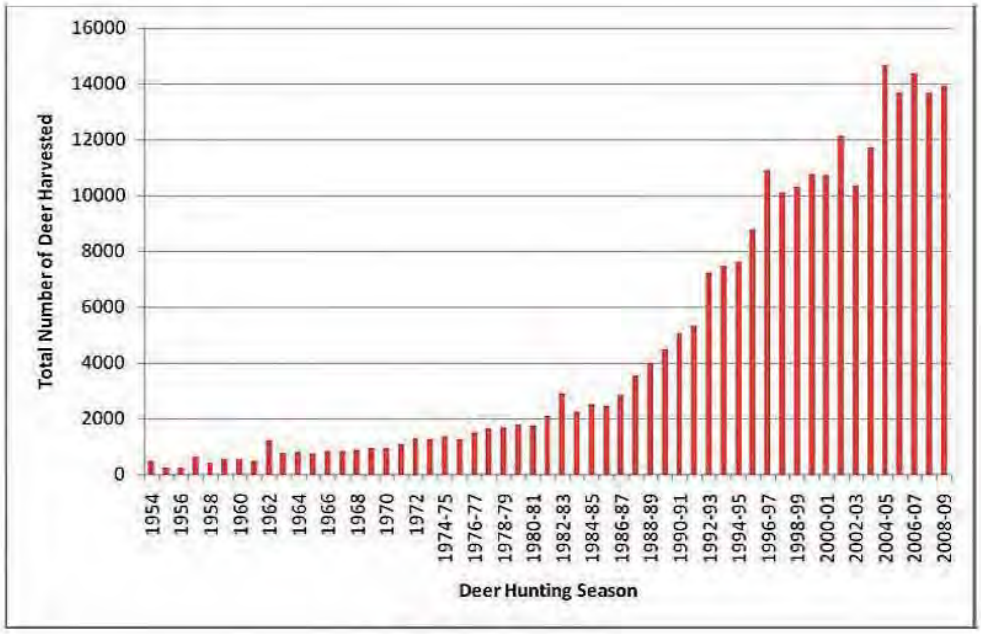

Table 1.8. Number of deer harvested and hunter visits on Prime Hook NWR compared to statewide harvest ***(Source: Refuge harvest data****; http://www.dnrec.state.de.us/fw/deer.pdf; http://www.fw.delaware.gov/Hunting/Documents/2007-08%20Historical%20Delaware%20White-tailed%20Deer%20Summary.pdf)*

Year	Statewide Deer Harvest	Refuge Deer Harvest	Refuge Hunter Visits
1988	3,998	141	1,289
1989	4,504	155	1,131
1990	5,066	178	1,689
1991	5,336	163	1,703
1992	7,245	257	1,608
1993	7,465	219	1,616
1994	7,615	169	1,568
1995	8,781	217	1,184
1996	10,915	221	1,326
1997	10,091	187	1,510
1998	10,312	138	1,335
1999	10,756	114	870
2000	10,741	125	941
2001	12,133	188	1,003
2002	10,357	160	913
2003	11,712	175	891
2004	14,669	143	841

2005	13,670	133	884
2006	14,401	120	825
2007	13,369	108	790
2008	13,926	106	670
2009	12,400*	107	552

**Data from DNREC (2010b).*

Table 1.9. Cumulative impacts of existing deer hunting on Prime Hook NWR/State Deer Management Zone 9 (2009-2010 data) compared to Statewide Harvest.

Hunt Location & Type	Harvest
Prime Hook NWR	107
State Deer Management Zone 9	767
Statewide Harvest (all 17 Deer Management Zones)	12,400

Delaware permits hunting for red fox, which assists State management efforts in reducing the incidence of mange outbreaks to maintain a healthy population and reducing the predatory impact of this species on migrating and breeding birds, particularly State and federally endangered or threatened species. Hunting would be opportunistic in most cases. In other states, the incidental harvest of fox occurs during other open seasons such as deer season and the pelts are often retained for personal use. Though no county-specific data are available, healthy populations of fox exist in the State and anticipated harvest rates would result in negligible impacts to local or State populations (Reynolds, personal communication 2010).

Impacts to Amphibians and Reptiles

The direct, indirect, and cumulative effects of hunting to amphibians and reptiles such as snakes, skinks, turtles, lizards, salamanders, frogs, and toads are expected to be negligible. Hibernation or torpor by cold-blooded reptiles and amphibians limits their activity during the hunting seasons for deer, waterfowl, and upland game when temperatures are low and hunters would rarely encounter them during most of the hunting season. Turkey season occurs during the warmer months of April and May; however, the impact of turkey hunters is expected to be negligible because hunter numbers are limited to less than five and are scattered over a large area.

Impacts to Invertebrates

Impacts to invertebrates such as butterflies, moths, other insects, and spiders are expected to be negligible. Invertebrates are not active during the majority of the hunting seasons and would have few interactions with hunters during the hunting season.

Impacts on Public Use and Access

Public opportunities to hunt on the Delmarva Peninsula are decreasing with increasing private land development. Refuge lands have become increasingly important in the region as a place to engage in this activity. A recent study found that 78% of hunters in Delaware hunt on private land (U.S. Department of the Interior 2006). When asked the importance of hunting activities in the USGS Visitor and Community Survey (Sexton et. al 2007), a little over half of responses were rated as moderately to very important. Both consumptive and nonconsumptive use visitors reported that being in a natural, undeveloped area and experiencing a serene environment are equally important to their refuge experience as well as the trails that afford this opportunity (Sexton et. al 2007).

Hunters have the opportunity to harvest a renewable resource in a traditional manner, which is culturally important to the local community. Refuge lands allow the public to enjoy hunting at no or little cost in a region where private land is leased for hunting, often costing a person several hundred to several thousand dollars per year for membership. Refuge hunting programs also make special accommodations for mobility-impaired hunters and youth hunters, which provide opportunities to experience a wildlife-dependent recreational activity, instill an appreciation for and understanding of wildlife, the natural world and the environment and promote a land ethic and environmental awareness.

The moderate beneficial impacts of providing the existing level of wildlife-dependent activities, with some modest increases, include helping meet existing and future demands for outdoor recreation and education, as documented in the State Comprehensive Outdoor Recreation Plan (DNREC 2003) and in the Visitor and Community Survey (Sexton et. al 2007). Visitors interested in hunting would find high quality opportunities to engage in their favored pastime. Visitor use is increasing over time as local residents and visitors become increasingly aware of Refuge opportunities, and as we progress in creating new facilities and programs. The economic benefits of increased tourism likely would also benefit local communities. There are also hunting opportunities for individuals with disabilities.

The refuge would also be promoting a wildlife-oriented recreational opportunity that is compatible with the purpose for which the refuge was established. The public would have an increased awareness of the refuge and the National Wildlife Refuge System and public demand for more areas to hunt and learn about wildlife would be met. Over time, it is reasonable to believe that public awareness of the refuge would increase, and, in turn, visitation would increase on the areas open to hunting. The refuge may or may not be capable of meeting the demand as it increases and would depend on staffing levels and the availability of partners and volunteers to assist.

Eventually, the level and means of use resulting from this increase in visitation could change the nature of the experience for many visitors. Some may choose either to forgo hunting due to issues of crowding or behavior, or to go elsewhere. Because the refuge provides opportunities now for only a small portion of the area's hunters, if that shift occurs, it is not imminent and would likely occur outside the 15 year life of the Comprehensive Conservation Plan. If it does occur, it could put additional strains on other public lands, or diminish the refuge contribution to the mission of the Refuge System. We would work to avoid that by continuing to distribute our programs and facilities to minimize conflicts among users.

The hunting program for deer, waterfowl, upland game and webless migratory birds (dove), and turkey provides an administratively simple program that balances other public use activities, supports Presidential Executive Order: Facilitation of Hunting Heritage and Wildlife Conservation and regional directives, parallels State hunting regulations, provides seasonal closures to minimize wildlife disturbance and/or avoid conflicts with other uses, eliminates hunting fees except for lottery hunts, enhances disabled hunting opportunities, and further develops an appreciation for fish and wildlife. The number of hunters that will participate in refuge hunting opportunities varies annually; however, it is anticipated that a slight increase from current levels will occur.

Preseason lottery drawings at the refuge provide hunting opportunities for local, in-State, and out-of-State hunters. Knowing in advance of a hunting opportunity allows hunters to prepare, plan, and scout, which ultimately helps to provide a quality hunting experience.

Hunting areas will be closed to other public uses, unless the other public uses can be safely sequestered to other locations separate from the locations of hunting activity. Experience has proven that time and space zoning (e.g., establishment of separate use area, use periods, and restriction on the number of users) is an effective tool in eliminating conflicts between user groups. Seasonal closures apply to non-consumptive users during the hunting season, which is typically a slower period of use due to weather conditions. Short-term, moderate adverse impacts are expected for non-consumptive users due to the seasonal closures that are highlighted below:

1) Western Prime Hook Creek (from old shop ramp to Waples Pond) (Unit III): Closed every day during the deer and waterfowl hunting seasons, which typically starts on September 1 and ends in early February. Additional seasonal closures may apply through the second Saturday in May for hunting during the snow goose conservation order and/or turkey hunting.

2) Deep Branch Road Trail (includes Goose & Flaxhole Ponds) and Eastern Prime Hook Creek (from old shop ramp to HQ ramp) (Unit III): Closed every day from September 1 through March 15. Additional seasonal closures may apply through the second Saturday in May for hunting during the snow goose conservation order and/or turkey hunting.

3) Headquarters Area (includes Turkle & Fleetwood Ponds) (Unit III): Closed only for a maximum of two days for deer hunts.

4) The northern portion of Unit IV (includes trail overlooking Vergie's Pond): Closed from the Monday before Thanksgiving through March 15. Additional seasonal closures may apply through the second Saturday in May for hunting during the snow goose conservation order and/or turkey hunting.

5) Hiking Trails on Fowler Beach Road (Unit I), Prime Hook Road (Unit III), and Slaughter Beach Road and Slaughter Canal (Unit I): Closed on Sundays from September 1 through the deer and waterfowl hunting seasons, which typically end in early February. Additional seasonal closures may apply through the second Saturday in May for hunting during the snow goose conservation order and/or turkey hunting.

According to the USGS Visitor and Community Survey (Sexton et. al 2007), the overall mean desirability of additional hunting opportunities was not as high as that of other public use activities. However, upon further breakdown between hunters and non-hunters, the additional hunting opportunities listed were very desirable by the hunting community.
The improvement of habitat quality from ongoing habitat management projects would likely result in an increase in some game populations and positively affect the hunting experience for many. Considerable change in the regulations and methods and practices of hunting, hunters will encounter some disruption of their expectations and routines.

White-tailed deer hunting: A total of 5,389 acres is open for deer hunting, which includes archery (to include the use of crossbows), muzzleloader, handgun, and shotgun hunting. Seasonal closures would occur to not only protect wildlife, but also to minimize conflicts between different hunting activities and/or other non-consumptive recreational uses (e.g., minimize conflict with anglers on Prime Hook Creek, offset hunting days for deer and waterfowl hunting on Prime Hook Creek and for disabled hunters in the disabled hunt area; close hunting in late November in designated areas to minimize bald eagle and waterfowl disturbance). Disabled hunting areas in Unit III and IV would limit access to individuals who are permanently confined to a wheelchair, which ensures quality opportunities for hunters with limited mobility.

The refuge proposes to open 1,513 additional acres for deer hunting which includes an area located north of Prime Hook Road commonly referred to as Oak Island, an area of red maple swamp along Prime Hook Creek and west of the existing Headquarters Area, an area north of Route 16 referred to as the Millman Tract, and an expansion of the Headquarters Area. Of these "new areas," Oak Island was previously hunted up until 1995 and the Millman Tract was hunted under private ownership up until the Service purchased it in 2001. Prime Hook Creek and its associated red maple swamp will provide additional opportunities and will be limited by access. Hunter numbers are expected to initially increase based on the opening of these areas and the opportunity for hunters to free-roam; however, cumulative impacts are expected to be negligible.

Permanent deer hunting stands will be phased out over a five-year period in all areas except the disabled hunting area. We will limit the number of permits to approximately 30 in the lottery hunt area to minimize hunter conflict in an area historically known to attract large hunter numbers. In the regular hunt area, hunting will be open every day during designated seasons (except the October antlerless and handgun seasons).

The phasing out of all permanent deer hunting stands (except non-ambulatory hunt blinds) will require hunters to find a suitable hunting location within designated hunting areas through effective scouting. Use of portable deer climbing stands is recommended but not required. Hunters have expressed an interest in scouting and choosing their hunting locations to enhance the quality of their hunt. Maintenance mowing will no longer occur to provide trails to facilitate hunting. Minor to moderate short-term adverse impacts are expected among hunters over desired hunting locations and we will continue to encourage proper hunting ethics.

Waterfowl hunting: A total of 3,455 acres is open to migratory bird hunting, which is 40% of the refuge (includes lands purchased with Land and Water Conservation Funds which are excluded from the 40% rule). Seasonal closures would occur to not only protect wildlife, but also to minimize conflicts between different hunting activities and/or other non-consumptive recreational uses (e.g., offset hunting days for deer and waterfowl hunting on Prime Hook Creek and for disabled hunters in the disabled hunt area; close hunting in late November in designated areas to minimize bald eagle and waterfowl disturbance, provide access for non-consumptive users on Sundays during the hunting season). In the lottery hunt area, hunting will occur three days per week and cease at noon. In the regular hunt area, hunting will be open every day during all waterfowl hunting seasons. Although the loss of one hunting day per week and an earlier closure at noon rather than the current 3:00pm will not be

well received by the hunting public; this perceived decrease in hunting is offset by the additional 1,732 acres being proposed to open under this alternative for waterfowl hunting.

This additional hunting acreage includes: an area between Slaughter Beach Road and Fowler Beach Road referred to as Unit I, an area located south of Prime Hook Road, Prime Hook Creek, an area along the Broadkill River in Unit IV, and a reconfiguration of the existing waterfowl hunt area in Unit III. Of these "new areas," Unit I was already open to dove hunting and Prime Hook Creek was hunted up until 1991. Hunter numbers are expected to initially increase based on the opening of these areas and the opportunity for hunters to free-roam in the regular waterfowl areas; however, cumulative impacts are expected to be negligible.

Although the permanent waterfowl blinds on the refuge will be phased out over a five-year period, we still require hunters in the lottery hunt area to hunt within a defined area around a designated blind site (marker). This will minimize hunter conflict in an area historically known to attract large hunter numbers. In past years for daily drawings on opening days, it was common to see over 60 to 80 duck hunting parties compete for 27 available hunting opportunities.

The phasing out of all permanent waterfowl hunting blinds (except non-ambulatory blinds) in lieu of blind sites in the lottery hunt area will now require hunters to provide their own means to camouflage themselves (e.g., boat blind, pop up blind, etc.). Hunters would be required to find a suitable hunting location within a specified area around the blind site marker. Hunters have expressed an interest in scouting and having the flexibility to adjust their hunting locations for weather conditions to enhance the quality of their hunt. In free roam areas, hunters may hunt anywhere in the designated area. Minor to moderate short-term adverse impacts are expected among hunters over desired hunting locations and proper hunting ethics will be encouraged.

The creation of sanctuaries in Unit III will result in the elimination of 6 hunting blinds from the 19 available federal blinds; however 9 new blinds sites will be added. These 9 new blinds sites, which include a wheelchair accessible blind, brings the total number of federal blind sites to 22 and does not include the 8 blinds on the state owned Prime Hook Wildlife Area. The addition of new free-roam waterfowl hunting areas in salt marsh habitats in Unit I and IV will also provide quality opportunities.

Upland game and webless migratory bird hunting: A total of 1,957 acres are available for hunting of upland game and webless migratory birds. Dove hunting will not be open on 105 of these acres, which should affect few hunters.

Wild turkey hunting: A total of 3,472 acres are open for hunting wild turkey until noon on selected hunt days. In recent years, hunter and staff observations indicate that a huntable population of turkeys may exist on the refuge. Limited opportunities exist on public lands to hunt turkey and the refuge may contribute to providing additional quality opportunities for hunters.

The refuge would collaborate with the Delaware Division of Fish & Wildlife to evaluate the status of the wild turkey population on the refuge. Hunting will be permitted if State and refuge personnel determine that the turkey population in the area is sufficient to support hunting on the refuge. It is anticipated that a limited number of hunters (less than five per year). Permits would be issued through preseason lottery drawing. The elimination of nearly all hunting permit fees (except for lottery hunts) should be well received by hunters. An administratively simplified hunting program minimizes the amount of staffing resources needed to conduct the hunt by as much as 54 staff days and by $17,890 from the previous program and thereby reduces the administrative burden and minimizes the amount of staffing resources needed to conduct the hunt. The minor beneficial impact to the hunter is a reduction in the cost to hunt.

Fees are required to manage the lottery hunts for deer, waterfowl, and turkey. The refuge Recreation Act requires that funds are available for the development, operation, and maintenance of the permitted forms of recreation. The permit fee ($10 for deer and turkey; $15 for waterfowl), preseason application fee ($5/hunter), and processing fee for permits acquired after the preseason drawing ($2-3 per hunt) are the minimal amounts needed to offset the cost of facilitating the preseason drawings and manage the lottery hunts. Due to the uncertainty in the level of hunter participation in future years, permit fees may need to be adjusted (increased

or decreased) and therefore will be evaluated. Preseason lottery drawings will be administered by a contracted company which will collect information and required fees, conduct the drawing, and issue the permits. This may reduce our costs by over $3,000 and application and processing fees will be paid to the contractors for administering this permitting process. Refuge staff will work with the contractor to provide the highest level of customer support to refuge users. New fees for preseason application for waterfowl and turkey hunting, new processing fees for standby permits, and charging a flat blind fee for waterfowl rather than an individual fee are anticipated to be unpopular with the hunting public.

Expanding hunting opportunities is expected to have moderate adverse impacts on a certain segment of the public that does not desire any change in public use programs and regulations, or that may hold differing views on the course of action. In addition, while new visitors become familiar with those changes, violations could increase. Some conflict between wildlife observers, photographers, students, and other refuge users is expected to result in short-term, moderate adverse impacts, which will be managed through seasonal closures. Negative reactions by some visitors may be caused by the closure of the western end of Prime Hook Creek to all uses (mainly fishing, canoeing, and kayaking) other than hunters from September 1 through the end of the deer and waterfowl hunting seasons; the closure of the eastern end of Prime Hook Creek from September 1 through March 15; and the temporary closure of the general public use area near the Refuge Headquarters to conduct deer hunts. Seasonal closures for hunting occur during the fall and winter months, which is typically a slower period of use due to weather conditions. Refuge officers would enforce these and other current refuge regulations, where appropriate, and would seek the assistance and cooperation of Delaware Division of Fish & Wildlife in enforcing common regulations, to provide a safe environment for refuge visitors and promote activities that are compatible with protecting the resources.

Dome conflict between concurrent hunting programs is anticipated (e.g., waterfowl, deer, and upland game hunting seasons overlapping). For the majority of the hunting seasons, the Delaware Division of Fish & Wildlife has made efforts to avoid these overlaps in the various hunting programs. As public use levels expand across time, unanticipated conflicts between user groups may occur. The refuge's visitor use programs would be adjusted as needed to eliminate or minimize each conflict and provide quality wildlife-dependent recreational opportunities. The Service's law enforcement efforts will be increased.

The refuge would work closely with State, Federal, and private partners to minimize impacts to adjacent lands and its associated natural resources. Due to an increase in new hunting areas and by allowing hunters to free roam, an increase in violations may occur until hunters become familiar with the refuge boundaries and regulations. As a result some landowner conflicts may erupt due to hunter trespassing. These minor short-term adverse impacts will be minimized through enhanced law enforcement efforts. For example, waterfowl hunting zones in Unit IV along the Broadkill River have the potential to conflict with nearby existing blinds on private lands. This activity will be evaluated and zones adjusted accordingly. Hunters will most likely opt to hunt within the marsh areas of these zones and not along the Broadkill River, which would lessen any direct conflicts with hunters on these nearby private lands.

Refuge Facilities: Minimal infrastructure, which includes the addition of two to three parking areas, enhancement of existing boat ramps, and placement of informational signs, is anticipated in support of this priority public use. There would be some costs associated with these programs in the form of road maintenance, law enforcement, and boat ramp maintenance. These costs should be minimal relative to total refuge operations and maintenance costs and would not diminish resources dedicated to other refuge management programs. Impacts to refuge resources are expected to be negligible.

Other Past, Present, Proposed, and Reasonably Foreseeable Actions and Anticipated Impacts

Cumulative effects on the environment result from incremental effects of a proposed action when these are added to other past, present, and reasonably foreseeable future actions. While cumulative effects may result from individually minor actions, they may, viewed as a whole, become substantial over time. The proposed hunt plan has been designed to be sustainable through time given relatively stable conditions.

Due to hunting history of low hunter use and harvest for resident geese and late season snow geese, the refuge has been closed during these seasons but will consider reopening if demand and opportunity exist and conflicts are minimized.

Greater snow geese have undergone a dramatic increase in recent decades, to current population estimates of over 1 million birds. Natural marsh habitats on some migration and wintering areas have been impacted by the destructive feeding strategies of overabundant light geese (Giroux and Bedard 1987, Giroux et al. 1998, Widjeskog 1977, Smith and Odum 1981, Young 1985). In addition, goose damage to agricultural crops has become a problem (Bedard and Lapointe 1991, Filion et al. 1998, Giroux et al. 1998, Delaware Div. of Fish and Wildlife 2000). Snow geese use the refuge wetland habitats extensively, and are not subjected to any hunting disturbance or mortality on the refuge. Impacts to refuge wetlands and impacts to wetland-dependent wildlife increase over time if the population is not adequately controlled at the flyway level, through the coordinated efforts of individual agencies.

