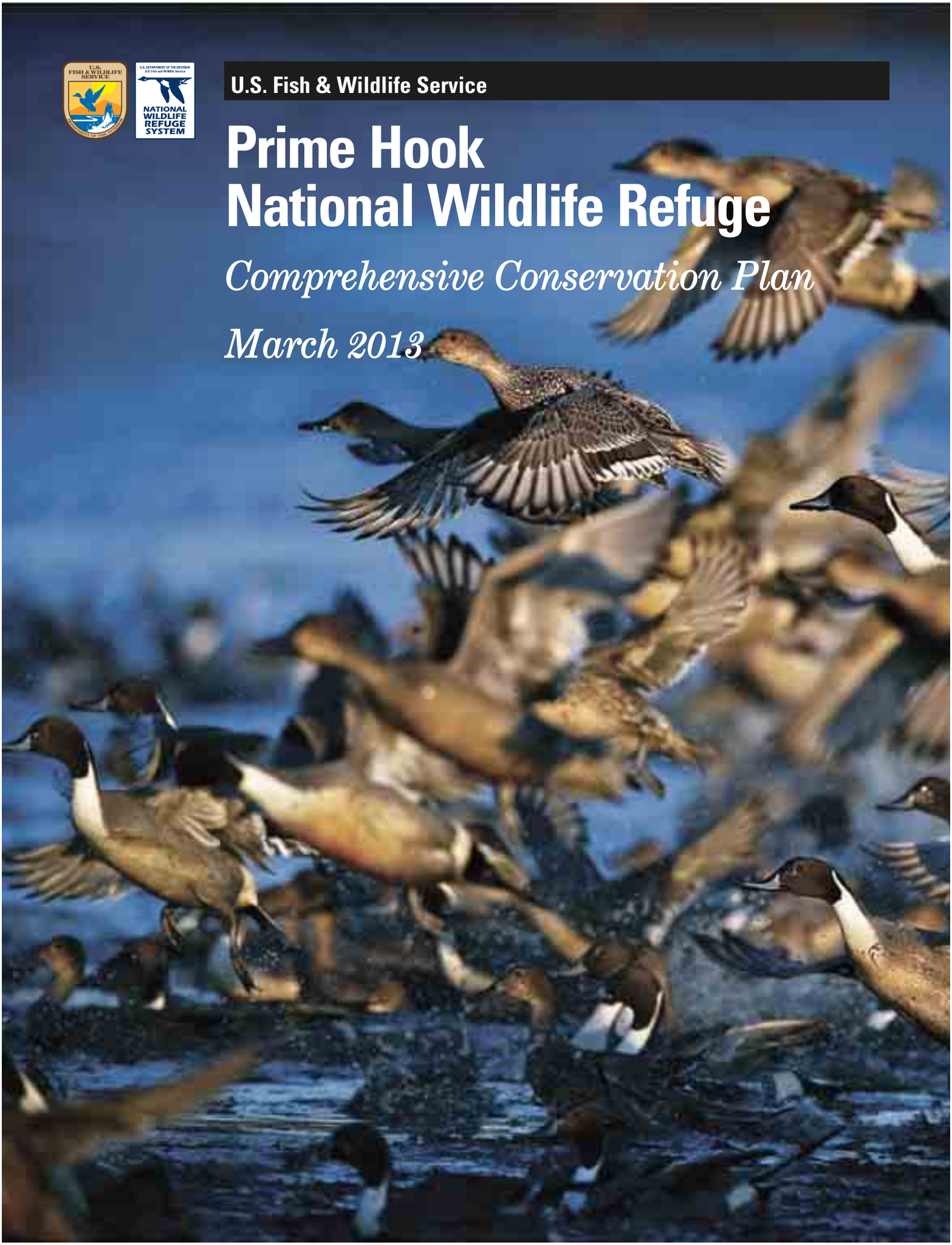
U.S. Fish & Wildlife Service

Prime Hook National Wildlife Refuge

Comprehensive Conservation Plan

March 2013



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 over 560 national wildlife refuges and thousands of waterfowl production areas. The Service also operates 70 national fish hatcheries and 86 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.

U.S. Fish & Wildlife Service

Prime Hook National Wildlife Refuge

Comprehensive Conservation Plan

March 2013

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U.S. Fish & Wildlife Service

Prime Hook National Wildlife Refuge

Comprehensive Conservation Plan

March 2013

Prime Hook National Wildlife Refuge Vision Statement

The vision statement below qualitatively describes our desired future character of Prime Hook National Wildlife Refuge. We will refine it throughout the planning process with input from our partners and the public, and it will guide program emphases and priorities at the refuge.