Similarly, resident Canada geese have been shown to cause changes in wetland community structure (Laskoswki et al. 2002). Resident geese can reduce the amount of plant biomass that would be available to migrant birds at the end of the growing season. Direct damage to agricultural resources by resident geese includes grain crops, trampling and spring seedlings. Heavy grazing by geese can result in reduced yields and in some instances a total loss of the grain crop (Allen et al. 1985, Flegler et al. 1987). Thus, uncontrolled Canada goose populations on the refuge can affect migratory bird populations utilizing the refuge as well as contribute to agricultural losses on lands surrounding the refuge.

The refuge will consider participating in additional deer hunting seasons if an overabundance of deer arises, as determined the Delaware Division of Fish & Wildlife (DFW) and concurrence by the refuge (Refer to Resident Wildlife Section for impacts of deer overabundance).

If visitation levels expand in the unforeseen future, unanticipated conflicts between user groups may occur. Service experience has proven that time and space zoning (e.g., establishment of separate use areas, use periods, and restrictions on the number of users) and limiting visitations are effective tools in eliminating conflicts between user groups.

Anticipate Impacts if Individual Actions are Allowed to Accumulate

National Wildlife Refuges, including Prime Hook NWR, conduct hunting programs within the framework of State and Federal regulations. Hunting at the refuge is at least as restrictive as the State of Delaware and in some cases more restrictive. By maintaining hunting regulations that are as, or more, restrictive than the State, individual refuges ensure that they are maintaining seasons which are supportive of management on a more regional basis. Additionally, the refuge coordinates with the DFW annually to maintain regulations and programs that are consistent with the states' management programs.

The cumulative impact of hunting on migratory and resident wildlife populations at Prime Hook NWR is negligible. As described in the previous sections, the proportion of the refuge's harvest of waterfowl, deer, and small game is negligible when compared to local, regional, and flyway populations and harvest.

Because of the regulatory process for harvest management of migratory birds in place within the Service, the setting of hunting seasons largely outside the breeding seasons of resident and migratory wildlife, the ability of individual refuge hunt programs to adapt refuge-specific hunting regulations to changing local conditions, and the wide geographic separation of individual refuges, we anticipate no direct or indirect cumulative effects on resident wildlife, migratory birds, and non-hunted wildlife of hunting on Prime Hook NWR.

PUBLIC REVIEW AND COMMENT:

This compatibility determination is part of the refuge's Comprehensive Conservation Plan and Environmental Impact Statement. Public notification and review include a notice of availability published in the *Federal Register,* a 60-day comment period, and local media announcements.

DETERMINATION (CHECK ONE BELOW):

____ Use is not compatible

__X__ Use is compatible, with the following stipulations

STIPULATIONS NECESSARY TO ENSURE COMPATIBILITY:

The refuge will manage the hunt program in accordance with Federal and State regulations and review it annually to ensure wildlife and habitat goals are achieved and that the program is providing a safe, high quality hunting experience for participants. The refuge based these stipulations on our draft CCP and Environmental Impact Statement on Hunting, Hunting Management Plan, and refuge-specific regulations (See Description of Use section).

To ensure compatibility with refuge purposes and the mission of the National Wildlife Refuge System, hunting can occur on the refuge if the refuge-specific regulations highlighted in this document and following stipulations are met:

- This use must be conducted in accordance with State and federal regulations, and special refuge regulations published in the refuge Hunting Regulations and Public Use Regulations brochures.
- A network of waterfowl sanctuaries will be maintained to ensure that migratory birds have adequate resting and feeding areas while hunting seasons are occurring.
- This use is subject to modification if on-site monitoring by refuge personnel or other authorized personnel results in unanticipated negative impacts to natural communities, wildlife species, or their habitats.
- Law Enforcement Officer(s) will promote compliance with refuge regulations, monitor public use patterns and public safety, and document visitor interactions. Law Enforcement personnel will monitor all areas and enforce all applicable State and Federal Regulations.
- The refuge manager may, upon annual review of the hunting program and in coordination with the Delaware Division of Fish and Wildlife, impose further restrictions on hunting, recommend that the refuge be closed to hunting, or further liberalize hunting regulations within the limits of state seasons and regulations. Hunting restriction may be implemented if it conflicts with other, higher priority refuge programs or endangers refuge resources or public safety.

JUSTIFICATION:

Hunting is a priority wildlife-dependent use for the National Wildlife Refuge System through which the public can develop an appreciation for fish and wildlife (Executive Order 12996, March 25, 1996 and The National Wildlife Refuge System Administration Act of 1966, as amended by the National Wildlife Refuge System Improvement Act of 1997 (Public Law 105-57)). The Service's policy is to provide expanded opportunities for wildlife-dependent uses when compatible and consistent with sound fish and wildlife management and ensure that they receive enhanced attention during planning and management.

Hunting seasons and bag limits are established by the State of Delaware and generally adopted by the refuge. These restrictions ensure the continued well-being of overall populations of game animals. Hunting does result in the taking of many individuals within the overall population, but restrictions are designed to safeguard an adequate breeding population from year to year. Specific refuge regulations address equity and quality of opportunity for hunters, and help safeguard refuge habitat. Disturbance to other fish and wildlife does occur, but this disturbance is generally short-term and adequate habitat occurs in adjacent areas. Loss of plants from boat or foot traffic is minor, or temporary, since hunting occurs mainly after the growing season.

Conflicts between hunters are localized and are addressed through law enforcement, public education, and continuous review and updating to State and refuge hunting regulations. Conflicts between other various user groups are minor given the season of the year for hunting, the location of most hunting away from public use facilities, and seasonal area closures.

Stipulations above will ensure proper control of the means of use and provide management flexibility should detrimental impacts develop. Allowing this use also furthers the mission of the National Wildlife Refuge System by providing renewable resources for the benefit of the American public while conserving fish, wildlife, and plant resources on the refuge.

This activity will not materially interfere with or detract from the mission of the National Wildlife Refuge System or the purpose for which the Refuge was established.

SIGNATURE:

Refuge Manager: _____ _____
(Signature) (Date)

CONCURRENCE:

Regional Chief: _____ _____
(Signature) (Date)

MANDATORY 15 YEAR RE-EVALUATION DATE: _____

LITERATURE CITED:

See CCP Bibliography.

COMPATIBILITY DETERMINATION

USE:

Wildlife Observation, Wildlife Photography, Environmental Education, and Interpretation

REFUGE NAME:

Prime Hook National Wildlife Refuge

ESTABLISHING AND ACQUISITION AUTHORITY(IES):

1. Migratory Bird Conservation Act {16 U.S.C. 715d}
2. Refuge Recreation Act {16 U.S.C. 460 K-1}

REFUGE PURPOSE(S):

1. "…for use as an inviolate sanctuary, or for any other management purposes, for migratory birds…" {16 U.S.C. 715d; Migratory Bird Conservation Act}
2. "…incidental fish and wildlife-oriented recreational development" {16 U.S.C. 460k-1; Refuge Recreation Act}
3. "the protection of natural resources" {16 U.S.C. 460k-1; Refuge Recreation Act}
4. "the conservation of endangered or threatened species…" {16 U.S.C. 460k-1; Refuge Recreation Act}

NATIONAL WILDLIFE REFUGE SYSTEM MISSION:

The mission of the Refuge System is to administer a national network of lands and waters for the conservation, management, and where appropriate, restoration of the fish, wildlife, and plant resources and their habitats within the United States for the benefit of present and future generations of Americans.

DESCRIPTION OF USE:

(a) What is the use? Is the use a priority public use?
The use is wildlife observation, wildlife photography, environmental education, and interpretation. These are priority public uses identified by Executive Order 12996 (March 25, 1996) and by the National Wildlife Refuge System Administration Act of 1966, as amended by the National Wildlife Refuge System Improvement Act of 1997 (Public Law 105-57).

(b) Where would the use be conducted?
The use would be conducted within the refuge's 10,132 acres, which lie between Slaughter Beach and the Broadkill River along the southeastern coastline of Delaware. In all four units, we plan to highlight viewing areas along the State roads (Slaughter Beach Road, Fowler Beach Road, Prime Hook Road, and Broadkill Road) in an interpretive auto tour route, where a visitor can access information about the refuge using advanced technology (radio, compact disc, cell phone, downloadable programming, etc.). Designated areas open to visitors for wildlife observation, photography, environmental education, and interpretation are as follows (see Map 4-15 for an illustration of where these uses would be conducted on the refuge):

Unit I (Slaughter Beach Road to Fowler Beach Road): Wildlife observation and photography are the primary uses at designated areas at Fowler Beach, Slaughter Canal, and along the roadsides of Slaughter Beach Road and Fowler Beach Road. This area includes interpretive signs at Fowler Beach, information kiosks (one at Slaughter Beach and two on Fowler Beach Road), parking areas, and an unimproved boat ramp on Fowler Beach Road. Access to the Slaughter Canal is by boat only. We plan to provide access to existing interior roads and trails on the north side of Fowler Beach Road and south side of Slaughter Beach Road for wildlife observation and photography opportunities. A new parking area will be established on the north side of Fowler Beach Road.

Unit II (Fowler Beach Road to Prime Hook Road): Wildlife observation and photography are the primary uses at Slaughter Creek on Cods Road and roadside pull-offs along Prime Hook Road. The area includes two information kiosks on Prime Hook Road and parking areas. We plan to provide access to an existing interior road on the south side of Fowler Beach for wildlife observation and photography opportunities by adding a wheelchair accessible photography blind near a restored wetland area. Visitors can use the new parking area mentioned in the Unit I description. Access to the north side of Fowler Beach Road will be from the existing interior road and trail network.

Unit III (Prime Hook Road to Broadkill Beach Road): Wildlife observation, photography, environmental education, and interpretation are important uses in this area of the refuge. The majority of the public use infrastructure is located near the refuge headquarters. This area includes 5.1 miles of hiking trails (Blue Goose Trail, Photography Blind Trail, Dike Trail-wheelchair accessible, Black Farm Trail, Pine Grove Trail, and Boardwalk Trail-wheelchair accessible); canoe trail on Prime Hook Creek and the Headquarters Canal Ditch; Turkle and Fleetwood Ponds; Goose & Flaxhole Ponds; Petersfield Ditch; trailhead kiosks; informational kiosks (one in partnership with Delaware Division of Fish and Wildlife on Little Neck Road); highway direction signage; parking areas; restrooms; a photography blind; wheelchair accessible observation platform (Dike Trail); wheelchair accessible fishing pier (Fleetwood Pond); numerous interpretive signs and kiosk maps; Visitor Contact Station containing interpretive displays and various mounted animal species; four refuge boat ramps; roadside pull-offs along Broadkill Beach Road; refuge auditorium; an environmental education pavilion; wildlife observation and photography opportunities through special events, programs, and benches along hiking trails. The areas immediately surrounding the refuge office and associated trails provide opportunities for environmental education. We also participate in off-refuge events in Milton, such as the Horseshoe Crab-Shorebird Festival and the Youth Fishing Event.

We plan to enhance opportunities in this area by extending the trail network near the deer check station to provide additional parking and hiking opportunities; developing new facilities for environmental education and visitor services programs; and providing access to existing interior roads and trails on the south side of Prime Hook Road and near Goose Pond (off Deep Branch Road) for wildlife observation and photography opportunities.

Unit IV (Broadkill Beach Road to Broadkill River): Wildlife observation and photography are the primary uses in this area. This area includes roadside pull-offs along Broadkill Beach Road. We plan to reevaluate the trail and observation platform overlooking Vergie's Pond.

(c) When would the use be conducted?

Except as noted below, the refuge is open for wildlife observation, wildlife photography, environmental education, and environmental interpretation in the following areas everyday from open one-half hour before sunrise to one-half hour after sunset. Some areas are seasonally restricted to minimize conflict among user groups and to minimize wildlife disturbance.

1) Designated beach dunes and overwash areas (Units I & II): Closed from March 1 through September 1 due to nesting State endangered least terns and American oystercatchers, and the potential for use by federally endangered piping plovers. Areas may be reopened if no nesting activity occurs or when nesting ends for the season.

2) Western Prime Hook Creek (from old shop ramp to Waples Pond) (Unit III): Closed every day during the deer and waterfowl hunting seasons, which typically starts on September 1 and ends in early February. Additional seasonal closures may apply through the second Saturday in May for hunting during the snow goose conservation order and/or turkey hunting.

3) Deep Branch Road Trail (includes Goose & Flaxhole Ponds) and Eastern Prime Hook Creek (from old shop ramp to HQ ramp) (Unit III): Closed every day from September 1 through March 15. Additional seasonal closures may apply through the second Saturday in May for hunting during the snow goose conservation order and/or turkey hunting.

4) Headquarters Area (includes Turkle & Fleetwood Ponds) (Unit III): Closed only for a maximum of two days for deer hunts.

5) The northern portion of Unit IV (includes trail overlooking Vergie's Pond): Closed from the Monday before Thanksgiving through March 15. Additional seasonal closures may apply through the second Saturday in May for hunting during the snow goose conservation order and/or turkey hunting.

6) Hiking Trails on Fowler Beach Road (Unit I), Prime Hook Road (Unit III), and Slaughter Beach Road and Slaughter Canal (Unit I): Closed except for Sundays from September 1 through the deer and waterfowl hunting seasons, which typically end in early February. Additional seasonal closures may apply through the second Saturday in May for hunting during the snow goose conservation order and/or turkey hunting.

7) Roadside pull offs and water control structures/fishing areas at Petersfield Ditch (Unit III), Slaughter Canal (Unit I) & Cods Road (Unit II): Open year round.

(d) How would the use be conducted?

These four priority public uses would be allowed on established roads, trails, parking areas, and in buildings that have been designed to accommodate such uses and in areas that are least sensitive to human intrusion. Uses would be conducted for the general public, as well as for organized groups, including schools and scout groups. Brochures and maps depicting the roads and trails open for these uses are available at the Visitor Contact Station and on the refuge's website.

Environmental education and interpretation will be conducted by way of personal presentations by staff and volunteers, teachers and other youth leaders, and at special events and displays both on and off the refuge. Educational and interpretive information will also be provided via signage, kiosks, printed information, exhibits, audiovisual presentations, and lecture programs. Wildlife observation and photography are self-conducted and are facilitated through the availability of trails, viewing areas, tours, and informational materials. Wildlife observation programs such as birding field trips, canoe trips, and other nature walks are frequently given. Viewing scopes are provided in designated areas. The refuge also promotes wildlife photography with the Friends of Prime Hook NWR through the annual nature photography contest and exhibition.

Refuge staff are responsible for on-site evaluations to resolve public use issues; monitor and evaluate impacts; maintain boundaries and signs; meet with interested public; recruit volunteers; prepare and present interpretive and educational programs; maintain existing trails and viewing areas; revise leaflets and develop new information materials, install and/or update kiosks; develop needed signage; organize and conduct refuge events; conduct regularly scheduled programs for the public; display off-site exhibits at local events; develop relationships with media; provide law enforcement and security; and respond to public inquiries.

Boats enter refuge waters from access points on Slaughter Canal at Fowler Beach Road, at Waples Mill Pond on the Brumbley Family Campground, at the office boat ramp, at the ramp at the old maintenance facility, at suitable sites on Goose and Flaxhole Ponds, and at boat ramps at Turkle and Fleetwood Ponds.

At Fowler Beach, access for these activities will occur only on refuge owned lands on the sandy part of the beach from the toe of the dunes to the Delaware Bay (mean high water demarcation to mean low water demarcation). One parking lot with a dune crossover provides access to the beach. Access on the dune and adjacent marshes is prohibited.

In addition to published 50CFR regulations and State regulations, refuge-specific regulations also apply for Wildlife Observation & Photography, Environmental Education & Interpretation and are as follows:

1) No refuge-specific permits are required.

2) All boats must be off the water at sunset.

3) Boat motor restrictions

   a) 30 horsepower motor restriction on Prime Hook Creek and Slaughter Canal
   b) Electric motors or manual propulsion only on Turkle & Fleetwood Ponds
   c) Manual propulsion only on Goose & Flaxhole Ponds
   d) Air thrust boats and jet skis are not permitted
   e) A "Slow No Wake" zone of one-half mile has been established on the Headquarters Ditch.

4) Areas may be closed on the refuge without prior warning.

5) Visitors must stay on the designated trail routes and areas.

6) Except as noted below, the refuge is open for wildlife observation, wildlife photography, environmental education, and environmental interpretation in the following areas everyday from open one-half hour before sunrise to one-half hour after sunset. Some areas are seasonally restricted to minimize conflict among user groups and to minimize wildlife disturbance.

   a) Designated beach dunes and overwash areas: Closed from March 1 through September 1 due to nesting State endangered least terns and American oystercatchers, and the potential for use by federally endangered piping plovers. Areas may be reopened if no nesting activity occurs or when nesting ends for the season.

   b) Western Prime Hook Creek (from old shop ramp to Waples Pond): Closed every day during the deer and waterfowl hunting seasons, which typically starts on September 1 and ends in early February. Additional seasonal closures may apply through the second Saturday in May for hunting during the snow goose conservation order and/or turkey hunting.

   c) Deep Branch Road Trail (includes Goose & Flaxhole Ponds) and Eastern Prime Hook Creek (from old shop ramp to HQ ramp): Closed every day from September 1 through March 15. Additional seasonal closures may apply through the second Saturday in May for hunting during the snow goose conservation order and/or turkey hunting.

   d) Headquarters Area (includes Turkle & Fleetwood Ponds): Closed only for a maximum of two days for deer hunts.

   e) The northern portion of Unit IV (includes trail overlooking Vergie's Pond): Closed from the Monday before Thanksgiving through March 15. Additional seasonal closures may apply through the second Saturday in May for hunting during the snow goose conservation order and/or turkey hunting.

   f) Hiking Trails on Fowler Beach Road, Prime Hook Road, and Slaughter Beach Road and Slaughter Canal: Closed except for Sundays from September 1 through the deer and waterfowl hunting seasons, which typically end in early February. Additional seasonal closures may apply through the second Saturday in May for hunting during the snow goose conservation order and/or turkey hunting.

   g) Roadside pulloffs and water control structures/fishing areas at Petersfield Ditch, Slaughter Canal & Cods Road: Open year round.

7) Dog walking is not permitted on the refuge.

8) Bicycling is allowed only on roads open to public vehicular traffic.

9) The Visitor Contact Station is open weekdays from 7:30am to 4:00pm and seasonally on weekends.

10) The following activities are prohibited, including, but not limited to: ice skating, camping, roller blading, horseback riding, geocaching/metal detecting, off-road and mountain biking, off-road vehicles including ATVs, picnicking, dog walking, competitions or organized group events (e.g. cross country races), non-competitive organized events (e.g., weddings), operation of model boats and airplanes, swimming and sunbathing, waterskiing, personal watercraft (PWC), air thrust boats, soliciting of funds (per 50CFR 27.97 for Private Operations and per 50CFR 27.86 for Begging), and other activities identified in 50CFR Part 27.

11) All boaters would be required to operate their craft and possess all safety equipment in accordance with Delaware State and U.S. Coast Guard Regulations.

12) Beach access will occur only on refuge owned lands on the sandy part of the beach from the toe of the dunes to the Delaware Bay (mean high water demarcation to mean low water demarcation). One parking lot with a dune crossover provides access to the beach. Access on the dune and adjacent marshes is prohibited.

(e) Why is this use being proposed?
Wildlife observation, wildlife photography, environmental education, and interpretation are Priority Public Uses as defined by The National Wildlife Refuge System Administration Act of 1966, as amended by the National Wildlife Refuge System Improvement Act of 1997 (Public Law 105-57), and if compatible, are to receive enhanced consideration over other general public uses.

These uses are conducted to provide compatible educational and recreational opportunities for visitors to enjoy the resource and to gain understanding and appreciation for fish and wildlife, wild lands ecology and the relationships of plant and animal populations within the ecosystem, and wildlife management. These uses will provide opportunities for visitors to observe and learn about wildlife and wild lands at their own pace in an unstructured environment and to observe wildlife habitats firsthand. These uses will enhance the public's understanding of natural resource management programs and ecological concepts to enable the public to better understand the problems facing our wildlife/wild lands resources, to realize what effect the public has on wildlife resources, to learn about the U.S. Fish and Wildlife Service's (Service) role in conservation, to better understand the biological facts upon which Service management programs are based, and to foster an appreciation for the importance of wildlife and wild lands. It is anticipated that participation in these uses will result in a more informed public, with an enhanced stewardship ethic and enhanced support and advocacy for Service programs.

These uses will also provide wholesome, safe, outdoor recreation in a scenic setting, with the realization that those who come strictly for recreational enjoyment will be enticed to participate in the more educational facets of the public use program, and can then become informed advocates for the refuge and the Service.

AVAILABILITY OF RESOURCES:

Allowing the use of wildlife observation, photography, environmental education, and interpretation is within the resources available to administer our Visitor Services program with the current level of participation and to ensure that the use remains compatible with the refuge purposes. Additional funding for visitor services improvements can also come from challenge cost share projects, grant funds, and contributions. Compliance with refuge regulations is handled within the regular duties of the Station Law Enforcement Officer. As funding is available, the refuge will complete and maintain projects and facilities. Volunteers and partners will be utilized to help with construction and maintenance.

Facilities or materials needed to support this use include maintaining access roads, parking areas, gates, roadside pull-offs, kiosks, signs, the Visitor Contact Station, observation platforms, photography blinds, environmental education pavilion, wheelchair accessible fishing pier, boat launching areas, and hiking and canoeing trails; upgrading some of the existing boat launching areas; and providing information in refuge publications and the refuge's website.