> *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.*

U.S. Fish & Wildlife Service

Prime Hook National Wildlife Refuge

Comprehensive Conservation Plan

March 2013

Summary

Type of Action: Administrative – Development of a Comprehensive Conservation Plan

Lead Agency: U.S. Department of the Interior, Fish and Wildlife Service

Location: Prime Hook National Wildlife Refuge
Milton, Delaware

Administrative Headquarters: Coastal Delaware NWR Complex
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This final comprehensive conservation plan (CCP) for the 10,144-acre Prime Hook National Wildlife Refuge (NWR, refuge) is the culmination of a planning effort involving Delaware State agencies, local partners, refuge neighbors, private landowners, and the local community. This CCP establishes 15-year management goals and objectives for wildlife and habitats, public use, and administration and facilities.

This plan sets forward the management direction that we think best achieves the refuge's purposes, vision, and goals, and responds to public issues. Under this plan, we will focus on focal species with proactive habitat management and expanded public use.

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Chapter 1

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Seaside sparrow

The Purpose of, and Need for, Action

- Introduction
- Need for the Action
- Purpose for the Action
- Project Area
- The U.S. Fish and Wildlife Service, its Policies, and Legal Mandates
- Refuge Establishment, History, and Purpose
- Refuge Vision Statement
- Refuge Goals
- Issues, Concerns, and Opportunities

Introduction

This final comprehensive conservation plan (CCP) for Prime Hook National Wildlife Refuge (hereafter referred to as Prime Hook NWR, or the refuge) presents the combination of management goals, objectives, and strategies that will guide the management decisions and actions of Prime Hook NWR over the next 15 years. CCPs are required by the National Wildlife Refuge System Administration Act of 1996, as amended by the National Wildlife Refuge System Improvement Act of 1997 (16 U.S.C. 668dd, et seq.; Refuge Improvement Act). An environmental impact statement (EIS), required by the National Environmental Policy Act of 1969 (NEPA) was prepared concurrent with the draft CCP.

The decision to adopt this plan is included as appendix M, Record of Decision. The Record of Decision will present and explain the decision, and certify that we have met agency compliance requirements and that the CCP, when implemented, will achieve the purposes of the refuge and help fulfill the Refuge System mission. Once the Regional Director has signed the Record of Decision and we have completed the CCP for the refuge, we will notify the public in the *Federal Register*, and implementation can begin.

This document is organized in five chapters to outline the history, driving mandates, purposes, and conservation priorities guiding the management direction, as well as the existing environment of the refuge.

Chapter 1, The Purpose of, and Need for, Action, explains why and how we must prepare a CCP for Prime Hook NWR. It states the purpose and need for Federal action, i.e., the U.S. Fish and Wildlife Service (Service, we, our) needs we want to meet by preparing a CCP and the goals we wish to accomplish. It explains the legislated purposes of the refuge and the regulations, policies, and laws covering units of the National Wildlife Refuge System (NWRS or Refuge System); states our vision and long-range management goals for managing and protecting the land, waters, and Federal trust resources of Prime Hook NWR in the future; and identifies issues of public concern.

Chapter 2, The Planning Policies and Process, explains the planning steps in developing the CCP; describes the influences of other national, regional, ecosystem, and State plans; and identifies refuge operational or step-down plans.

Chapter 3, Existing Environment, describes the physical, biological, and human environment of the refuge, and explains some of the ecological processes that influence the existing environment in a manner that impacts management outcomes.

Chapter 4, Management Direction and Implementation, presents the actions, goals, objectives, and strategies that will guide our decision-making and land management for the refuge. It also outlines the staffing and funding needed to accomplish that management.

Chapter 5, Consultation and Coordination with Others, describes the public and partner involvement used throughout the planning process, and identifies the individuals involved in preparing this document.

Thirteen appendixes, a glossary with acronyms, and a bibliography provide additional documentation and references to support our analysis summarized within the report.

Need for the Action

When Prime Hook NWR was established in 1963 *"for use as an inviolate sanctuary, or for any other management purpose, for migratory birds,"* the marshes, uplands, and waters now encompassed by the refuge had already been manipulated for more than 50 years through ditching and impoundments, draining agricultural lands, reducing mosquito habitat, and increasing freshwater waterfowl habitat. While many Service management actions over

the ensuing years improved the condition of the natural ecosystems, the Service also intentionally increased some of these manipulations and allowed others to continue. Climate change and natural processes, apart from human actions, have altered, and will continue to alter, this coastal environment apart from human actions. Over the nearly 50 years of Service management, the national directives from Congress and the Service for managing uses and planning for units of the Refuge System have become more comprehensive and attuned to the essential features of natural systems. Current Refuge System policies direct refuge managers to assess the historic (pre-human condition) or natural conditions of refuge ecosystems to inform management decisions. These policies direct the Service to avoid additional degradation of environmental conditions and natural processes and to restore degraded environmental components.

Development of a CCP addresses three needs:

First, there is currently no master plan to formally establish and ensure strategic management for the refuge. A vision statement, goals, objectives, and management strategies are all necessary to successful refuge management. Public and partner involvement throughout the planning process will also help to resolve various management issues.