In 2009, funds were allocated to upgrade refuge public use signage. Sufficient staff and maintenance funding within our base budget of nearly $596,000 is available to make annual progress toward completion of all the projects described above and to maintain those already completed.

ANTICIPATED IMPACTS OF THE USE:

For a more complete analysis of the impacts of wildlife observation, photography, environmental education and interpretation, refer to chapter 5 of the CCP.

Wildlife observation and photography and environmental education and interpretation can result in positive or negative impacts to the wildlife resource. A positive effect of allowing visitor's access to the refuge will be the provision of additional wildlife-dependent recreational opportunities and a better appreciation and more complete understanding of the wildlife and habitats associated with Delmarva ecosystems.

Disturbance of refuge resources is the primary concern regarding commercially guided activities for wildlife observation. While field trip routes and observation sites are usually located in areas open to the general public, disturbance caused by large groups could be more intense because the number of people, and desire to get close to wildlife, may be greater than what normally occurs during general public activities. This disturbance will displace individual animals to adjacent areas of the refuge.

The refuge expects that wildlife observation, wildlife photography, environmental education, and environmental interpretation will have negligible short-term, long-term or cumulative impacts on the economy of the towns or county in which the refuge lies. We would not expect these activities to considerably alter the demographic of economic characteristics of the local community. No adverse impacts are foreseen to be associated with changes in the community character or demographic composition. In addition, impacts are expected to be negligible based on our observations of past visitor impacts from these uses.

Wildlife observation, wildlife photography, environmental education, and interpretation are expected to have negligible adverse short-term, long-term or cumulative impacts on soils, local or regional air quality, and hydrology or water quality. Environmental education activities that involve the sampling of wetlands and ponds could cause temporary, localized, minor impacts on water quality as the students disturb the bottom of the pond or walk on the marsh to gather specimens. Negative impacts to water quality can also result from human waste and litter.

Wildlife observation, wildlife photography, environmental education, and interpretation are expected to have negligible adverse short-term, long-term or cumulative impacts on vegetation.
Negligible disturbance to vegetation will occur during the construction of new parking areas on Fowler Beach Road and on Broadkill Beach Road to facilitate wildlife observation/photography activities because existing interior roads and access routes will be used. Additionally, shoreline and bank activities such as hiking, wildlife viewing, photography, and environmental education programs can result in trampling of vegetation.

Disturbance factors resulting from public use are always considered for all listed species. Of these, impacts on the piping plover, American oystercatcher, common tern, Forster's tern, and least tern will be minimized through the seasonal closure of designated beach dunes and overwash areas from March 1 through September 1. A Section 7 Evaluation has been conducted as part of this review and it was determined that proposed activities would not likely affect the Delmarva fox squirrel. The bald eagle, a State-endangered species occurs on the refuge and areas near active bald eagle nests will not be open at anytime for wildlife observation, photography, environmental education, and interpretation and, therefore, are not expected to have any negative impacts on bald eagles (U.S. Fish and Wildlife Service 2007).

Wildlife observation, wildlife photography, environmental education, and interpretation are expected to have negligible adverse short-term, long-term or cumulative impacts on waterfowl.
Providing waterfowl sanctuaries will minimize some of these impacts and allow waterfowl to have undisturbed access to these areas during biologically critical periods of the day. To minimize waterfowl disturbance from these uses, the refuge has designated approximately 3,000 acres as waterfowl sanctuaries that will be closed to hunting and other recreational use on a seasonal or annual basis.

This use is expected to have negligible adverse short-term, long-term or cumulative impacts on shorebirds and landbirds. We expect indirect impacts to landbirds to increase due to proposed expansions in public use activities including wildlife observation, wildlife photography, environmental education and interpretation. Disturbance to landbirds in proposed areas for wildlife observation, photography, and fishing is expected to be negligible since all visitors will be required to be on designated walking trails and access routes.

Wildlife observation, wildlife photography, environmental education, and interpretation are expected to have negligible adverse short-term, long-term or cumulative impacts on secretive marsh and waterbirds. We expect negligible impacts to secretive marsh and waterbirds due to proposed expansions in public use activities including wildlife observation, wildlife photography, and environmental education and interpretation. An increase in the number of hiking trails, particularly in or near wetland areas, has the potential to increase disturbance to secretive marsh and waterbirds.

Impacts to fisheries from visitors engaged in wildlife observation, photography, environmental education and interpretation are expected to be temporary and minor. Use of boats and canoes will cause increased suspension of bottom sediments, which should not adversely affect biological oxygen demand for fisheries resources. Boat motors may also harm submerged or emergent vegetation, which may cause a negligible negative impact to protective cover for fisheries.

Wildlife observation, wildlife photography, environmental education, and interpretation are expected to have negligible adverse short-term, long-term or cumulative impacts on mammals.
We also evaluated these uses for their potential to benefit or adversely affect amphibians and reptiles or their habitats used for mating, reproduction, over-wintering, and foraging. Public outreach and education efforts by the refuge that emphasize buffering of wetlands, connectivity and easy access between forest, grassland, and wetlands, protection of vernal pools, and augmentation of patch size will benefit amphibians and reptiles on an even larger scale where embraced by other landowners. Additionally, impacts to invertebrates such as butterflies, moths, other insects, and spiders are expected to be negligible.

The beneficial impacts of providing the existing level of wildlife-dependent activities, with some modest increases, include helping meet existing and future demands for outdoor recreation and education, as documented in the State Comprehensive Outdoor Recreation Plan (DNREC 2003) and in the Visitor and Community Survey (Sexton et. al 2007). Visitor use is increasing over time as local residents and visitors become increasingly aware of refuge opportunities, and as we progress in creating new facilities and programs. The economic benefits of increased tourism likely would also benefit local communities.

Expanding opportunities for these uses is expected to have adverse impacts on a certain segment of the public that does not desire any change in public use programs and regulations, or that may hold differing views on the course of action. In addition, while new visitors become familiar with those changes, violations could increase. Some conflict between wildlife observers, photographers, students, and other refuge users is expected to result in short-term moderate adverse impacts, which will be managed through seasonal closures.

Guided tour activities may also conflict with other refuge users. For example, commercial or non-commercial tours will most likely use the same areas as independent wildlife viewers, kayakers and canoeists, and hunters and anglers during open seasons. Unregulated or inadequately regulated commercial guiding operations may adversely affect the safety of other refuge users, the quality of their experience, and the equity of opportunity.

Expanded facilities for environmental education and new or expanded visitor services programs are expected to increase public awareness of, and visitation to, the refuge, and would enable staff to provide better customer service. We would expect a certain level of inconvenience during the construction of refuge facilities. The adverse effects generally are short-term, and more than offset by the long-term gains in public education and appreciation. Impacts to refuge resources are expected to be negligible.

PUBLIC REVIEW AND COMMENT:

This compatibility determination is part of the refuge's Comprehensive Conservation Plan and Environmental Impact Statement. Public notification and review include a notice of availability published in the *Federal Register*; a 60-day comment period, and local media announcements.

DETERMINATION (CHECK ONE BELOW):

____ Use is not compatible

__X__ Use is compatible, with the following stipulations

STIPULATIONS NECESSARY TO ENSURE COMPATIBILITY:

The refuge will manage these four priority public uses (wildlife observation, photography, environmental education, and interpretation) in accordance with Federal and State regulations and review it annually to ensure wildlife and habitat goals are achieved and that these programs are providing safe, high quality experiences for participants. The refuge based these stipulations on our 1993 Public Use Plan; draft CCP and Environmental Impact Statement, and refuge-specific regulations (See Description of Use section).

To ensure compatibility with refuge purposes and the mission of the National Wildlife Refuge System, wildlife observation, photography, environmental education, and interpretation can occur on the refuge if the refuge-specific regulations are followed and following stipulations are met:

1) This use must be conducted in accordance with state and federal regulations (50CFR), and special refuge-specific regulations published in the Public Use Regulations brochure.

2) The public use program will be reviewed annually to ensure that it contributes to refuge objectives in managing quality recreational opportunities and protecting habitats, and is subject to modification if on-site monitoring by refuge personnel or other authorized personnel results in unanticipated negative impacts to natural communities, wildlife species, or their habitats. Refuge Law Enforcement Officer(s) will promote compliance with refuge regulations, monitor public use patterns and public safety, and document visitor interactions. Refuge Law Enforcement personnel will monitor all areas and enforce all applicable State and Federal Regulations.

3) No refuge-specific permits are required.

4) All boats must be off the water at sunset.

5) Boat motor restrictions

   a) 30 horsepower motor restriction on Prime Hook Creek and Slaughter Canal

   b) Electric motors or manual propulsion only on Turkle & Fleetwood Ponds

   c) Manual propulsion only on Goose & Flaxhole Ponds

   d) Air thrust boats and jet skis are not permitted

   e) A “Slow No Wake” zone of one-half mile has been established on the Headquarters Ditch

6) Areas may be closed on the refuge without prior warning.

7) Visitors must stay on the designated trail routes.

8) Except as noted below, the refuge is open for wildlife observation, wildlife photography, environmental education, and environmental interpretation in the following areas everyday from open one-half hour before sunrise to one-half hour after sunset. Some areas are seasonally restricted to minimize conflict among user groups and to minimize wildlife disturbance

   a) Designated beach dunes and overwash areas: Closed from March 1 through September 1 due to nesting State endangered least terns and American oystercatchers, and the potential for use by federally endangered piping plovers. Areas may be reopened if no nesting activity occurs or when nesting ends for the season.

b) Western Prime Hook Creek (from old shop ramp to Waples Pond): Closed every day during the deer and waterfowl hunting seasons, which typically starts on September 1 and ends in early February. Additional seasonal closures may apply through the second Saturday in May for hunting during the snow goose conservation order and/or turkey hunting.

c) Deep Branch Road Trail (includes Goose & Flaxhole Ponds) and Eastern Prime Hook Creek (from old shop ramp to HQ ramp): Closed every day from September 1 through March 15. Additional seasonal closures may apply through the second Saturday in May for hunting during the snow goose conservation order and/or turkey hunting.

d) Headquarters Area (includes Turkle & Fleetwood Ponds): Closed only for a maximum of two days for deer hunts.

e) The northern portion of Unit IV (includes trail overlooking Vergie's Pond): Closed from the Monday before Thanksgiving through March 15. Additional seasonal closures may apply through the second Saturday in May for hunting during the snow goose conservation order and/or turkey hunting.

f) Hiking Trails on Fowler Beach Road, Prime Hook Road, and Slaughter Beach Road and Slaughter Canal: Closed except for Sundays from September 1 through the deer and waterfowl hunting seasons, which typically end in early February. Additional seasonal closures may apply through the second Saturday in May for hunting during the snow goose conservation order and/or turkey hunting.

g) Roadside pulloffs and water control structures/fishing areas at Petersfield Ditch, Slaughter Canal & Cods Road: Open year round.

9) Dog walking is not permitted on the refuge.

10) Bicycling is allowed only on roads open to public vehicular traffic.

11) The Visitor Contact Station is open weekdays from 7:30am to 4:00pm and seasonally on weekends.

12) Groups of 15 or more pedestrian travelers and groups of six or more cyclists will require a Special Use Permit.

13) The following activities are prohibited, including, but not limited to: ice skating, camping, roller blading, horseback riding, geocaching/metal detecting, off-road and mountain biking, off-road vehicles including ATVs, picnicking, dog walking, competitions or organized group events (e.g. cross country races), non-competitive organized events (e.g., weddings), operation of model boats and airplanes, swimming and sunbathing, waterskiing, personal watercraft (PWC), air thrust boats, soliciting of funds (per 50CFR 27.97 for Private Operations and per 50CFR 27.86 for Begging), and other activities identified in 50CFR Part 27.

14) Beach access will occur only on refuge owned lands on the sandy part of the beach from the toe of the dunes to the Delaware Bay (mean high water demarcation to mean low water demarcation). One parking lot with a dune crossover provides access to the beach. Access on the dune and adjacent marshes is prohibited.

15) Access to closed areas or use during the refuge's closed hours requires a special use permit, which is subject to the refuge manager's approval, unless the activity is in conjunction with a refuge staff- or volunteer-led program

16) Changes outlined in the CCP dealing with closed and seasonally closed areas and public use regulations, when approved, will be incorporated into their respective public use program.

JUSTIFICATION:

Wildlife observation, photography, environmental education, and interpretation are priority wildlife-dependent uses for the National Wildlife Refuge System through which the public can develop an appreciation for fish and wildlife (Executive Order 12996, March 25, 1996 and the National Wildlife Refuge System Administration Act of 1966, as amended by the National Wildlife Refuge System Improvement Act of 1997 (Public Law 105-57)). The Service's policy is to provide expanded opportunities for wildlife-dependent uses when compatible and consistent with sound fish and wildlife management and ensure that they receive enhanced attention during planning and management.

Specific refuge regulations address equity and quality of opportunities for visitors and help safeguard refuge habitats. Impacts from this proposal, short-term and long-term, direct, indirect, and cumulative, are expected to be minor and are not expected to diminish the value of the refuge for its stated objectives. Available parking and size of the facilities will typically limit use at any given time, except during special events.

Conflicts between visitors are localized and are addressed through law enforcement, public education, and continuous review and updating to public use regulations. Conflicts are further reduced by the establishment of seasonal area closures.

Stipulations above will ensure proper control of the means of use and provide management flexibility should detrimental impacts develop. Allowing this use also furthers the mission of the National Wildlife Refuge System by providing renewable resources for the benefit of the American public while conserving fish, wildlife, and plant resources on the Refuge.

This activity will not materially interfere with or detract from the mission of the Refuge System or the purpose for which the Refuge was established.

SIGNATURE:

Refuge Manager: _____ _____
(Signature) (Date)

CONCURRENCE:

Regional Chief: _____ _____
(Signature) (Date)

MANDATORY 15 YEAR RE-EVALUATION DATE: _____

LITERATURE CITED:

See CCP Bibliography.

Appendix F

©Kevin Fleming

Delmarva fox squirrel on the refuge

Wilderness Review

WILDERNESS REVIEW AND EVALUATION FOR PRIME HOOK NATIONAL WILDLIFE REFUGE

Introduction

A wilderness review is the inventory, study, and decision making process we use to determine whether to recommend Refuge System lands and waters for wilderness designation. The purpose of a wilderness review is to identify and recommend to Congress lands and waters of the National Wildlife Refuge System (NWRS) that merit inclusion in the National Wilderness Preservation System (NWPS). Wilderness reviews are a required element of comprehensive conservation plans (CCP), and we follow the planning process outlined in 602 FW 1 and 3. This process includes interagency, state and public involvement and NEPA compliance. Natural and Cultural Resources Management Part 610 Wilderness Stewardship chapter 4 Wilderness Review and Evaluation is followed for conducting wilderness reviews.

The wilderness review process consists of three phases:

(1) Inventory: where we identify lands and waters that meet the minimum criteria for wilderness. These areas are called Wilderness Study Areas (WSAs).

(2) Study: where we evaluate WSAs to determine if they are suitable for wilderness designation.

(3) Recommendation: where we use the findings of the study to determine if we will recommend the area for designation as wilderness in the final CCP. We report our wilderness recommendations from the Director through the Secretary of the Interior and the President to Congress in a wilderness study report.

Phase I – Inventory: During the inventory phase, we assess wilderness inventory areas (WIAs) under the minimum criteria for wilderness. The Wilderness Inventory Areas are First Hill, Second Hill, and Negro Island. Refuge lands and waters that meet those criteria are called wilderness study areas (WSAs). During the study phase we evaluate a range of management alternatives to determine whether a WSA is suitable for wilderness designation or for management under an alternate set of goals and objectives that do not involve wilderness designation. If we identify a WSA, we study it further in accordance with CCP process to determine its suitability for wilderness designation. We inventory Refuge System lands and waters to identify areas that meet the definition of wilderness in section 2(c) of the Wilderness Act. The criteria we used to evaluate areas and identify WSAs are:

(1) Size
(2) Naturalness
(3) Opportunities for solitude or primitive recreation
(4) Supplemental values

(1) **Size:** Section 3(c) of the Wilderness Act directed the Secretary to review every roadless area of 5,000 contiguous acres or more and every roadless island. The size criteria will also be satisfied for areas under Service jurisdiction in the following situations (610 FW 4.8):

(A) – An area with more than 5,000 contiguous acres (2,000 hectares). State and private land inholdings are not included in making this acreage.

(B) – A roadless island of any size. A roadless island is a roadless area that is surrounded by permanent waters or that is markedly distinguished from surrounding lands by topographical or ecological features such a precipices, canyons, thickets, or swamps.

(C) – An Area of less than 5,000 contiguous acres that is of sufficient size to make its preservation and use in an unimpaired condition practicable and is of a size suitable for wilderness management.

(2) **Naturalness:** we evaluated the naturalness criteria to identify a WSA during the inventory phase of the Wilderness Review as per Service policy 610 FW 4.9 which is premised on Section 2(c) wilderness area definition that "…generally appears to have been affected primarily by the forces of nature with the imprint of man's work substantially unnoticeable." To make this determination, it must be possible to observe the area as being generally natural, rather than "pristine."

Naturalness Evaluation Criteria. Current policy (610 FW 4.9) provides the following guidance for naturalness evaluation:

(A) –"We make a distinction between an area's **"apparent naturalness"** and **"historic conditions"** in the context of biological integrity, diversity, and environmental health. The term "historic condition" refers to the condition of the landscape in a particular area before the onset of significant human-caused change. The term "apparent naturalness" refers to whether or not an area looks natural to the average visitor who is not familiar with historic conditions versus human-affected ecosystems in a given area. We have addressed the question of the presence or absence of apparent naturalness (i.e., are the works of humans substantially unnoticeable to the average visitor?)" when considering areas to be included in the inventory phase of our wilderness review.

(B) –"We avoided an approach of assessing naturalness that limits designation only to those areas judged to be pristine. Land that was once logged, used for agriculture, or otherwise significantly altered by humans is eligible for wilderness designation if it has been restored or is in the process of being restored to a substantially natural appearance".

(C) **-** "We use caution in assessing the effects on naturalness that relatively minor human impacts create. An area being evaluated may include some human impacts provided they are substantially unnoticeable in the unit as a whole. Examples of manmade features that would not disqualify an area for consideration as a WSA include: trails, trail signs, bridges, fire towers, fire breaks, fire presuppression facilities, pit toilets, fisheries enhancement facilities (such as fish traps and stream barriers), fire rings, hitching posts, snow gauges, water quantity and quality measuring devices, research monitoring markers and devices, wildlife enhancement facilities, radio repeater sites, air quality monitoring devices, fencing, spring developments, and small reservoirs. Even with these features, an area may express wilderness character and values."

(D) **-**"We may disqualify portions of an area from consideration where significant human-caused hazards make that area unsafe for public use, such as contaminated sites or the existence of unexploded ordnance from military activity. Once these conditions are corrected, we may then consider that portion of the area."

(E) -Additional policy guidance suggests that "we do not disqualify areas from further wilderness study solely on the basis of the 'sights and sounds' of civilization located outside the areas. Where human impacts are outside the area being inventoried, we do not normally consider them in assessing naturalness. However, if an outside impact of major significance exists, we should note it and evaluate it in the inventory conclusions. Human impacts outside the area should not automatically lead us to conclude that an area lacks wilderness characteristics".

(F) -Policy guidance also stipulates that "we do not disqualify areas from further wilderness study solely on the basis of established refuge management activities or refuge uses that require the use of temporary roads, motor vehicles, motorized equipment, motorboats, mechanical transport, landing of aircraft, structures, and installations generally prohibited in designated wilderness. The physical impacts of these practices should be the focus of the naturalness evaluation. We evaluate existing and proposed refuge management activities and uses in the study phase of the wilderness review."

(3) **Opportunities for Solitude or Primitive Recreation:** "Section 2(c) of the Wilderness Act defines wilderness as an area that has outstanding opportunities for solitude or a primitive and unconfined type of recreation. An area does not need to have outstanding opportunities for both elements and does not need to have outstanding opportunities on every acre". (610 FW 4.10) Solitude is defined as "wilderness solitude is a state of mind, a mental freedom that emerges from settings where visitors experience nature essentially free of the reminders of society, its inventions, and conventions. Privacy and isolation are important components, but solitude also is enhanced by the absence of distractions, such as large groups, mechanization, unnatural noise and light, unnecessary managerial presence (such as signs), and other modern artifacts". Primitive recreation is defined as "activities that provide dispersed, undeveloped recreation and do not generally require permanent facilities."

The service evaluates outstanding opportunities for solitude or a primitive and unconfined type of recreation based on the following 610 FW 4.10:

(A) – "The Wilderness Act does not define what was intended by "solitude or a primitive and unconfined type of recreation." In most cases, we could expect the two opportunities to go hand-in-hand. However, an outstanding opportunity for solitude may be present in an area offering only limited primitive recreation potential. Conversely, an area may be so attractive for recreational use that it would be difficult to maintain opportunities for solitude (e.g., around water)".

(B) – "We assess each inventory area on its own merits to determine if an outstanding opportunity exists; we must not compare areas. We may not use any type of rating system or scale, whether numerical, alphabetical, or qualitative (i.e., high-medium-low), in making the assessment".

(C) – "When an area is contiguous to designated wilderness, proposed wilderness, recommended wilderness, a WSA, or other Federal lands that a land management agency has already determined to have wilderness character (i.e., Service, BLM, Park Service, or Forest Service lands), an additional evaluation of outstanding opportunities is not required".

(D) – "An area does not have to be open to public entry and use. Congress has designated several Service wilderness areas that are closed to public use to conserve wildlife and fragile habitats".

(4) **Supplemental Values:** The Wilderness Act states that an area of wilderness may contain ecological, geological, or other features of scientific, cultural, symbolic, or educational value. Supplemental values of the area are optional, but the degree to which their presence enhances the area's suitability for wilderness designation should be considered. The evaluation should be based on an assessment of the estimated abundance or importance of each of the features. Wilderness Values "are biophysical (e.g., ecosystems, scenery, and natural processes), psychological (e.g., opportunity for solitude or primitive recreation), symbolic (e.g., national and natural remnants of American cultural and evolutionary heritage), spiritual (e.g., sense of connection with nature and values beyond one's self)".

SUMMARY OF PHASE I WILDERNESS INVENTORY FINDINGS

As part of the CCP planning process we have conducted a wilderness review and Phase I Inventory to evaluate new information and implement new policy of Wilderness Stewardship Guidelines for national wildlife refuges (610 FW 4) issued on November 2008, for a discrete part of the Refuge (cluster of roadless islands located in Management Unit II) that has been identified as having wilderness potential.

The vast majority of the 10,132 acres of Prime Hook NWR was eliminated from consideration because they do not meet the roadless, naturalness, or solitude criteria, based on one or more of the following factors. The imprint of human work is obvious and prominent throughout those areas, which are divided by refuge and state roads, agricultural fields, impoundments, buildings, parking lots, utility right-of-ways, ditches, trails, and levees. This includes existing areas of forest, agriculture lands, impounded wetlands, and salt marshes within Units I , II, III, and IV.

Ongoing refuge management activities include plantings, mowing and managing impoundments. Numerous roads, ditches and levees are present in the forested wetlands. The 10,132 acres also contain developed areas for maintenance, visitor services, and administration, with all their associated parking areas, tour roads, and office and storage facilities. Traffic along state roads is constantly visible or with in hearing of any location within this area. Boat traffic is evident within some of the area as well.

During the preplanning phase of the Refuge's CCP process, the Service contracted the State's Natural Heritage Program to inventory rare plant and animal species and communities and map out Prime Hook's NVCS cover-types. Based on the discovery of several "Legacy Trees" located on inventoried roadless islands in Unit II, these areas may have wilderness potential when considering the context of State's current forested landscape conditions. These areas not only serve as a repository of exceptional large trees but also contain significant ecological, cultural, and scientific value as remnants of eastern North American natural and evolutionary heritage left standing in the State of Delaware.

Ecological Significance of Legacy Trees Today: Prior to pre-European settlement, old growth stands dominated the forested landscape (70-90%) throughout the northeast and east coast providing critical elements of biodiversity and habitat characteristics for many wildlife species that are uncommon and/or endangered today in the State of Delaware. However, old-growth and late successional forests are extremely rare in Delaware as most fragmented forest parcels are secondary growth forest. The only example of old-growth or late-successional remnants remaining, are large, old trees sometimes referred to as "Legacy Trees."

Legacy trees are large (25-30" dbh), old (150+ years) trees that have been spared during previous harvest or have survived stand-replacing natural disturbances (e.g., windstorms, ice and snow storms, insect outbreaks, and disease). Old, large trees are rare today but they were historically a dominant age class in forests of the past. As measured by species richness, diversity, and use by a number of different wildlife taxa, several studies have shown that the retention/conservation of individual legacy trees can have added significant habitat and wilderness values associated with long term biodiversity and managing biological legacies (Mazurek & Zielinski -2004; Hunter & Bond 2001; Bull et al 1997).

Summary of Key Benefits of Individual Legacy trees

- high correlation between legacy tree retention and species richness and diversity, especially for birds;
- adds diversity of tree diameters that provide habitat and cover for a wider range of species compared to younger trees or even-aged stands;
- unique crown architecture & bark morphology provide plentiful micro-niches for lichens, mosses, insects, and nesting perches for migratory birds;
- provide tree elements with basal hollows that support birds, bats, and other mammal species making it possible for many wildlife species to breed where they would not otherwise be able to;
- can serve as "old-growth ambassadors" for public appreciation, experience, and education of ecological significance and beauty of legacy trees and a sense of connection with more ancient

symbols of nature;
- given scarcity of old-growth or late-successional tree examples and highly fragmented nature of secondary growth in the state, individual legacy trees may function as "mini-reserves" to promote ecosystem function and conservation;
- retain a primeval character and influence on the land serving as historical and natural benchmarks for ecological studies.

Historic and Cultural Significance of Refuge Roadless Islands within Unit II: As part of the CCP pre-planning process, a study and summary of known Refuge historic and prehistoric sites plus an evaluation of archaeological sensitivity in and around Refuge lands was conducted to identify landforms and areas likely to contain undiscovered archaeological resources. Of the wilderness review areas First Hill (PMH-033P)/7S-C-78 has been designated as a prehistoric site.

Prior to allowing Open Marsh and Water Management (OMWM) excavations to occur on the Refuge and as part of the EA for proposed OMWM work, Wise (1988) using prehistoric settlement patterns and wetland sites identified by Custer and Galasso (1983) and Custer (1986) developed a graphic model for paleography and prehistoric site sensitivity at PHNWR. Later, archeologists in 2004 (Tetra-Tech-FW, Inc.) enhanced capabilities of prior explanatory models since the known sites on Refuge were limited (16 prehistoric & 31 historic). Additional known sites within a one mile radius of the Refuge were included to expand model data set to include 25 prehistoric and 53 historic sites. This expanded focus included more wetland sites based on the archaeological monitoring prior to OMWM excavations at PHNWR had led to the identification of several archaeological sites in wetland areas (Clark & Blume, 1990 & 1993).

Qualification of Wilderness Inventory Areas as Wilderness Study Areas (WSAs):
First Hill, Second Hill, and Negro Islands

Conditions Common to all Three Islands

Size Criteria: First Hill (3 acres), Second Hill (5 acres), and Negro Island (2 acres) all meet the size criteria, as the Wilderness Act does not specify a minimum size for roadless islands. The size criteria for areas under Service jurisdiction state that a roadless island can be any size, as long a it fits the definition in 610 FW 1.5 AA:

> *A roadless island is defined as "a roadless area that is surrounded by permanent waters or that is markedly distinguished from surrounding lands by topographical or ecological features such as precipices, canyons, thickets, or swamps."*

Naturalness Criteria: All three roadless islands do not meet the naturalness criteria where the term "apparent naturalness" is defined as whether or not an area looks natural to the average visitor who is not familiar with the historic condition versus human-affected ecosystems in a given area. The three islands do not meet the naturalness criteria because they are within and altered and managed impoundment. However, there are existing elements of biological integrity, diversity, and environmental health. All three roadless islands are part of the Mesic Coastal Plain Oak Forest community found on the Refuge. These islands are located within isolated wetlands. The islands are dominated by a mixture of loblolly pine, pond pine, and one or more oak species. Understory strata is characterized by American holly, highbush blueberry, swamp doghobble, sweet pepperbush, swamp azalea, and green briar. The herbaceous layer is sparse with rice-cut grass, stout wood reedgrass, slender spikegrass, partridge betty, royal fern and wintergreen. These features enhance the "naturalness" of the areas. However, a road was once used to access these islands. The remnants of this road are still visible today

and can also be seen in aerial photographs taken in the 1930's. The aerial photographs taken in the 1930's also show that there was also an agricultural field on Second Hill. It should also be noted that the surrounding wetlands are artificial. As noted in the vegetation survey, Japanese stilt grass and Phragmites are common invasive species to these island habitats.

The unit in which these islands reside is influenced by the artificial water management capabilities developed by the Service. This management unit is bounded on the north by Fowler's Beach Road, barrier dunes on the east facing the Delaware Bay, Prime Hook Road on the south, an upland interface on the west, and a sand dike plus Prime Hook beach community on the east. During storm tides this sand dune system has been breached several times and washouts have deposited sand and salt water into the Unit II impoundment.

Delaware Bay's normal tidal ranges are from 3 to 3.5 feet except for storm surges and spring tides (+ 6.5 ft). Tidal flow enters Slaughter Canal from the Delaware Bay through Unit I salt marshes into the northern portion of Unit II and fresh water flow enters Unit II on the west from Slaughter creek. Since 2009, salt water enters Unit II via the breaches south of Fowler's Beach Road.

General description and background history of Unit II impoundment

Until 1900, Unit II marshes remained unchanged, consisting of a brackish system dominated with cattails and sedges. Prior to the refuge acquiring Unit II, both private land owners and the state mosquito control agency used timber sheeting to construct small water control structures throughout Unit II to manage water levels. Portions of Unit II were also heavily grid ditched during the 1930's for mosquito control. To maintain water on the marsh during the fall and winter for muskrat trapping and waterfowl hunting, private owners built water control structures at Fowler's Beach Road, Oak Island and near the bridge at Slaughter Creek to hold water.

Landowners had the marsh drained and dug Slaughter Canal in the early 1900s to improve drainage of their upland areas by channelizing water north to Cedar Creek. In 1906 the Slaughter Canal dredging reached into Unit II and ended at Oak Island. The construction of Slaughter Canal vastly increased drainage in Unit II marshes and lowered water tables in upland areas and significantly altered tidal exchange, leaving only a narrow band of tidal marsh along the edge of the canal and around Oak Island. The dredging of the canal also contributed to *Phragmites* colonization so that by the 1980s, Unit II had completely reverted to a *Phragmites* jungle, with dense stands covering 1,000 acres (See Prime Hook's Environmental Assessment for Chemical Control of *Phragmites* and Proposed Marsh Rehabilitation-March 21, 1983).

In 1934, a dike was dug by dragline, along the eastern edge of the marsh from Slaughter Beach to Prime Hook Beach to prevent the bay from washing into the marshes. The deep borrow ditch is still evident today but several sections have been filled by washouts. Until the early 1950s, access to Prime Hook Beach was possible only by boat or during the dry summer by horse or vehicle. In 1953, a gravel roadway was constructed across the marsh and today this roadway is paved (Prime Hook Beach Road). It has effectively acted as a dike between Units II and III with culverts under the roadway resulting in some limited flow of water between the units. All of these anthropocentric activities have significantly altered the hydrology of Unit II wetlands (USFWS 1986).

From the establishment of the refuge in 1963 to 1986, Unit II had no water level management capabilities. In 1963, the Service proposed a water management plan which outlined marsh management needs for the entire refuge including Unit II to the public. The plan was designed to

impound refuge marshes without backing water against upland areas. Local residents expressed strong opposition to the proposal and the state Drainage Engineer felt that it had the potential to flood or waterlog contiguous agricultural lands as occurred at Bombay Hook NWR. A revised plan with inland canals to provide drainage of uplands was also strongly opposed. Subsequently, a "No Management" policy was adopted which resulted in a severe decline in the quality, quantity, and productivity of the Unit II marshes over the ensuing years (USFWS 1986). Then in 1987 a large concrete water control structure was put into place. Impounding 1,500 acres this water control structure located on the northern boundary at Fowler Beach Road held back salt water from intrusion into Unit II. After water level management capability was established, salinities within this impoundment range from 0 to 8 ppt year round.

Slaughter Creek was the most significant watercourse in the unit, flowing southeasterly across the entire Unit II to Prime Hook Creek south to Prime Hook Road. Today, the hydrology of Unit II was first changed with the installment of water control infrastructure as water flows northward to Unit I from First and Second Hills to Fowler Beach Road but from Oak Island south, water flows in a southerly direction to Prime Hook Road. With the breaches the salinities can vary from 10 to 30 ppt.

Unit II restoration of water level management in 1987 significantly enhanced the water table of these marshes. Water sources that affect the hydrology of this unit today come from tidal action, runoff from Slaughter Creek, excess water from the Unit III, rainfall and local runoff. Tidal waters have dramatically affected the salinities and extent of open water in Unit II since the breaches occurred.

Opportunities for Solitude or Primitive Recreation: The WIAs identified in the Refuge's Inventory Phase are discrete roadless islands identified by State Heritage scientists as having wilderness potential based on unique ecological, scientific and historic value. However, the small acreage of the islands does not lend themselves to primitive recreation.

Supplemental Wilderness Values: All three roadless islands possess several supplemental values which include ecological and geological features, archaeological significance, symbolic wilderness value in the form of legacy trees, and unique opportunities for public environmental education and appreciation of exemplary large trees. Examples of unique ecological and geological features on the islands include poorly drained sand makes up the substrate for the community and it also has a very high water table. They also support several examples of "Legacy Trees" unique to the State that include pin oak, willow oak, black walnut, water oak and pond pine tree species. Due to the natural seclusion of these areas, eagle nests have been established on the First and Second Hills, all on exceptionally large loblolly pines. Fist Hill is an example of an archeological significant area as it is a designated state and federal prehistoric site. Also the scientific, educational and recreational values of the islands could include with special planning, seasonal trips to the islands could provide unique opportunities for the public to enjoy legacy trees, understand their ecological, historic, and provide for scientific research of late successional remnant trees and adjacent habitats.

Land Status and Service Jurisdiction: The Service has full jurisdiction over the lands and waters of these three roadless islands and surrounding wetlands that would ensure maintenance of wilderness resources and character within these potential wilderness study areas and there are no non-federal lands within the WSAs.

Conclusion

The vast majority of the 10,132 acres of Prime Hook NWR was eliminated from consideration to be wilderness because they do not meet the roadless, naturalness, solitude or primitive recreation criteria and the imprint of human work is obvious.

The Service also finds that none of the WIAs in Prime Hook NWR meet the minimum criteria to qualify as a WSA as defined by the Wilderness Act. First Hill, Second Hill, and Negro Island all meet the size criteria, as the Wilderness Act does not specify a minimum size for roadless islands. But, the three islands do not meet the naturalness criteria because they are not primarily affected by nature and the imprint of mans' work is substantially noticeable. The islands reside in a unit influenced by artificial water management developed by the Service. The management of the Unit II impoundment, past and current has had a tremendous impact on the hydrology of the area. These impacts include invasive species intrusion, fluctuating water tables, reduced salinity for several decades and now inundation of former marsh, altered hydrology, and mosquito control to include grid ditching. This area has been heavily manipulated by humans for over a century, and its historic natural appearance (as confirmed by core studies) would have been as an extensive salt marsh system. The islands also do not qualify for opportunities for primitive recreation because of the small acreage of the islands. The last criteria of supplemental values are not required for wilderness, but do exist on the Islands. All three islands possess supplemental values which include ecological and geological features, archaeological significance, symbolic wilderness value and opportunities for environmental education.

None of the Wilderness Inventory Areas meet the minimum criteria to qualify as a Wilderness Study Area so Prime Hook NWR is not considered further for possible designation in its CCP.

Appendix G

©Kevin Fleming

American black ducks take flight

Intra-Service Section 7 Biological Evaluation Form

INTRA-SERVICE SECTION 7 BIOLOGICAL EVALUATION FORM

Originating Person: Michael Stroeh
Telephone Number: 302-653-9345

I. Region: Region 5 (Northeast)

II. Service Activity (Program): National Wildlife Refuge System

III. Pertinent Species and Habitat:

A. Listed species potentially present within the action area:

1) Delmarva Fox Squirrel (DFS) (*Sciurus niger cinereus*)
2) Piping Plover (*Charadrius melodus*)

There is no Federally-designated critical habitat within the action area.

B. Proposed species and/or proposed critical habitat within the action area
None

C. Candidate species within the action area:
None

D. Include species/habitat occurrence on a map.
Habitat maps are found in Chapter 3 of the draft CCP/EA.

IV. Geographic area or station name and action:
Prime Hook National Wildlife Refuge – Development of a Comprehensive Conservation Plan.

A. Ecoregion Number and Name: Ecosystem No. 36 Delaware River/Delmarva Coastal Ecosystem

B. Distance (miles) and direction to nearest town: The Refuge is located 5 miles east of Milton, DE.

Prime Hook National Wildlife Refuge is in the process of preparing a Comprehensive Conservation Plan (CCP) that is vital for the management of the Refuge. The final CCP will provide strategic management direction over the next 15 years, by

- providing a clear statement of desired future conditions for habitat, wildlife, visitor services, and facilities;
- providing Refuge neighbors, visitors, and partners with a clear understanding of the reasons for management actions;
- ensuring Refuge management reflects the policies and goals of the System and legal mandates;
- ensuring the compatibility of current and future public uses;
- providing long-term continuity and direction for Refuge management; and
- providing direction for staffing, operations, maintenance, and developing budget requests.

The Refuge Improvement Act requires that all national wildlife refuges have a CCP in place by 2012 to help fulfill the mission of the System.

With the Refuge located in the mid-Atlantic region of the U.S., it provides significant, even critical amounts of habitat for the majority of wildlife species known to occur along the east coast. The Refuge consists of over 10,000 acres with 34 different habitat classifications. The coastal location of the Refuge also makes them part of a major migration corridor for a variety of birds, including waterfowl, waterbirds, raptors, and songbirds.

V. Location:
Maps are found in Chapters 1 through 3 of the draft CCP/EA.

A. Ecoregion Number and Name: Ecosystem No. 36 Delaware River/Delmarva Coastal Ecosystem

B. County and State: Sussex County, Delaware

C. Section, township, and range (or latitude and longitude):

D. The Refuge headquarters is located at latitude 38 degrees, 49'48" and longitude -75 degrees, 14'54"

E. Distance (miles) and direction to nearest town: The Refuge is located 5 miles east of Milton, DE

F. Species/habitat occurrence:

1) **Delmarva Fox Squirrels** are associated with forested habitats on the refuge, primarily inhabiting a core area near the refuge headquarters area of the refuge, in Unit III.

2) **Piping plovers** are associated with intertidal or strand habitats. Piping plovers have been noted on overwash areas of the beach along the refuge's eastern boundary. However, there has been no confirmed breeding on the refuge documented thus far.

Although delisted in 2007, the bald eagle is also present on the refuge and its protection through management is still a consideration for the refuge.

For more information and details, please refer to chapter 3, "Affected Environment" of the draft CCP/EA.

VI. Description of proposed action (attach additional pages as needed):
The proposed actions and alternatives selected by the Service are described in Chapter 2 of the draft CCP/EA.

VII. Determination of effects:

A. Explanation of effects of the action on species in item III:

Refer to Chapter 4 of the draft CCP/EA for more information and details.

The proposed actions provide more potential habitat for fish and wildlife species native to the waters, wetlands, and forest associated with the Delaware River/Delmarva Ecosystem. Prime Hook NWR plans to preserve, manage, and restore some of the last significant natural areas for wildlife in Delaware. The Refuge's proposed actions will incorporate methods such as restoration, habitat management, and/or monitoring of important wildlife habitats, ranging from coastal systems to mature forests. The proposed management actions presented in the CCP will provide support for threatened and endangered species in addition to hundreds of species of migratory birds and other wildlife within the Atlantic Flyway.

From the draft CCP/EA, (Chapter 2, Alternative B, the Service-Preferred Alternative), Goals One through Four outline the proposed preservation, restoration, and management of barrier beach and saltmarsh habitats, forests, freshwater wetlands and impoundments, and early successional habitats. Proposed actions include reforestation of substantial potential Delmarva Fox Squirrel habitat and protection of beach overwash habitats created in certain parts of the refuge, which would be suitable for piping plovers.

The Service announced in July 2007 the final decision to remove the bald eagle from the list of threatened and endangered species. After 40 years of conservation efforts, eagle populations have rebounded and no longer need Endangered Species Act protection.

The refuge has two active Bald eagle nests. The Service will effectively monitor the species in cooperation with the states for a minimum of five years after delisting. The post-delisting monitoring plan provides a solid framework for surveying eagles and documenting eagle success after delisting. The monitoring plan is designed to track the population status of bald eagles in the lower 48 states by sampling the number of breeding pairs, similar to the current monitoring methods. The monitoring plan is not intended to monitor causal factors such as circumstances that "disturb" bald eagles or their habitat, a term defined under Bald and Golden Eagle Protection Act. We will continue to monitor that nest and any new ones located on the Refuge. Bald eagles are protected by two other major federal laws: the Bald and Golden Eagle Protection Act and the Migratory Bird Treaty Act.

Information on the occurrence of listed species and their habitats is frequently updated; thus, Refuge staff will continue to consult with the Service's Ecological Services (ES) Branch.

B. Explanation of actions to be implemented to reduce adverse effects:

As explained above, we believe that implementation of the proposed alternative in the CCP will result in either completely beneficial effects to the listed species described above; or that any direct, indirect, or cumulative adverse effects that may result will be no more than insignificant or discountable. In order to ensure that habitat restoration activities and other management actions in listed species habitat will have no adverse effects, these actions will be performed outside listed species growing/breeding seasonal windows.

VIII. Effect determination and response requested: [* = optional]

A. List species/designated critical habitat:

Determination	**Response requested**
No effect/No adverse modification **Species:**	____**Concurrence**
May affect, but is not likely to adversely affect species/adversely modify critical habitat **Species:** 1) Delmarva Fox Squirel (any effects completely beneficial) 2) Piping Plover (any effects completely beneficial)	__X__**Concurrence**
May affect, and is likely to adversely affect species/adversely modify critical habitat **Species:** None	_____**Formal Consultation**

_____ _____

Signature **Date**

[Title/office of supervisor at originating station]

IX. Reviewing ESO Evaluation:

A. Concurrence _____ Nonconcurrence_____

B. Formal consultation required_____

C. Conference required _____

D. Informal conference required _____

E. Remarks (attach additional pages as needed):

_____ _____

Signature **Date**

[Title/office of reviewing official]

Appendix H

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Swamp sparrow

Refuge Operation Needs System (RONS) and Service Asset Maintenance Management System (SAMMS)

Work Order Number	Work Order Description	Estimated Cost
2008865688	Rehabilitate Old Concrete Masonry Unit Shop Near Maintenance Boat Ramp	$10,000.00
2006502430	Rehabilitate Turkle Pond Road	$100,000.00
05137378	Rehabilitate Old Shop Access Road	$47,000.00
2005240138	Replace Refuge Boundary Signs	$36,000.00
2008865678	Remove Barbed Wire Fence	$109,000.00
2005258126	Remove Unit IV Tract 79C Bridge - Contract	$72,000.00
2005225837	Rehabilitate Turkle and Fleetwood Ponds - Replace Boat Ramp Fleetwood Pond	$6,000.00
2005225787	Rehabilitate Turkle and Fleetwood Ponds - Turkle Pond dredge	$27,000.00
2005258131	Remove Old Shop Building - Contract	$71,000.00
2005225831	Rehabilitate Turkle and Fleetwood Ponds - Replace Boat Ramp Turkle Pond	$6,000.00
2008865635	Rehabilitate Island Farm Water Control Structures and Ditches	$90,000.00
2005225818	Rehabilitate Turkle and Fleetwood Ponds - Fleetwood Pond dredge	$13,000.00
2006502410	Rehabilitate Old Shop Road Parking Pad	$30,000.00
2005225904	Rehabilitate Dike Access to Prime Hook Creek- Dump/Spread Gravel	$62,000.00
2005241919	Replace Bulkhead on Prime Hook Creek Water Control Structure - DU	$436,000.00
2009943353	Replace Rrime Hook Creek Structure	$387,600.00
2009943356	Replace Prime Hook Creek Flap Gate Structure	$6,900.00
2005213049	Rehabilitate Rip Rap Petersfield Ditch - DU Contract	$112,000.00
2005257919	Replace Route 39 Culverts - Contract	$44,000.00
2008857579	Replace Bulkhead	$250,000.00
2009943354	Replace Petersfield Ditch Structure	$775,200.00
2009943355	Replace Petersfield Ditch Flap Gate Structure	$13,800.00
2005258135	Rehabilitate Headquarters Dike - DU Contract	$159,000.00
2008865638	Rehabilitate Island Farm Unit IV Access Road	$24,000.00
2005258120	Rehabilitate Gravel Road at Office, Headquarters - Contract	$139,000.00
2005213978	Rehabilitate Gravel Roads in Unit IV -Dump Spread Gravel	$231,000.00
2005258028	Rehabilitate Wells Tract Road - Contract	$109,000.00
2005258035	Rehabilitate Farm Road on Isaac's Tracts 1 - Contract	$112,000.00
2008865685	Rehabilitate Back Bay Road	$55,000.00
2005241922	Rehabilitate Unit II Water Control Structure Bulkhead with Emergency Spillway	$195,000.00
2009943357	Replace Fowler's Beach Flap Gate Structure	$11,500.00

Work Order Number	Work Order Description	Estimated Cost
2005257914	Rehabilitate Office and Visitor Doors - Engineering	$5,000.00
2006502018	Replace Office/Visitor Center Roof	$38,000.00
2006502054	Replace Office HVAC - Tier 2A	$85,000.00
2006508219	Construct Administrative Wing	$750,000.00
2009956540	Construct Geothermal Well at Office/Visitor Contact	$60,000.00
2008865681	Replace Refuge Access Gates	$123,000.00
2005257938	Rehabilitate Slaughter Canal Ditches Phase II - Contract	$430,000.00
2007741675	Construct Public Use Signs/Panels for Entire Refuge	$147,000.00
2006508222	Rehabilitate Dike to Unit III Duck Blinds	$504,000.00
2005258163	Rehabilitate Earth Roads at Jefferson/Lofland Tract - Contract	$157,000.00
2006351066	Construct Observation Tower, Panels, Kiosks, Signs and Brochures - Contract	$212,064.41
2007564772	Construct Observation Tower, Panels, Kiosks, Signs and Brochures - Engneering	$161,437.32
2009954670	Rehabilitate Three Existing Pulloffs On Broadkiln Beach Road	$160,000.00
	Total	**$6,572,501.73**

Work Order Number	Work Order Description	Estimated Cost
2009894756	Replace 2008 Ford escape suv	$30,000.00
01113189	Replace 1998 John Deere 7710 Tractor	$85,000.00
2009894755	Replace 2006 F350 utility truck	$45,000.00
2009894754	Replace John deere 777 Ztrak mower	$10,000.00
2008855953	Replace 2003 John Deere 6420 Tractor	$130,000.00
01113273	Replace 1998 Dodge Grand Caravan Minivan	$34,000.00
01113275	Replace 2000 Ford 250 4x4 Pickup Truck	$37,000.00
05137409	Replace JD Gator with a 4x4 Polaris Ranger ATV	$25,000.00
2009894753	Replace Marsh Master Tractor	$195,000.00
2006501986	Replace 1999 4400 JD Tractor	$100,000.00
01113279	Replace 1983 Panther Airboat	$30,000.00
01113282	Replace 1986 International Stake Body Truck	$79,000.00
01113280	Replace 1999 Carolina Skiff w/25 hp Go-Devil Motor	$10,000.00
01113277	Replace 1998 Ford 150 pickup	$30,000.00
01113031	Replace Marsh Master Tractor	$159,000.00
	Total	$999,000.00

Appendix I

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Field sparrow

Regional Economic Impacts

NOTE: **Appendix I (Regional Economic Impacts)** was developed prior to the finalization of alternatives as presented in Chapter 4 of the draft CCP/EIS. The report presents a description of the methods used to conduct a regional economic impact analysis, and an analysis of CCP management strategies that could affect stakeholders and residents and the local economy. Refuge management activities of economic concern in the analysis are:

- Refuge purchases of goods and services within the local community;
- Refuge personnel salary spending;
- Revenues generated from Refuge Revenue Sharing;
- Spending in the local community by Refuge visitors; and
- Other management activities –Cooperative Farming Program.

Differences between alternative strategies analyzed in the report and those presented in the draft CCP/EIS are minor. In the report, alternative A (No Action Alternative) included cooperative farming as one of the strategies. In Chapter 4 of the draft CCP/EIS, the strategy of cooperative farming was subsequently moved to alternative C. While farming operations are not currently occurring on the refuge, the impacts to cooperators associated with farming 600 acres of corn or soybeans are briefly discussed in the report. A Federal court order would need to be resolved before the cooperative farming program could resume; therefore, the economic impacts of farming were not included in the economic analysis of alternative A in the report. This change did not result in a significant difference for the report or the draft CCP/EIS, and the original Regional Economic Impacts report is presented here.

Regional Economic Impacts of Current and Proposed Management Alternatives for Prime Hook National Wildlife Refuge

By Lynne Koontz

Introduction

The National Wildlife Refuge System Improvement Act of 1997 requires all units of the National Wildlife Refuge System to be managed under a Comprehensive Conservation Plan (CCP). The CCP must describe the desired future conditions of a Refuge and provide long range guidance and management direction to achieve refuge purposes. Prime Hook National Wildlife Refuge, located in Sussex County, Delaware is in the process of developing a range of management goals, objectives, and strategies for the CCP. The CCP for the Refuge must contain an analysis of expected effects associated with current and proposed Refuge management strategies.

For refuge CCP planning, an economic analysis provides a means of estimating how current management (No Action Alternative) and proposed management activities (alternatives) affect the local economy. This type of analysis provides two critical pieces of information: 1) it illustrates a Refuge's contribution to the local community; and 2) it can help in determining whether economic effects are or are not a real concern in choosing among management alternatives.

It is important to note that the economic value of a refuge encompasses more than just the impacts of the regional economy. Refuges also provide substantial nonmarket values (values for items not exchanged in established markets) such as maintaining endangered species, preserving wetlands, educating future generations, and adding stability to the ecosystem (Carver and Caudill, 2007). However, quantifying these types of nonmarket values is beyond the scope of this study.

This report first presents the methods used to conduct a regional economic impact analysis are described. An analysis of the final CCP management strategies that could affect stakeholders and residents and the local economy is then presented. The Refuge management activities of economic concern in this analysis are:

- Refuge purchases of goods and services within the local community;
- Refuge personnel salary spending;
- Revenues generated from Refuge Revenue Sharing;
- Spending in the local community by Refuge visitors; and
- Other management activities –Cooperative Farming Program.

Methods for a Regional Economic Impact Analysis

Economic input-output models are commonly used to determine how economic sectors will and will not be affected by demographic, economic, and policy changes. The economic impacts of the management alternatives for Prime Hook NWR were estimated using IMPLAN (Impact Analysis for Planning), a regional input-output modeling system developed by the USDA Forest Service. IMPLAN is a computerized database and modeling system that provides a regional input-output analysis of economic activity in terms of 10 industrial groups involving more than five hundred economic sectors (Olson and Lindall, 1999). The IMPLAN model draws upon data collected by the Minnesota IMPLAN Group

from multiple federal and state sources including the Bureau of Economic Analysis, Bureau of Labor Statistics, and the U.S. Census Bureau (Olson and Lindall, 1999). The year 2007 IMPLAN Sussex County data profile was used in this study. The IMPLAN county level employment data estimates were found to be comparable to the US Department of Commerce, Bureau of Economic Analysis, Regional Economic Information System data for the year 2007.

Because of the way industries interact in an economy, a change in the activity of one industry affects activity levels in several other industries. Because of the way industries interact in an economy, activity in one industry affects activity levels in several other industries. For example, if more visitors come to an area, local businesses will purchase extra labor and supplies to meet the increase in demand for additional services. The income and employment resulting from visitor purchases from local businesses represent the *direct* effects of visitor spending within the economy. Direct effects measure the net amount of spending that stays in the local economy after the first round of spending, the amount that doesn't stay in the local economy is termed a leakage (Carver and Caudill, 2007). In order to increase supplies to local businesses, input suppliers must also increase their purchases of inputs from other industries. The income and employment resulting from these secondary purchases by input suppliers are the *indirect* effects of visitor spending within the economy. Employees of the directly affected businesses and input suppliers use their incomes to purchase goods and services. The resulting increased economic activity from new employee income is the *induced* effect of visitor spending. The indirect and induced effects are known as the secondary effects of visitor spending. "Multipliers" (or "Response Coefficients") capture the size of the secondary effects, usually as a ratio of total effects to direct effects (Stynes, 1998). The sums of the direct and secondary effects describe the total economic impact of visitor spending in the local economy.

For each alternative, regional economic effects from the IMPLAN model are reported for the following categories:

- **Local Output** represents the change in local sales or revenue.
- **Employment** represents the change in number of jobs generated in the region from a change in regional output. IMPLAN estimates for employment include both full time and part time workers, which are measured in total jobs.
- **Labor Income** includes employee wages and salaries, including income of sole proprietors and payroll benefits.

There are three alternatives evaluated in the CCP. The CCP provides long range guidance and management direction to achieve Refuge purposes over a 15 year timeframe. The economic impacts reported in this report are on an annual basis in 2007 dollars. Large management changes often take several years to achieve. The estimates reported for Alternatives B and C represent the final economic effects after all changes in management have been implemented.

Economic Impacts of Alternative A

Impacts from Refuge Revenue Sharing

Under provisions of the Refuge Revenue Sharing (RRS) Act, local counties receive an annual payment for lands that have been purchased by full fee simple acquisition by the Service. Payments are based on the greater of 75 cents per acre or 0.75% of the fair market value of lands acquired by the Service. The exact amount of the annual payment depends on Congressional appropriations, which in recent years have tended to be less than the amount to fully fund the authorized level of payments. In 2008, Sussex County received a RRS payment of $46,850. Table 1 shows the resulting economic impacts of RRS payments under Alternative A. Accounting for both the direct and secondary effects, RRS payments for Alternative A generate total annual economic impacts of $61.4 thousand in local output and $16.7 thousand in labor income in the local impact area.

Table 1. Annual Impacts from Refuge Revenue Sharing Payments for Alternative A.

	Local output ($ Thousands)	Labor income ($ Thousands)	Employment (# full & part time jobs)
Direct effects	$46.8	$11.9	0
Secondary effects	$14.6	$4.8	0
Total economic impact	$61.4	$16.7	0

Impacts from Public Use and Access Management

Refuge Visitor Expenditures in Local Economy

Spending associated with recreational visits to national wildlife Refuges generates significant economic activity. The FWS report Banking on Nature: The Economic Benefits of National Wildlife Refuges Visitation to Local Communities estimated the impact of national wildlife Refuges on their local economies (Carver and Caudill, 2007). According to the report, more than 34.8 million visits were made to national wildlife Refuges in FY 2006 which generated $1.7 billion of sales in regional economies. Accounting for both the direct and secondary effects, spending by national wildlife visitors generated nearly 27,000 jobs, and over $542.8 million in employment income (Carver and Caudill, 2007). Approximately eighty two percent of total expenditures were from non-consumptive activities, twelve percent from fishing, and six percent from hunting (Carver and Caudill, 2007).

The Refuge offers a wide variety of year round accessible recreational opportunities including big game hunting, upland game hunting, fishing, migratory game bird and waterfowl hunting, and non-consumptive wildlife viewing, education and photography opportunities. Information on state and regional trends and associated economic impacts of these recreational activities were presented in the Affected Environment chapter. This section focuses on the local economic impacts associated with Refuge visitation. Annual Refuge visitation estimates are based on several Refuge statistic sources including: visitors entering the Visitor Center/Office, hunting permits, and general observation by Refuge personnel. Annual Refuge visitation estimates are on a per visit basis. Table 2 summarizes estimated Refuge visitation by type of visitor activity for Alternative A.

Table 2. Estimated Annual Refuge Visitation by Visitor Activity for Alternative A.

Visitor activity	Total number of visits	Percentage of non-local visits (%)	Total number of non-local visits	Number of hours spent at Refuge	Number of non-local visitor days[a]
Consumptive use					
Fishing	8,886	40%	3,554	8	3,554
Big game hunting	831	83%	690	8	690
Waterfowl and migratory bird hunting	1585	25%	396	8	396
Upland game hunting	166	10%	17	8	17
Non-consumptive use					
Nature trails/other wildlife observation/office visits	115,732	46%	53,237	4	26,618
Total	127,200		57,894		31,275

[a]One visitor day = 8 hours.

To determine the local economic impacts of visitor spending, only spending by persons living outside the local area of Sussex County are included in the analysis. The rational for excluding local visitor spending is twofold. First, money flowing into Sussex County from visitors living outside the local area (hereafter referred to as non-local visitors) is considered new money injected into the local economy. Second, if residents of Sussex County visit the Refuge more or less due to the management changes, they will correspondingly change their spending of their money elsewhere in Sussex County, resulting in no net change to the local economy. These are standard assumptions made in most regional economic analyses at the local level. Refuge visitation statistics and hunting permits were used to determine the percentage of non-local Refuge visitors. Table 2 shows the estimated percent of non-local Refuge visits for Alternative A.

A visitor usually buys a wide range of goods and services while visiting an area. Major expenditure categories include lodging, restaurants, supplies, groceries, and recreational equipment rental. In this analysis we use the average daily visitor spending profiles from the Banking on Nature report (Carver and Caudill, 2007) that were derived from the 2006 NSHFWR. The NSHFWR reports trip related spending of state residents and non residents for several different wildlife-associated recreational activities. For each recreation activity, spending is reported in the categories of lodging, food and drink, transportation, and other expenses. Carver and Caudill (2007) calculated the average per-person per-day expenditures by recreation activity for each FWS region. Residents were defined as living within 30 miles of the Refuge and nonresidents as living outside the 30 mile radius (Carver and Caudill, 2007). For our analysis, non-local visitors match the nonresident spending profile definition. Therefore, we used the spending profiles for nonresidents for FWS Region 5 (the region Prime Hook NWR is located in). Nonresident average daily spending profiles for big game hunting ($48.81 per-day), small game hunting ($93.79 per-day), migratory bird hunting ($107.48 per-day), and fresh water fishing ($53.34 per-day) were used to estimate non-local visitor spending for the Refuge hunting and fishing related activities. The average daily nonresident spending profile for non-consumptive wildlife recreation (observing, feeding, or photographing fish and wildlife) was used for non-consumptive wildlife viewing activities ($84.83 per-day).

The visitor spending profiles are estimated on an average per day (8 hours) basis. Because some visitors only spend short amounts of time on the Refuge, counting each Refuge visit as a full visitor day would overestimate the economic impact of Refuge visitation. In order to properly account for the amount of spending, the annual number of non-local Refuge visits were converted to visitor days.

Refuge personnel estimate that non-local hunters and anglers spend a full visitor day (8 hours) on the Refuge. Non-local visitors that view wildlife on nature trails or participate in other wildlife observation activities typically spend 4 hours (1/2 half a visitor day) on the Refuge. Table 2 shows the number of non-local visitor days by recreation activity for Alternative A.

Total spending by non-local Refuge visitors was determined by multiplying the average non-local visitor daily spending by the number of non-local visitor days. Table 3 summarizes the total economic impacts associated with current non-local visitation for Alternative A. Non-local Refuge visitors would spend over $2.5 million in Sussex County annually. This spending would directly account for $2.4 million in local output, 23 jobs, and $674.2 thousand in labor income in the local economy. The secondary or multiplier effects would generate an additional $1 million in local output, 8 jobs, and $303.7 thousand in labor income. Accounting for both the direct and secondary effects, spending by non-local visitors for Alternative A would generate total economic impacts of $3.5 million in local output, 31 jobs and $977.9 thousand in labor income.

Table 3. Annual Impacts of Non-Local Visitor Spending for Alternative A.

	Local output ($ Thousands)	Labor income ($ Thousands)	Employment (# full & part time jobs)
Direct effects	$2,437.4	$674.2	23
Secondary effects	$1,015.9	$303.7	8
Total economic impact	$3,453.3	$977.9	31

Costs of Administering Hunting Programs

Table 4 provides a breakdown of the funding and staff time required for managing each hunting program under Alternative A. All hunting programs under Alternative A would cost almost $31 thousand dollars and 95 days of staff time annually. The deer and waterfowl hunting programs account for 95% of all costs and 94% of all staff time. While the deer and waterfowl hunting programs have similar total costs, $14.8 and $14.5 thousand respectively, the waterfowl hunting program requires 51 days of staff time compared to 38 days for the deer hunting program.

Table 4. Annual Costs Associated with Hunting Programs for Alternative A.

	Big Game-Deer		Big Game-Turkey		Upland Game		Waterfowl		Other Migratory Birds		All Hunting	
Item	Staff Days	Cost	Staff Days	Cost	Staff Days	Cost	Staff Days	Cost	Staff Days	Cost	Staff Days	Cost
Planning	6.5	$2,100	-	-	0.5	$150	5.5	$1,800	0.5	$150	13	$4,200
Processing applications	5	$1,300	-	-	-	-	-	-	-	-	5	$1,300
Printing costs-handouts	1.5	$3,040	-	-	0.25	$60	1	$300	-	-	2.75	$3,400
Law Enforcement	7.5	$1,350	-	-	0.75	$200	3.5	$650	0.75	$200	12.5	$2,400

Item	Big Game-Deer		Big Game-Turkey		Upland Game		Waterfowl		Other Migratory Birds		All Hunting	
	Staff Days	Cost	Staff Days	Cost	Staff Days	Cost	Staff Days	Cost	Staff Days	Cost	Staff Days	Cost
Inquiries	10	$2,380	-	-	1	$250	4	$950	1	$250	16	$3,830
Facilities maintenance & supplies	3.5	$2,500	-	-	-	-	30	$8,550	-	-	33.5	$11,050
Hunt operations	4	$1,000	-	-	1.25	$350	7	$1,900	-	-	12.25	$3,250
Fuel, electricity	-	$400	-	-	-	-	-	-	-	-	0	$400
Toilet rental	-	$750	-	-	-	-	-	$375	-	-	0	$1,125
Total	38	$14,820	0	$0	3.75	$1,010	51	$14,525	2.25	$600	95	$30,955

Table 5 shows the breakdown of total program expenses between staff and actual expenses for each hunting program and the Refuge cost recovery for each hunting program. The Refuge receives 80% of total fees collected. For all programs, over $12 thousand is recovered by the Refuge under Alternative A. Accounting for total Refuge expenditures and total Refuge cost recovery, the total program cost of all hunting programs under Alternative A is $18.9 thousand.

Table 5. Annual Costs Associated with Hunting Programs for Alternative A.

	Big Game-Deer	Big Game-Turkey	Upland Game	Waterfowl	Other Migratory Birds	All Hunting
Refuge Expenditures						
Staff salary expenses	$9,312	-	$950	$13,799	$600	$24,661
Non-salary expenses	$5,508	-	$60	$726	-	$6,294
Total Expenditures	$14,820	-	$1,010	$14,525	$600	$30,955
Cost Recovery from Hunting Fees						
Total amount collected	$8,313	-	$302	$6,416	-	$15,031
Amount returned to Refuge (80%)	$6,650	-	$242	$5,133	-	$12,025
Total Program Cost (total expenditures – total returned from fees)	$8,170	$0	$768	$9,392	$600	$18,930
Value of Volunteer Contributions ($20.25/hour)	272 hrs $5,508			242 hrs $4,901		514hrs $10,409

Additionally, as shown in Table 5, volunteers contribute 272 hrs of time assisting the deer hunting program with maintenance of deer stands, mowing, and hunt operations. Volunteers contribute 242 hours the waterfowl hunting program including State assistance, maintenance, and grassing duck blinds. Accounting for volunteer hours at a rate of $20.25 per/hour, the value of volunteer time totals $10.4 thousand for Alternative A.

Impacts from Refuge Administration

Staff – Personal Purchases

Refuge Employees reside and spend their salaries on daily living expenses in communities near the Refuge thereby generating impacts within the local economy. Household consumption expenditures consist of payments by individuals/households to industries for goods and services used for personal consumption. The IMPLAN modeling system contains household consumption spending profiles that account for average household spending patterns by income level. These profiles allow for leakage of household spending to outside the region. The current approved Refuge staff consists of five employees for Alternative A (Table 6).

Table 6. Current Approved Staff (Alternative A).

Refuge Manager
Wildlife Biologist
Park Ranger
Administrative Support Asst
Maintenance Worker

Based on FY 2009 salary charts, it was estimated that annual salaries for Alternative A total over $371 thousand. Table 7 shows the economic impacts associated with spending of salaries in local area by Refuge employees under Alternative A. For Alternative A, salary spending by Refuge personnel would directly account for $244.6 thousand in local output, 1.5 jobs, and $52.6 thousand in labor income in the local economy. Accounting for both the direct and secondary effects, salary spending by Refuge personnel for Alternative A would generate total economic impacts of $313.6 thousand in local output, 2 jobs and $74 thousand in labor income.

Table 7. Annual Local Economic Impacts of Salary Spending by Refuge Personnel.

	Local output ($ Thousands)	Labor income ($ Thousands)	Employment (# full & part time jobs)
Direct effects	$244.6	$52.6	1.5
Secondary effects	$69.0	$21.4	0.5
Total economic impact	$313.6	$74.0	2

Work-related Purchases

A wide variety of supplies and services are purchased for Refuge operations and maintenance activities. Refuge purchases made in Sussex County, contribute to the local economic impacts associated with the Refuge. Major local expenditures include: supplies and services related to building maintenance and construction; auto repairs, parts, and fuel; and utilities. Average annual non-salary expenditures for Alternative A are anticipated to be $234 thousand. Table 8 shows the economic impacts associated with work related expenditures in Sussex County. According to Refuge records, approximately $32.8 thousand (14%) of the annual non-salary budget expenditures are spent on goods and services purchased in Sussex County. For Alternative A, work related expenditures would directly account for $32.8thousand in local output and $3.4 thousand in labor income in the local economy. Accounting for both the direct and secondary effects, work related purchases for Alternative A would generate total economic impacts of $37 thousand in local output and $4.8 thousand in labor income.

Table 8. Local Economic Impacts of Refuge Related Purchases for Alternative A.

	Local output ($ Thousands)	Labor income ($ Thousands)	Employment (# full & part time jobs)
Direct effects	$32.8	$3.4	0
Secondary effects	$4.2	$1.4	0
Total economic impact	$94,900	$28,400	1.2

Other Management Activities – Cooperative Farming

Farming historically took place on the Refuge under an annual cooperative farming agreement where cooperators harvested corn or soybeans. Rather than paying land rent, cooperators provided the Refuge with in-kind services such as the planting of cover crops (barley, wheat, ryegrass, buckwheat and/or clover) to benefit wildlife. Refuge cropland acreage increased to approximately 1,000 acres in 1987 but then gradually declined (due to access, saltwater intrusion, and research) to approximately 600 acres by 2002.

In April 2006, a complaint challenging the legality of the Refuge cooperative farm program was filed the U.S. District Court by Delaware Audubon Society, the Center for Food Safety, and Public Employees for Environmental Responsibility. The Refuge suspended the farm program in December of 2006 when the existing agreements with cooperators expired. In March 2009, a federal court order officially prohibited the Refuge cooperative program until necessary compatibility determinations have been addressed as part of the CCP.

Alternative A would continue the cooperative farming program on a maximum of 600 acres to provide cover-crops for ducks (primarily mallard, black duck, pintail, and wood duck) and Canada geese during the fall and winter. While farming operations are not currently occurring on the Refuge, the impacts to cooperators associated with farming 600 acres of corn or soybeans are discussed below. However, the federal court order would need to be resolved before the cooperative farming program could resume therefore, the economic impacts of farming were not included in the economic analysis of Alternative A.

Value of Refuge Cropland and Associated Government Payments

Under Alternative A, either corn or soybeans would be grown with conventional tillage practices using Roundup Ready corn or no-tillage practices with Roundup Ready soybeans. To determine the value of farming 600 acres of corn or soybeans, the 2004-2008 USDA National Agricultural Statistics Service

(2009) crop data for Sussex County and Delaware were used to determine the five year annual average annual yield (133 bushels/acre for corn and 29 bushel/acre for soybeans) for Sussex County and the five year average annual price ($3.45/bushel for corn and $7.63/bushel for soybeans) for Delaware (county level price data were not available).

The 2006 crop enterprise budgets from the University of Delaware Cooperative Extension (2009) and the USDA Economic Research Service 2009 corn cost-of-production forecast (USDA*a*, 2009) were used to estimate the average cost per acre to grow corn or soybeans. According to the 2006 enterprise budgets, the anticipated costs (excluding rent or land payments) are $297.71/acre for corn and $163.51/acre of soybeans. Fertilizer and nitrogen costs associated with growing an acre of corn have increased substantially in recent years, estimates from the USDA 2009 cost-of-production for corn were $32.43/acre higher ($102.33/acre compared to $69.90/acre) than the 2006 University of Delaware corn enterprise budget. To account for cost increases since 2006, fertilizer/nitrogen cost in the 2006 corn enterprise budget was adjusted by $32.43/acre for a total anticipated corn production cost of $330.14/acre.

As shown in Table 9, profit per acre was determined by multiplying the yield (bushels/acre) times the price ($/bushel) and subtracting the per acre cost. The anticipated profit from farming 600 acres would be $77.2 thousand for corn or $34.7 thousand for soybeans.

Table 9. Anticipated Profit and Commodity Payments Associated with 600 Acres of Corn or Soybeans in Sussex County.

	Corn	Soybeans
Yield (bushel/acre – 5 yr annual average)	133	29
Price ($/bushel– 5 yr annual average)	$3.45	$7.63
Cost ($/per acre)	$330.14	$163.51
Profit per acre (yield*price-cost)	$128.71	$57.76
Anticipated profit from 600 acres	**$77,226**	**$34,656**
Farm Bill Commodity Program		
Payment rate ($/bushel)	0.28	0.44
Base acres (83.3% of 600 acres)	500	500
Anticipated payment for 600 acres (payment rate *yield*base acres)	**$18,613**	**$6,377**

The Food, Conservation, and Energy Act of 2008 continued the previous Farm Bill legislation (Farm Security and Rural Investment Act of 2002) for providing income support to producers through direct payments (USDA*b*, 2009). An eligible farm's "payment amount" for a given commodity is determined by: 1) the payment rate for the specified commodity ($0.28/bushel for corn, $0.44/bushel for soybeans); 2) the payment acres – 83.3% of base acres for 2009-2011; and 3) the commodity payment yield (USDA*b*, 2009). As shown in Table 9, based on the Sussex County five year average yield of 133 bushels/acre for corn and 29 bushels/acre for soybeans, the anticipated annual payment for 600 acres would be approximately $18.6 thousand for corn or $6.4 thousand for soybeans.

Summary of Economic Impacts for Alternative A

Table 10 summarizes the direct and total economic impacts of Refuge management activities for Alternative A in Sussex County. Under Alternative A, Refuge management activities directly related to Refuge operations generate an estimated $2.7 million in local output, 25 jobs and $742 thousand in labor income in the local economy. Including direct, indirect, and induced effects, all Refuge activities would generate total economic impacts of $3.9 million in local output, 33 jobs and $1.1 million in labor income. In 2007, total labor income was estimated at $2.996 billion and total employment was estimated at 87,113 jobs for Sussex County (IMPLAN 2007 data). Total economic impacts associated with Refuge operations under Alternative A represent less than one percent of total income (0.04%) and total employment (0.04%) in the overall Sussex County economy. Total economic effects of Refuge operations play a much larger role in the Prime Hook communities near the Refuge such as Milton and Lewes where most of the Refuge public use related economic activity occurs.

Table 10. Economic Impacts of Refuge Management Activities for Alternative A.

	Local output ($ Thousands)	Labor income ($ Thousands)	Employment (# full & part time jobs)
Refuge revenue sharing			
Direct effects	$46.8	$11.9	0
Total effects	$61.4	$16.7	0
Refuge administration (staff salary spending and work related purchases)			
Direct effects	$277.4	$56.0	2
Total effects	$350.6	$78.8	2
Public use activities			
Direct effects	$2,437.4	$674.2	23
Total effects	$3,453.3	$977.9	31
Aggregate impacts			
Direct effects	$2,761.60	$742.05	25
Total effects	$3,865.30	$1,073.39	33

Economic Impacts of Alternative B

Impacts from Refuge Revenue Sharing

Same as Alternative A.

Impacts from Public Use and Access Management

Refuge Visitor Expenditures in Local Economy

Changes in Refuge management activities can affect recreational opportunities offered and visitation levels. Table 11 shows the estimated visitation levels associated with each visitor activity for Alternative B. Under Alternative B, annual visitation is anticipated to increase for fishing (5%), big game hunting (10%), waterfowl hunting (10%), upland game hunting (5%), and nonconsumptive use activities (15%) compared to Alternative A (Table 2). The percentage of nonlocal waterfowl hunters is anticipated to increase by 10% (from 25% to 35%) compared to Alternative A.

Table 11. Estimated Annual Refuge Visitation by Visitor Activity for Alternative B.

Visitor activity	Total number of visits	Percentage of non-local visits (%)	Total number of non-local visits	Number of hours spent at Refuge	Number of non-local visitor days[a]
Consumptive-use					
Fishing	9,775	40%	3,910	8	3,910
Big game hunting	873	83%	724	8	724
Waterfowl and migratory bird hunting	1,664	35%	582	8	582
Upland game hunting	174	10%	17	8	17
Nonconsumptive-use					
Nature trails/ other wildlife observation/office visits	133,092	46%	61,222	4	30,611
Total	145,578		66,456		35,845

[a]One visitor day = 8 hours.

Table 12 summarizes the total economic impacts associated with current non-local visitation for Alternative B. Non-local Refuge visitors would spend over $2.9 million in Sussex County annually. This spending would directly account for $2.8 million in local output, 27 jobs, and $775.5 thousand in labor income in the local economy. The secondary or multiplier effects would generate an additional $1.2 million in local output, 10 jobs, and $349 thousand in labor income. Accounting for both the direct and secondary effects, spending by non-local visitors for Alternative B would generate total economic impacts of $3.97 million in local output, 37 jobs and $1.1million in labor income. Due to the increased visitation levels for Alternative B, the associated economic effects of visitor spending would generate $518.8 thousand more in local output, 6 more jobs, and $146.9 thousand more in labor income than Alternative A.

Table 12. Annual Impacts of Non-Local Visitor Spending for Alternative B.

	Local output ($ Thousands)	Labor income ($ Thousands)	Employment (# full & part time jobs)
Direct effects	$2,803.3	$775.5	27
Secondary effects	$1,168.5	$349.3	10
Total economic impact	$3,971.8	$1,124.8	37

Costs of Administering Hunting Programs

Table 13 provides a breakdown of the funding and staff time required for managing each hunting program under Alternative B. All hunting programs under Alternative B would cost $13 thousand dollars and 40 days of staff time annually. The deer and waterfowl hunting programs account for 82% of all costs and 81% of all staff time. While the deer and waterfowl hunting programs both cost approximately $5.4 thousand, have similar total costs, the deer hunting program requires 18 days of staff time compared to 14.5 days for the waterfowl hunting program. The hunt programs for Alternative B are $17.9 thousand less than and require 54.75 fewer staffing days compared to Alternative A.

Table 13. Annual Costs Associated with Hunting Programs for Alternative B.

	Big Game-Deer		Big Game-Turkey		Upland Game		Waterfowl		Other Migratory Birds		All Hunting	
Item	Staff Days	Cost	Staff Days	Cost	Staff Days	Cost	Staff Days	Cost	Staff Days	Cost	Staff Days	Cost
Planning	3	$1,000	0.5	$150	0.5	$150	3	$1,000	0.5	$150	7.5	$2,450
Processing applications	1	$400	0.5	$150			1	$400			2.5	$950
Printing costs-handouts	0.5	$800	0.5	$150	0.25	$220	1	$1,250	-	$0	2.25	$2,420
Law Enforcement	7.5	$1,350	0.5	$125	0.75	$200	3.5	$650	0.75	$200	13	$2,525
Inquiries	5	$1,190	1	$250	1	$250	5	$1,200	1	$250	13	$3,140
Facilities maintenance & supplies	1	$600	-	$0			1	$800			2	$1,400
Hunt operations	-	$0	-	$0	-	$0	-	$0			0	$0
Fuel, electricity	-	$60			-	$60		$60			0	$180
Toilet rental	-	$0						$0			0	$0
Total	**18**	**$5,400**	**3**	**$825**	**2.5**	**$880**	**14.5**	**$5,360**	**2.25**	**$600**	**40.25**	**$13,065**

Table 14 shows the breakdown of total program expenses between staff and actual expenses and the Refuge cost recovery for each hunting program. Under Alternative B, the Refuge must pay $2,870 to contractors for application fee collection. The Refuge receives 80% of the remainder of total fees collected. For all programs, $3.8 thousand is recovered by the Refuge under Alternative B. Accounting for total Refuge expenditures and total Refuge cost recovery, the total program cost of all hunting programs under Alternative A is $9.2 thousand.

Table 14. Annual Costs Associated with Hunting Programs for Alternative B.

	Big Game-Deer	Big Game-Turkey	Upland Game	Waterfowl	Other Migratory Birds	All Hunting
Refuge Expenditures						
Staff salary expenses	$4,235	$675	$600	$3,385	$600	$9,495
Non-salary expenses	$1,165	$150	$280	$1,975		$3,570
Total Expenditures	$5,400	$825	$880	$5,360	$600	$13,065
Cost Recovery from Hunting Fees						
Total amount collected	$1,790	$300	$0	$5,570	$0	$7,660
Amount returned to Refuge (80% of total after contractor fees)						$3,832
Total Program Cost (total expenditures - total returned from fees)	**$5,400**	**$0**	**$880**	**$5,360**	**$600**	**$9,233**
Value of Volunteer Contributions ($20.25/hour)	32 hrs $648			16 hrs $324		48hrs $972

Additionally, as shown in Table 14, volunteers contribute 32 hrs of time assisting the deer hunting program with mowing of non-ambulatory hunt areas and hunt operations. Volunteers contribute 16 hours the waterfowl hunting program with blind stake placement and maintenance. Accounting for volunteer hours at a rate of $20.25 per/hour, the value of volunteer time totals $972 for Alternative B. The volunteer contributions for Alternative B are 466 hours and $9.4 thousand less than Alternative A.

Impacts from Refuge Administration

Staff – Personal Purchases

Proposed staff for Alternative B includes all approved staff positions (Alternative A, Table 6) plus five additional positions. The new positions are for: Maintenance Worker; Law Enforcement Officer; Wildlife Biologist; Visitor Services Professional; and a Clerk. Table 15 shows the economic impacts associated with spending of salaries in Sussex County by Refuge employees under Alternative B. For Alternative B, salary spending by Refuge personnel would directly account for $461.6 thousand in local output, 3 jobs, and $99.1 thousand in labor income in the local economy. Accounting for both the direct and secondary effects, salary spending by Refuge personnel for Alternative B would generate total economic impacts of over $591.9 thousand in local output, 4 jobs and $139.5 thousand in labor income. Due to the increased staffing levels for Alternative B, the associated economic effects of staff salary

spending would generate $278.3 thousand more in local output, 2 more jobs, and $65.5 thousand more in labor income than Alternative A.

Table 15. Local Economic Impacts of Salary Spending by Refuge Personnel for Alternative B.

	Local output ($ Thousands)	Labor income ($ Thousands)	Employment (# full & part time jobs)
Direct effects	$461.6	$99.1	3
Secondary effects	$130.3	$40.4	1
Total economic impact	$591.9	$139.5	4

Work-related Purchases

Non-salary expenditures for Alternative B are anticipated to increase in proportion with the salary increase for the new staff positions for a total annual non-salary budget $462 thousand (89% increase compared to Alternative A). Table 16 shows the economic impacts associated with work related expenditures in Sussex County for Alternative B. These estimates assume 14% of the non-salary budget ($61.8 thousand) will be spent on goods and services purchased in Sussex County (same percentage as current and Alternative A). Work related expenditures under Alternative B would directly account for $68.1 thousand in local output and $6.4 thousand in labor income in the local economy. Accounting for both the direct and secondary effects, work related purchases for Alternative B would generate a total economic impact of $67.7 thousand in local output and $8.9 thousand in labor income. Due to the increased non-salary expenditures for Alternative B, the associated economic effects of work related purchases would generate $32.7 thousand more in local output and $4.1 thousand more in labor income than Alternative A.

Table 16. Local Economic Impacts of Refuge Related Purchases for Alternative B.

	Local output ($ Thousands)	Labor income ($ Thousands)	Employment (# full & part time jobs)
Direct effects	$61.8	$6.4	0
Secondary effects	$7.9	$2.5	0
Total economic impact	$69.7	$8.9	0

Other Management Activities – Cooperative Farming

The cooperative farming program would be eliminated under Alternative B. The value of the farm program was discussed but not included in the economic analysis of Alternative A because a federal court order would need to be resolved before the cooperative farming program could resume. Therefore, there are no changes in economic impacts associated with the cooperative farming program between Alternatives A and B.

Summary of Economic Impacts for Alternative B

Table 17 summarizes the direct and total economic impacts of Refuge management activities for Alternative B in Sussex County. Under Alternative B, Refuge management activities directly related to Refuge operations generate an estimated $3.3 million in local output, 30 jobs and $892.9 thousand in labor income in the local economy. Including direct, indirect, and induced effects, Refuge activities would generate total economic impacts of $4.7 million in local output, 41 jobs and $1.29 million in labor income. In 2007, total labor income was estimated at $2.996 billion and total employment was estimated

at 87,113 jobs for Sussex County (IMPLAN 2007 data). Total economic impacts associated with Refuge operations under Alternative B represent less than one percent of total income (0.04%) and total employment (0.05%) in the overall Sussex County economy. Total economic effects of Refuge operations play a larger role in the Prime Hook communities near the Refuge such as Milton and Lewes where most of the Refuge public use related economic activity occurs.

Table 17. Summary of Refuge Management Activities for Alternative B.

	Local output ($ Thousands)	Labor income ($ Thousands)	Employment (# full & part time jobs)
Refuge Revenue Sharing			
Direct effects	$46.8	$11.9	0
Total effects	$61.4	$16.7	0
Refuge administration (staff salary spending and work related purchases)			
Direct effects	$523.4	$105.5	3
Total effects	$661.6	$148.4	4
Public use activities			
Direct effects	$2,803.3	$775.5	27
Total effects	$3,971.8	$1,124.8	37
Aggregate impacts			
Direct effects	$3,373.5	$892.9	30
Total effects	$4,694.8	$1,289.9	41

Table 18 summarizes the change in economic effects associated with Refuge operations under Alternative B as compared to Alternative A. Due to increases in Refuge administration and visitation, Alternative B would generate $829.5 thousand more in local output, 7 additional jobs and $216.5 thousand more in labor income as compared to Alternative A.

Table 18. Change in Economic Impacts under Alternative B Compared to Alternative A.

	Local output ($ Thousands)	Labor income ($ Thousands)	Employment (# full & part time jobs)
Refuge Revenue Sharing			
Direct effects	$0	$0	0
Total effects	$0	$0	0
Refuge Administration (staff salary spending and work related purchases)			
Direct effects	$246.0	$49.5	1
Total effects	$311.0	$69.6	2
Public use activities			
Direct effects	$365.9	$101.3	3
Total effects	$518.5	$146.9	5
Aggregate impacts			
Direct effects	$611.9	$150.8	5
Total effects	$829.5	$216.5	7

Economic Impacts of Alternative C

Impacts from Refuge Revenue Sharing

Same as Alternative A.

Impacts from Public Use and Access Management

Refuge Visitor Expenditures in Local Economy

Table 19 shows the estimated visitation levels associated with each visitor activity for Alternative C. Under Alternative C, annual visitation is anticipated to slightly increase for big game hunting (5%), waterfowl hunting (5%) and upland game hunting (2.5%) compared to Alternative A (Table 2). No change is anticipated for nonconsumptive activities while fishing is anticipated to decrease by 10% compared to Alternative A. Additionally, the percentage of nonlocal waterfowl hunters is anticipated to increase by 10% (from 25% to 35%) compared to Alternative A.

Table 19. Estimated annual Refuge visitation by visitor activity for Alternative C.

Visitor activity	Total number of visits	Percentage of non-local visits (%)	Total number of non-local visits	Number of hours spent at Refuge	Number of non-local visitor days[a]
Consumptive use					
Fishing	7,997	40%	3,199	8	3,199
Big game hunting	873	83%	724	8	724
Waterfowl and migratory bird hunting	1,664	35%	582	8	582
Upland game hunting	170	10%	17	8	17
Non-consumptive use					
Nature trails/ other wildlife observation/office visits	115,732	46%	53,237	4	26,618
Total	126,436		57,759		31,141

[a]One visitor day = 8 hours.

Table 20 summarizes the total economic impacts associated with current non-local visitation for Alternative C. Non-local Refuge visitors would spend over $2.5 million in Sussex County annually. This spending would directly account for $2.4 million in local output, 23 jobs, and $675 thousand in labor income in the local economy. The secondary or multiplier effects would generate an additional $1 million in local output, 8 jobs, and $304 thousand in labor income. Accounting for both the direct and secondary effects, spending by non-local visitors for Alternative C would generate total economic impacts of $3.5 million in local output, 31 jobs and $979 thousand in labor income. Due to the slight increases in visitation levels for Alternative C, the associated economic effects of visitor spending would generate $3.4 thousand more in local output and $1.1 thousand more in labor income than Alternative A.

Table 20. Annual Impacts of Non-Local Visitor Spending for Alternative C.

	Local output ($ Thousands)	Labor income ($ Thousands)	Employment (# full & part time jobs)
Direct effects	$2,439.7	$675.0	23
Secondary effects	$1,017.0	$304.1	8
Total economic impact	$3,456.7	$979.0	31

Costs of Administering Hunting Programs

Table 21 provides a breakdown of the funding and staff time required for managing each hunting program under Alternative C. All hunting programs under Alternative C would cost $11.8 thousand dollars and 35.25 days of staff time annually. The deer and waterfowl hunting programs account for 87% of all costs and staff time. While the deer and waterfowl hunting programs both cost approximately $5.4 thousand, have similar total costs, the deer hunting program requires 17 days of staff time compared to 13.5 days for the waterfowl hunting program. The hunt programs for Alternative C are $19.2 thousand less than and require 59.75 fewer staffing days compared to Alternative A.

Table 21. Annual Costs Associated with Hunting Programs for Alternative C.

	Big Game-Deer		Big Game - Turkey		Upland Game		Waterfowl		Other Migratory Birds		All Hunting	
Item	Staff Days	Cost	Staff Days	Cost	Staff Days	Cost	Staff Days	Cost	Staff Days	Cost	Staff Days	Cost
Planning	3	$1,000	-	-	0.5	$150	3	$1,000	0.5	$150	7	$2,300
Processing applications	1	$400	-	-	-	-	1	$400	-	-	2	$800
Printing costs-handouts	0.5	$800	-	-	0.25	$220	1	$1,250	-	-	1.75	$2,270
Law Enforcement	7.5	$1,350	-	-	0.75	$200	3.5	$650	0.75	$200	12.5	$2,400
Inquiries	4	$950	-	-	1	$250	4	$950	1	$250	10	$2,400
Facilities maintenance & supplies	1	$600	-	-	-	-	1	$800	-	-	2	$1,400
Hunt operations	-	$0	-	-	-	$0	-	$0	-	-	0	$0
Fuel, electricity	-	$60	-	-	-	$60	-	$60	-	-	0	$180
Toilet rental	-	$0	-	-	-	-	-	$0	-	-	0	$0
Total	**17**	**$5,160**	**0**	**$0**	**2.5**	**$880**	**13.5**	**$5,110**	**2.25**	**$600**	**35.25**	**$11,750**

Table 22 shows the breakdown of total program expenses between staff and actual expenses and the Refuge cost recovery for each hunting program. Under Alternative C, the Refuge must pay $2,620

to contractors for application fee collection. The Refuge receives 80% of the remainder of total fees collected. For all programs, $3.8 thousand is recovered by the Refuge under Alternative C. Accounting for total Refuge expenditures and total Refuge cost recovery, the total program cost of all hunting programs under Alternative A is $8 thousand.

Table 22. Annual Costs Associated with Hunting Programs for Alternative C.

	Big Game - Deer	Big Game - Turkey	Upland Game	Waterfowl	Other Migratory Birds	All Hunting
Refuge Expenditures						
Staff salary expenses	$3,995	$0	$600	$3,135	$600	$8,330
Non-salary expenses	$1,165	$0	$280	$1,975		$3,420
Total Expenditures	$5,160	$0	$880	$5,110	$600	$11,750
Cost Recovery from Hunting Fees						
Total amount collected	$1,790	$0	$0	$5,570	$0	$7,360
Amount returned to Refuge (80% of total after contractor fees)						$3,792
Total Program Cost (total expenditures - total returned from fees)	**$5,160**	**$0**	**$880**	**$5,110**	**$600**	**$7,958**
Value of Volunteer Contributions ($20.25/hour)	24 hrs $486			16 hrs $324		40hrs $810

Additionally, as shown in Table 22, volunteers contribute 24 hrs of time assisting the deer hunting program with mowing of non-ambulatory hunt areas and hunt operations. Volunteers contribute 16 hours the waterfowl hunting program with blind stake placement and maintenance. Accounting for volunteer hours at a rate of $20.25 per/hour, the value of volunteer time totals $972 for Alternative B. The volunteer contributions for Alternative B are 474 hours and $9.6 thousand less than Alternative A.

Impacts from Refuge Administration

Staff – Personal Purchases

Proposed staff for Alternative C includes all current staff positions (Alternative A, Table 6) plus two additional positions for a Maintenance Worker and Law Enforcement Officer. Table 23 shows the economic impacts associated with spending of salaries in Sussex County by Refuge employees under Alternative C. For Alternative C, salary spending by Refuge personnel would directly account for $356.6 thousand in local output, 2 jobs, and $76.6 thousand in labor income in the local economy. Accounting for both the direct and secondary effects, salary spending by Refuge personnel for Alternative C would generate total economic impacts of $457.2 thousand in local output, 3 jobs and $107.9 thousand in labor income. Due to the increased staffing levels for Alternative C, the associated economic effects of staff salary spending would generate $143.6 thousand more in local output, 1 more job, and $33.9 thousand more in labor income than Alternative A.

Table 23. Local Economic Impacts of Salary Spending by Refuge Personnel for Alternative C.

	Local output ($ Thousands)	Labor income ($ Thousands)	Employment (# full & part time jobs)
Direct effects	$356.6	$76.6	2
Secondary effects	$100.6	$31.3	1
Total economic impact	$457.2	$107.9	3

Work-related Purchases

Non-salary expenditures for Alternative C are anticipated to increase in proportion with the salary increase for the new staff positions for a total annual non-salary budget of $357 thousand (46% increase compared to Alternative A). Table 24 shows the economic impacts associated with work related expenditures in Sussex County for Alternative C. These estimates assume 14% of the non-salary budget ($47.7 thousand) will be spent on goods and services purchased in Sussex County (same percentage as Alternative A). Work related expenditures under Alternative B would directly account for $47.7 thousand in local output and $5 thousand in labor income in the local economy. Accounting for both the direct and secondary effects, work related purchases for Alternative C would generate a total economic impact of $53.8 thousand in local output and $6.9 thousand in labor income. Due to the increased non-salary expenditures for Alternative C, the associated economic effects of work related purchases would generate $16.8 thousand more in local output and $2.1 thousand more in labor income than Alternative A.

Table 24. Local Economic Impacts of Refuge Related Purchases for Alternative C.

	Local output ($ Thousands)	Labor income ($ Thousands)	Employment (# full & part time jobs)
Direct effects	$47.7	$5.0	0
Secondary effects	$6.1	$2.0	0
Total economic impact	$53.8	$6.9	0

Other Management Activities – Cooperative Farming

Same as Alternative B.

Summary of Economic Impacts for Alternative C

Table 25 summarizes the direct and total economic impacts of all Refuge management activities for Alternative C in Sussex County. Under Alternative C, Refuge management activities directly related to all Refuge operations generate an estimated $2.9 million in local output, 26 jobs and $768.4 thousand in labor income in the local economy. Including direct, indirect, and induced effects, all Refuge activities would generate total economic impacts of $4.03 million in local output, 34 jobs and $1.1 million in labor income. Total economic impacts associated with Refuge operations under Alternative C represent less than one percent of total income (0.04%) and total employment (0.04%) in the overall Sussex County economy. Total economic effects of Refuge operations play a larger role in the Prime Hook communities near the Refuge such as Milton and Lewes where most of the Refuge public use related economic activity occurs.

Table 25. Summary of Refuge Management Activities for Alternative C.

	Local output ($ Thousands)	Labor income ($ Thousands)	Employment (# full & part time jobs)
Refuge Revenue Sharing			
Direct effects	$46.8	$11.9	0
Total effects	$61.4	$16.7	0
Refuge administration (staff salary spending and work related purchases)			
Direct effects	$404.3	$81.6	2
Total effects	$511.0	$114.8	3
Public use activities			
Direct effects	$2,439.7	$675.0	23
Total effects	$3,456.7	$979.0	31
Aggregate impacts			
Direct effects	$2,890.8	$768.4	26
Total effects	$4,029.1	$1,110.5	34

Table 26 summarizes the change in economic effects associated with Refuge operations under Alternative C as compared to Alternative A. Due to increases in Refuge administration and visitation, Alternative C would generate $163.8 thousand more in local output, 1 additional job and $37.1 thousand more in labor income as compared to Alternative A.

Table 26. Change in Economic Impacts under Alternative C Compared to Alternative A.

	Local output ($ Thousands)	Labor income ($ Thousands)	Employment (# full & part time jobs)
Refuge Revenue Sharing			
Direct effects	$0	$0	0
Total effects	$0	$0	0
Refuge Administration (staff salary spending and work related purchases)			
Direct effects	$126.9	$25.6	1
Total effects	$160.4	$36.0	1
Public use activities			
Direct effects	$2.3	$0.8	0
Total effects	$3.4	$1.1	0
Aggregate impacts			
Direct effects	$129.2	$26.4	1
Total effects	$163.8	$37.1	1

Summary and Conclusions

Under Alternative A, Refuge management activities directly related to Refuge operations generate an estimated $2.7 million in local output, 25 jobs and $742 thousand in labor income in the local economy. Including direct, indirect, and induced effects, all Refuge activities would generate total economic impacts of $3.9 million in local output, 33 jobs and $1.1 million in labor income. Total economic impacts associated with Refuge operations across all Alternatives represents less than one percent of total income and total employment in the overall Sussex County and the economy. Total economic effects of Refuge operations play a larger role in the Prime Hook communities near the Refuge such as Milton and Lewes where most of the Refuge public use related economic activity occurs.

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Appendix J

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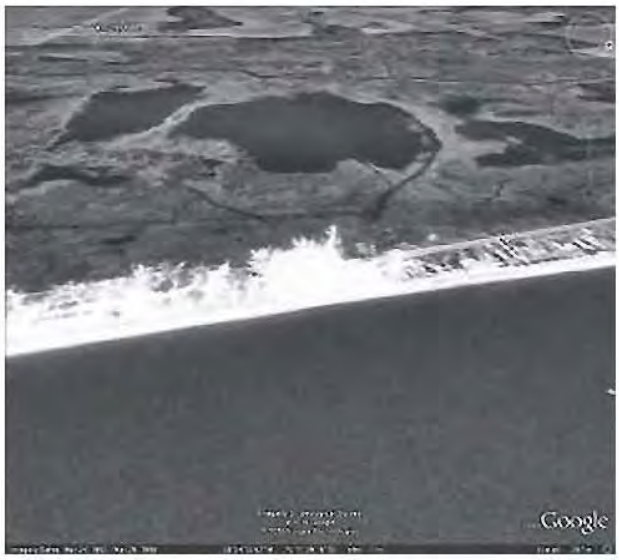
Flock of snow geese on the refuge

Aerial Photography

Examples of overwash, inlet, and beach formation processes along the Delaware Coast
(Aerial imagery obtained from Google Earth)

1) South end of Slaughter Beach, dated 1992, 1998, and 2007. Note house built upon the high ground furnished by a natural overwash.

1992

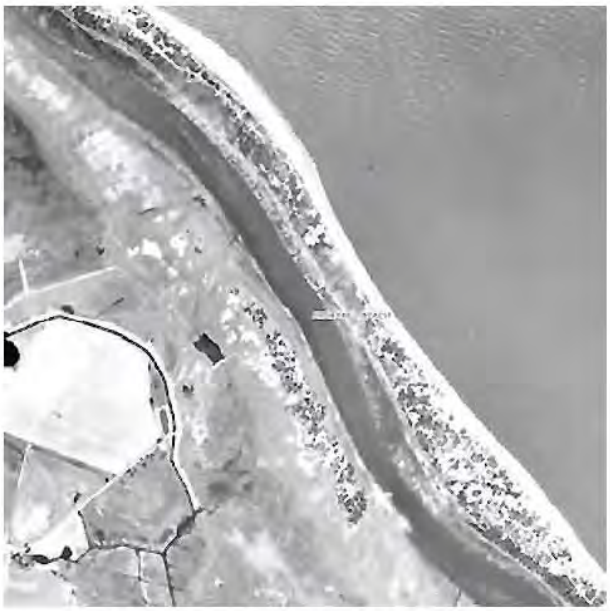


1998

2007

2) Broadkill Beach, dated 1937, 1961, 1968, and 2007 showing pattern of natural overwash and subsequent island community development

1937

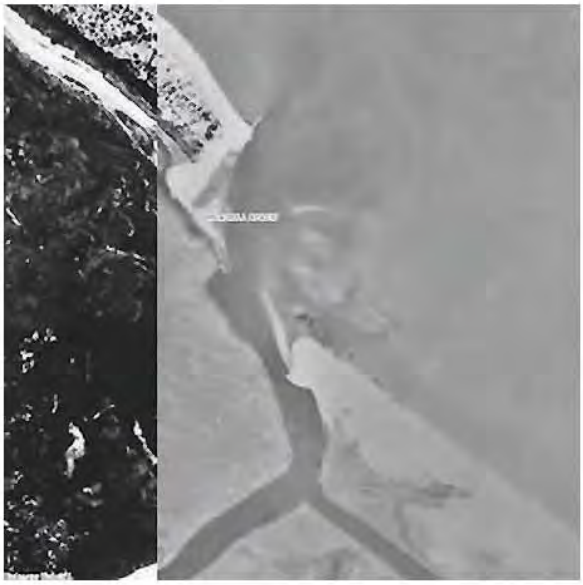


1961

1968

2007

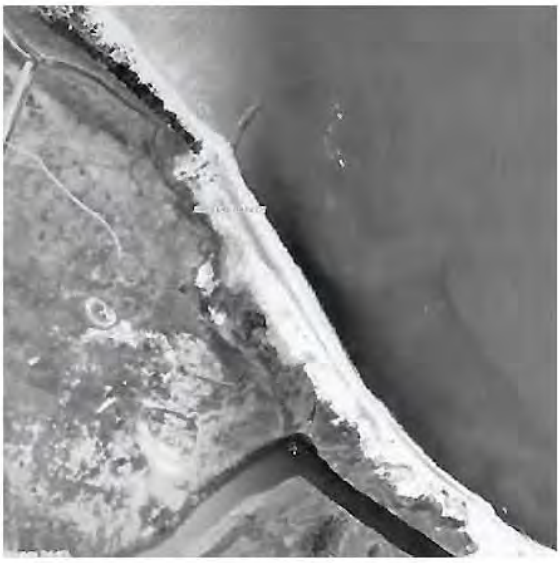
3) Former inlet at south end of Broadkill Beach, dated 1937, 1954, 1968, and 2007 showing pattern of natural inlet filling, overwash, revegetation and subsequent island community development



1937

1954

1968



2007

4) This series of four aerial photographs dated 1992, 1998, 2007 and 2009, show the Delaware Bay coast, north of Mispillion Inlet. They show the roll-over and loss of a marsh island and filling of a man-made ditch (seen at center).

1992

1998

2007

2009

5) Shoreline north of Mispillion Inlet, Delaware, March 30, 2007. This photo illustrates the natural shoreline migration to the west. Note the mosquito ditches, now evident in the intertidal zone, in Delaware Bay.

6) Near the south end of Slaughter Beach, showing the eroded marsh base along the bayshore, overlain by overwashed beach sand.

7) Three photos dated 2005, 2007, and 2009, north of Kitts Hummock, showing natural progression of overwash and inlet formation.

2005

2007

2009

8) Marsh south of Bowers Beach, dated 1992, 1998, 2003, 2005, 2007, and 2009, showing inlet formation, refilling, overwash and revegetation. Note eroded marsh peat (last photo) fronting the beach, exposed as beach rolls to the west.

1992

1998

2003

2005

2007

2009

9) Fowler Beach Road showing portions of Units I and II, dated 1992, 1998, 2005, 2006, 2007, and 2009.

1992

1998

2005

2006

2007

2009

10) Close-up of the overwash in Unit I, north of Fowler Beach Rd., taken in 2009. Note the thin veneer of sand on the beach fronted by an eroded marsh face.

2009 (close-up)

Appendix K

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Forster's terns

Elevation Data

Elevation Data for Refuge Water Control Structures and Refuge Wetlands

Coastal Progam with the Delaware Department of Natural Resources and Environmental Control (DNREC) conducted elevation and positioning surveys within refuge impoundments and at water control structures. Their methods and findings are summarized below.

Methods:

Marsh elevation surveys were conducted in April and May, 2010. All field elevation and positioning surveying was conducted using a Trimble 5700 RTK- receiver system (with a Trimble HPB450 External Radio Base and a Trimble TSC2 Controller). The Trimble 5700 has the potential of horizontal and vertical accuracies of ± 5 to 20 mm, while in static measurements surveys controlled by an existing bench marks (Trimble 2007). During static surveys a base station is set-up on a primary control point, which could be a vertical point of reference (VPR) or benchmark, while a "rover" is then set-up on the point of interest. The base station collects satellite data relative to its known fixed position and transmits that information through a Trimble HPB450 External Radio Base to the rover. The rover utilizes this positioning and distance information, in addition to its own satellite positioning, to determine the position of the point of interest. Millimeter accuracy can be easily attained through second- to minute-long surveys, depending upon the distance from the base station. The greater the distances involved between stations, the more observation time is needed.

All surveyed points are referenced to North American Datum of 1983 (NAD 83), which uses the Geodetic Reference System of 1980 (GRS 80) ellipsoid as the reference surface for three-dimensional positions. These are the official federally recognized survey datums. Vertical positioning is referenced to North American Vertical Datum of 1988 (NAVD 88), which represents the point's orthometric or topographic height. This is often referred to as a point's "elevation," while the true corrected height (relative to sea-level) will be determined by integrating the orthometric height (NAVD88), ellipsoidal height (GRS80), and a gravitational "hybrid geoid model" (Geoid09). The hybrid geoid model corrects for the large differences in the Earth's gravitational field for each surveyed point elevation, using Trimble Geomatic Office (TGO) and Trimble Survey Controller software (NGS 2001, Roman et al. 2004).

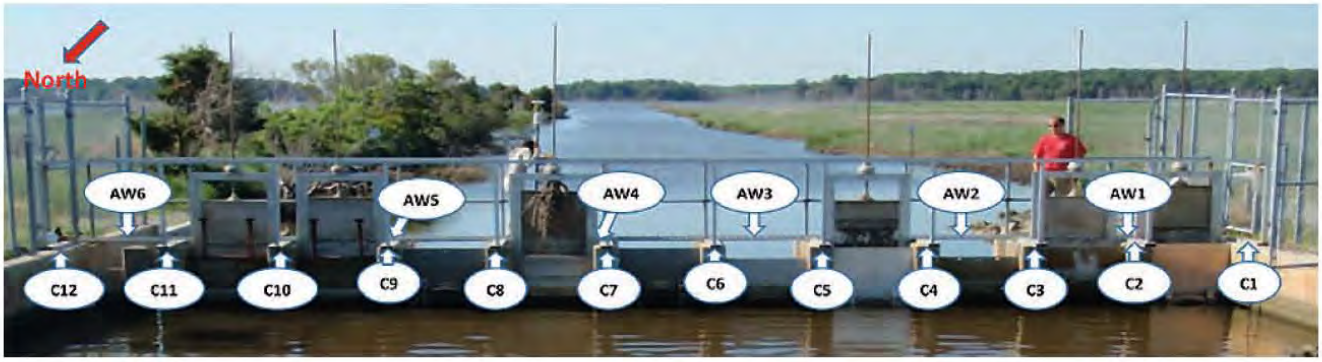
The water control structure and wetland elevation surveys were conducted using VPR "Prim 1" as the primary control point. This VPR was established by the Delaware Department of Natural Resources and Environmental Control (DNREC) Shoreline and Waterway Section. This VPR was established by a loop closure survey that uses existing NGS benchmarks to create a vertically accurate control point, in areas where vertically accurate benchmarks do not exist. A loop-closure survey creates a benchmark that is then used to survey back to the original NGS benchmark, so horizontal and vertical data can be corrected based upon this comparison.

All water control structure construction elevations were extracted from the 1981 and 1985 engineering drawings, which reported the elevations of the concrete structures, metal walkways, and screw-gate frames. Elevations were reported in the vertical datum of feet Mean Sea-Level (MSL). MSL is the arithmetic mean of hourly heights observed over the National Tidal Datum Epoch, which for these measurements was 1960 to 1978. The vertical datum transformation program "VDatum," developed by the National Oceanic and Atmospheric Administration (NOAA), was used to transform the 1985 feet MSL vertical datum into meters NAVD 88 (using Geiod09). VDatum uses the MSL epoch of 1978 to 2001 for its vertical transformations, but the MSL data for the water control structures was constructed using the epoch of 1960 to 1978. This difference in MSL epochs could result in an increase in the construction elevations of ~ 6 cm (Local sea Level rate of 3.20 mm/yr at Lewes, DE, for 19 years) in NAVD88. (CCP Figure 2.1, available at: *http://tidesandcurrents.noaa.gov/sltrends/sltrends_station.shtml?stnid=8557380*).

Findings:

Findings are summarized below for each water control structure, for the Unit I salt marsh, and for the Unit II and Unit III wetland impoundments. For each water control structure, note the tidal elevations for the area of the WCS, calculated using NOAA VDatum software (see WEBSITE), as a reference concerning the tidal reach of water levels in relation to the water control structures.

Slaughter Canal Water Control Structure (on Fowler Beach Rd.)



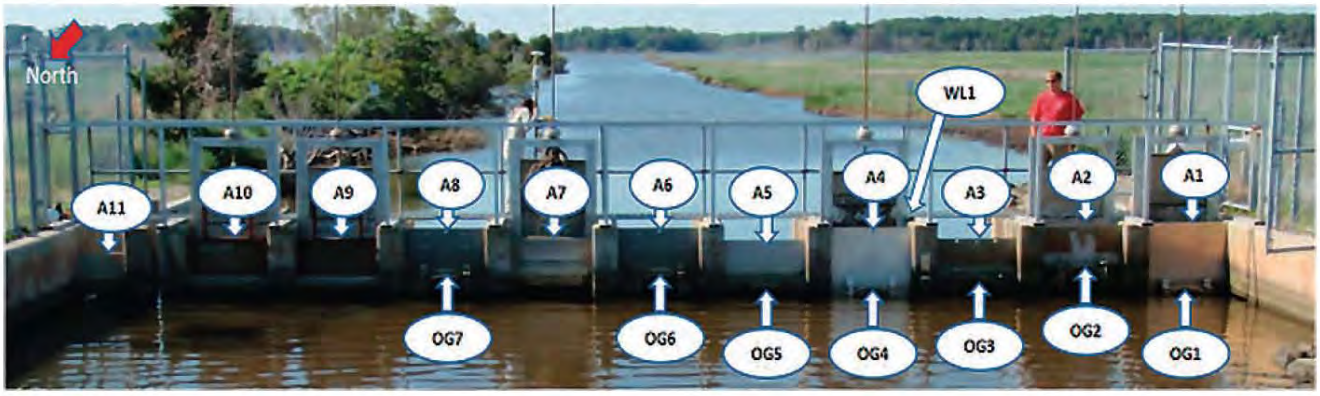
Tops of Concrete Structures

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12
Current Elevation (m NAVD 88; 06/07/10)	1.134 m HP 0.008 m VP 0.013 m	1.165 m HP 0.007 m VP 0.012 m	1.164 m HP 0.006 m VP 0.011 m	1.158 m HP 0.006 m VP 0.009 m	1.159 m HP 0.006 m VP 0.010 m	1.152 m HP 0.006 m VP 0.010 m	1.150 m HP 0.006 m VP 0.010 m	1.153 m HP 0.008 m VP 0.013 m	1.172 m HP 0.012 m VP 0.019 m	1.176 m HP 0.013 m VP 0.022 m	1.170 m HP 0.008 m VP 0.013 m	1.128 m HP 0.006 m VP 0.009 m
Constructed Elevation (m NAVD 88; 1985)	1.276m	1.276m	1.276m	1.276m	1.276m	1.276m	1.276m	1.276m	1.276m	1.276m	1.276m	1.276m

Tops of Aluminum Walkways

	AW1	AW2	AW3	AW4	AW5	AW6
Current Elevation (m NAVD 88; 06/07/10)	1.156 m HP 0.008 m VP 0.013 m	1.166 m HP 0.010 m VP 0.015 m	1.184 m HP 0.008 m VP 0.012 m	1.191 m HP 0.007 m VP 0.011 m	1.176 m HP 0.007 m VP 0.011 m	1.172 m HP 0.009 m VP 0.015 m
Constructed Elevation (m NAVD 88; 1985)	1.276m	1.276m	1.276m	1.276m	1.276m	1.276m

Slaughter Canal Water Control Structure (on Fowler Beach Rd) – cont'd



Tops of Aluminum Gates

	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11
Current Elevation (m NAVD 88; 06/07/10)	1.114 m HP 0.006m VP 0.010 m	1.104 m HP 0.007 m VP 0.011 m	0.950 m HP 0.012 m VP 0.019 m	1.093 m HP 0.006 m VP 0.009 m	0.950 m HP 0.007 m VP 0.012 m	1.120 m HP 0.008 m VP 0.012 m	0.958 m HP 0.010 m VP 0.020 m	1.121m HP 0.009 m VP 0.013 m	0.920 m HP 0.007 m VP 0.010 m	0.904 m HP 0.007 m VP 0.010 m	1.121m HP 0.009 m VP 0.013 m

Top of O-Gate Openings

	OG1	OG2	OG3	OG4	OG5	OG6	OG7
Current Elevation (m NAVD 88; 06/07/10)	0.296 m HP 0.018 m VP 0.030 m	0.575 m HP 0.007 m VP 0.012 m	0.430 m HP 0.022 m VP 0.031 m	0.305 m HP 0.024 m VP 0.034 m	0.329 m HP 0.030 m VP 0.047 m	0.493 m HP 0.030 m VP 0.042 m	0.477 m HP 0.018 m VP 0.025 m

2.8 MSL Mark on Water Gauge

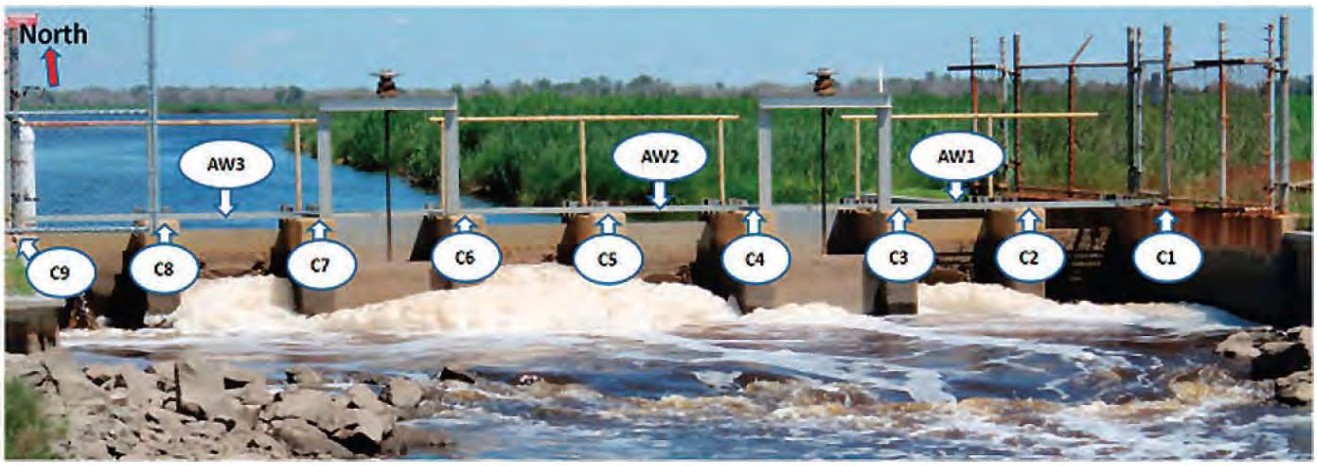
	WL1
Current Elevation (m NAVD 88; 06/07/10)	0.603 m HP 0.007 m VP 0.011 m
Constructed Elevation (m NAVD 88; 1985)	0.757 m

Tidal Elevations at Fowler Beach Rd.

(calculated with NOAA VDatum Software)

	MLLW	MLW	MTL	MHW	MHHW
Elevation (m NAVD 88)	-0.8466	-0.7951	-0.1008	0.5935	0.7248

Petersfield Water Control Structure (on Broadkill Beach Rd.)



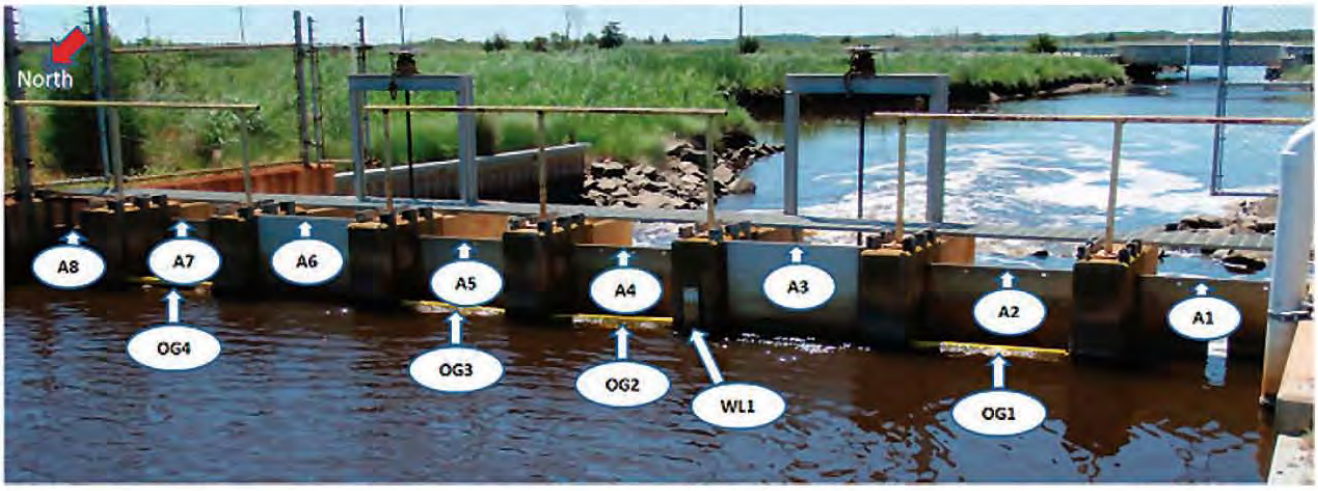
Tops of Concrete Structures

	C1	C2	C3	C4	C5	C6	C7	C8	C9
Current Elevation (m NAVD 88; 06/07/10)	1.009 m HP 0.009 m VP 0.013 m	1.012 m HP 0.008 m VP 0.012 m	1.006 m HP 0.007 m VP 0.010 m	1.024 m HP 0.008 m VP 0.011 m	1.018 m HP 0.007 m VP 0.010 m	1.017 m HP 0.007 m VP 0.010 m	1.009 m HP 0.008 m VP 0.011 m	1.016 m HP 0.008 m VP 0.011 m	1.012 m HP 0.010 m VP 0.014 m
Constructed Elevation (m NAVD 88; 1985)	1.265 m	1.265 m	1.265 m	1.265 m	1.265 m	1.265 m	1.265 m	1.265 m	1.265 m

Tops of Aluminum Walkways

	AW1	AW2	AW3
Current Elevation (m NAVD 88; 06/07/10)	1.042 m HP 0.010 m VP 0.014 m	1.063 m HP 0.009 m VP 0.012 m	1.063 m HP 0.007 m VP 0.011 m
Constructed Elevation (m NAVD 88; 1985)	1.265 m	1.265 m	1.265 m

Petersfield Water Control Structure (on Broadkill Beach) – cont'd



Tops of Aluminum Gates

	A1	A2	A3	A4	A5	A6	A7	A8
Current Elevation (m NAVD 88; 06/07/10)	0.879 m HP 0.007m VP 0.010 m	0.888 m HP 0.012 m VP 0.017 m	1.006 m HP 0.007 m VP 0.010 m	0.869 m HP 0.009 m VP 0.013 m	0.870 m HP 0.008 m VP 0.011 m	1.030 m HP 0.008 m VP 0.011 m	0.861 m HP 0.007 m VP 0.010 m	0.731m HP 0.006 m VP 0.009 m

Top of O-Gate Openings

	OG1	OG2	OG3	OG4
Current Elevation (m NAVD 88; 06/07/10)	0.386 m HP 0.008 m VP 0.013 m	0.405 m HP 0.008 m VP 0.012 m	0.249 m HP 0.007 m VP 0.010 m	0.231m HP 0.007 m VP 0.012 m

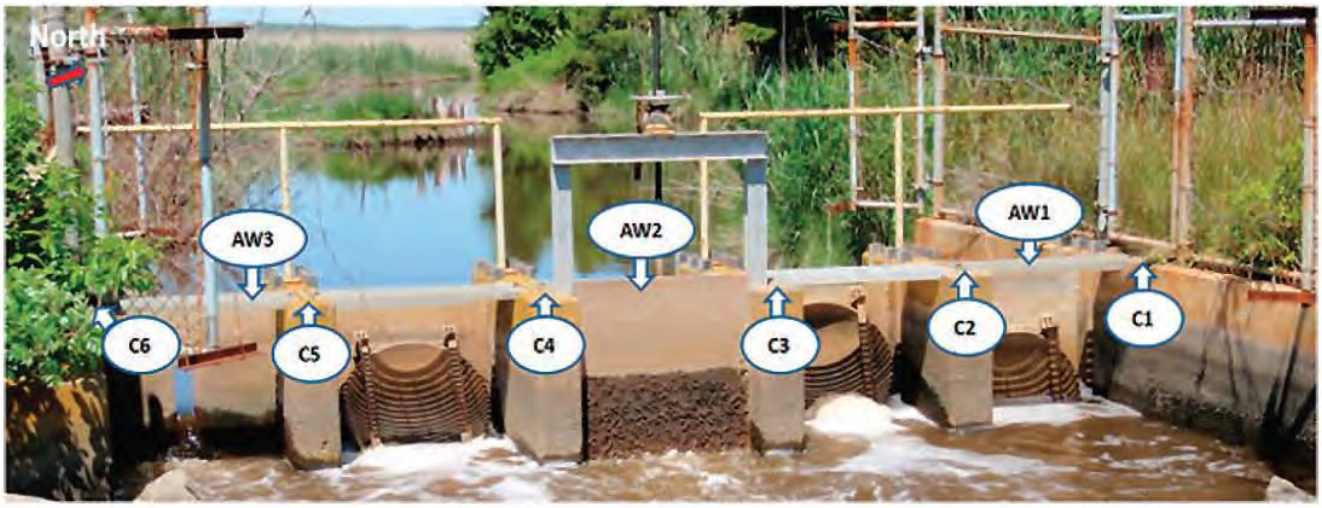
2.8 MSL Mark on Water Gauge

	WL1
Current Elevation (m NAVD 88; 06/07/10)	0.452 m HP 0.008 m VP 0.013 m
Constructed Elevation (m NAVD 88; 1985)	0.747 m

Tidal Elevations at Petersfield Ditch
(calculated with NOAA VDatum Software)

	MLLW	MLW	MTL	MHW	MHHW
Elevation (m NAVD 88)	- 0.8190	- 0.7676	- 0.1113	0.5450	0.6750

Primehook Creek Water Control Structure (just north of Broadkill Beach Rd)



Tops of Concrete Structures

	C1	C2	C3	C4	C5	C6
Current Elevation (m NAVD 88; 06/07/10)	0.999 m HP 0.007 m VP 0.010 m	0.998 m HP 0.006 m VP 0.010 m	0.981 m HP 0.008 m VP 0.012 m	0.989 m HP 0.009 m VP 0.014 m	0.993 m HP 0.006 m VP 0.010 m	0.983 m HP 0.007 m VP 0.011 m
Constructed Elevation (m NAVD 88; 1985)	1.267 m	1.267 m	1.267 m	1.267 m	1.267 m	1.267 m

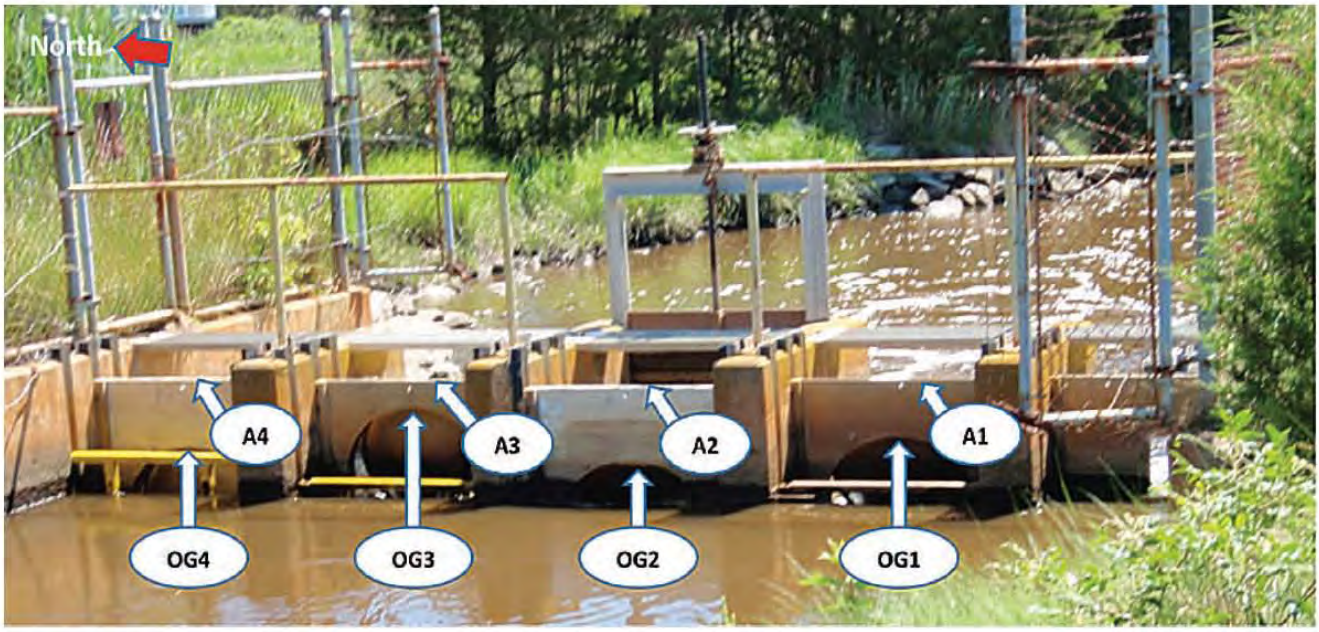
Tops of Aluminum Walkways

	AW1	AW2	AW3
Current Elevation (m NAVD 88; 06/07/10)	0.992 m HP 0.007 m VP 0.011 m	0.967 m HP 0.009 m VP 0.014 m	0.978 m HP 0.009 m VP 0.014 m
Constructed Elevation (m NAVD 88; 1985)	1.267 m	1.267 m	1.267 m

Tidal Elevations at Petersfield Ditch (nearby)
(calculated with NOAA VDatum Software)

	MLLW	MLW	MTL	MHW	MHHW
Elevation (m NAVD 88)	-0.8190	-0.7676	-0.1113	0.5450	0.6750

Primehook Creek Water Control Structure (just north of Broadkill Beach Rd) – cont'd



Tops of Aluminum Gates

	A1	A2	A3	A4
Current Elevation (m NAVD 88; 06/07/10)	0.802 m HP 0.007 m VP 0.013 m	0.810 m HP 0.009 m VP 0.014 m	0.812 m HP 0.009 m VP 0.013 m	0.828 m HP 0.009 m VP 0.013 m

Top of O-Gate Openings

	OG1	OG2	OG3	OG4
Current Elevation (m NAVD 88; 06/07/10)	0.504 m HP 0.010 m VP 0.016 m	0.415 m HP 0.015 m VP 0.025 m	0.668 m HP 0.007 m VP 0.011 m	0.436 m HP 0.007 m VP 0.011 m

2.8 MSL Mark on Water Gauge

	WL1
Current Elevation (m NAVD 88; 06/07/10)	0.662 m HP 0.007 m VP 0.012 m
Constructed Elevation (m NAVD 88; 1985)	0.749 m

Unit 1 Elevations

Primehook National Wildlife Refuge

Legend

Unit 1 Marsh Elevation (m NAVD 88)	Unit 1 Dune Elevation (m NAVD 88)
0.025 - 0.236	0.635 - 0.872
0.237 - 0.345	0.873 - 1.177
0.346 - 0.415	1.178 - 1.432
0.416 - 0.517	1.433 - 1.949
0.518 - 0.703	1.950 - 2.425
0.704 - 1.000	

Marsh Elevation:	Dune Elevation:
Mean: 0.416 m	Mean: 1.380 m
Min: 0.025 m	Min: 0.635 m
Max: 1.000 m	Max: 2.425 m

N
W E
S

380 190 0 380 Meters

DELAWARE COASTAL PROGRAMS
DCMP

Unit 2 Elevations

Primehook National Wildlife Refuge

Legend

Unit 2 Wetland Elevation (m NAVD 88)	Unit 2 Bottom Elevation (m NAVD 88)
0.250 - 0.349	-0.901 - -0.065
0.350 - 0.392	-0.064 - 0.089
0.393 - 0.441	0.090 - 0.176
0.442 - 0.503	0.177 - 0.277
0.504 - 0.556	0.278 - 0.418

Wetland Elevation:	Bottom Elevation:
Mean: 0.407 m	Mean: 0.140 m
Min: 0.250 m	Min: -0.901 m
Max: 0.556 m	Max: 0.418 m

N
W E
S

410 205 0 410 Meters

DELAWARE COASTAL PROGRAMS
DCMP

Unit 3 Elevations

Primehook National Wildlife Refuge

Legend

Unit 3 Wetlands Elevation (m NAVD 88)	Unit 3 Bottom Elevation (m NAVD 88)
-0.074 - 0.250	-0.901 - -0.065
0.251 - 0.349	-0.064 - 0.089
0.350 - 0.392	0.090 - 0.176
0.393 - 0.441	0.177 - 0.277
0.442 - 0.503	0.278 - 0.418
0.504 - 0.555	

Wetland Elevation:	Bottom Elevation:
Mean: 0.332 m	Mean: 0.102 m
Min: 0.155 m	Min: -0.307 m
Max: 0.555 m	Max: 0.257 m

N W E S

640 320 0 640 Meters

DELAWARE COASTAL PROGRAMS DCMP

References:

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Prime Hook National Wildlife Refuge
11978 Turkle Pond Road
Milton, DE 19968
Phone: 302/684 8419
http://www.fws.gov/northeast/primehook/

Federal Relay Service
for the deaf and hard-of-hearing
1 800/877 8339

U.S. Fish & Wildlife Service
http://www.fws.gov

For Refuge Information
1 800/344 WILD

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