Second, the Refuge Improvement Act of 1997 requires that all national wildlife refuges have a CCP by 2012.

Third, management practices should be consistent with current policies; the new CCP will bring the refuge into conformity with all current laws and policies.

Purpose for the Action

This CCP has been developed in the context of a changing world. Our natural environment, human uses, and management direction have all changed over the past 50 years. This CCP is designed to address management and protection of valuable natural resources into the future; a future where continued change is even more likely to occur. Thus, the purpose of this CCP is to provide strategic management direction to ensure that our management of the refuge will best respond to four key areas of concern. Strategic here means approaches that are ecologically sound and sustainable in light of physical and biological change, practical, viable, or economically realistic, and responsive to the following:

(1) Abides by and contributes to the mission, mandates, and policies of the Service and the Refuge System.

(2) Meets the refuge's goals.

(3) Addresses key issues.

(4) Responds to public concerns.

While explained in more depth beginning on page 1-7, briefly this CCP will address:

(1) 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.*" Important Refuge System laws and policies concerning habitat management and wildlife conservation include a key Service policy addressing biological integrity, diversity, and environmental health, known as "BIDEH." Other Service policies regarding human uses require that all uses of a refuge be evaluated for their appropriateness, and direct that inappropriate, incompatible, or harmful uses be prevented or eliminated. Compatible uses can be allowed and, in particular, six wildlife-dependent public uses should

be facilitated whenever possible. Not every aspect of refuge management implemented at earlier times complies with current directives. Other policies and laws direct how long-term refuge planning is conducted. This CCP is designed to bring all aspects of refuge management into conformity with current laws and policies.

(2) The refuge's goals (pages 1-13 and 1-14) describe the desired future condition of the refuge and provide a framework for developing alternative objectives to achieve that desired future condition. Along with a vision statement, six fundamental goals were developed for Prime Hook NWR to frame how its purpose *"as an inviolate sanctuary, or for any other management purpose, for migratory birds"* can be best achieved in the future. Four of the goals direct management attention to protection and restoration of the ecological integrity, diversity, and sustainability of four key habitat types (barrier island beach and coastal salt marsh habitats, forests, wetland impoundments, and early successional uplands.) Other refuge goals address public uses of the refuge and collaborative initiatives with partners and the local community.

(3) Through the NEPA scoping process and the refuge's understanding of its particular challenges, and incorporating the best available scientific and technical information, several key issues have been identified which this CCP will address. They are:

- Climate change/sea level rise/barrier island overwash/marsh management and restoration
- Mosquito control
- Cooperative farming
- Hunt management

(4) Public interest in the future management of Prime Hook NWR is widespread. The concerns and situations of the interested members of the public are diverse. We have heard from neighboring farmers and residents of barrier island communities; hunters and harvesters of waterfowl, fish, and shellfish, and upland species; visitors who come to observe birds and other wildlife or who seek solitude and respite in the natural world; boaters, dog walkers, beach-goers and other non-priority recreation users; and State agencies and other programs and organizations concerned about the role and contributions the refuge can play in a larger network of natural areas across the State, the Mid-Atlantic, and the migratory bird flyway of the Atlantic coast.

NEPA requires that a thorough analysis be made of a range of alternatives, including the proposed action and no action. Both the draft and final CCP/EIS evaluated three alternatives that represented different ways to achieve the four areas of concern outlined above. We analyzed the socioeconomic, biological, physical, and cultural consequences of implementing each alternative, and selected among these alternatives based on their greater or lesser ability to meet the purposes and needs described above. For the final CCP, we chose alternative B which focuses on focal species with proactive habitat management and expanded public use. We have made several changes to alternative B based on comments we received on the draft CCP/EIS. This modified alternative B is presented in chapter 4 as the management direction that the refuge will implement over the next 15 years.

Developing a CCP with partner and public involvement is vital to the success of management at every national wildlife refuge. A CCP provides management direction for the next 15 years by:

- Stating clearly the desired future conditions of refuge habitat, wildlife, visitor services, staffing, and facilities.
- Providing state agencies, refuge neighbors, visitors and partners with a clear understanding of the reasons for refuge management actions.
- Ensuring that refuge management reflects the policies, legal mandates and the mission of the Refuge System and refuge purpose.
- Ensuring the compatibility of current and future public use.
- Providing long-term continuity in refuge management.
- Providing justification for our staffing, operations and maintenance, and projected budget requests.

The CCP will be reviewed, evaluated, and subsequently updated approximately every 15 years. However, if and when significant new information becomes available, ecological conditions change, major refuge expansion occurs, or when we identify the need to do so, the plan can be reviewed sooner. All plan revisions will require NEPA compliance.

Project Area

Prime Hook NWR is located in the outer Atlantic Coastal Plain, along the southwestern shore of the Delaware Bay in Milton, Sussex County, Delaware. Located within 2 hours driving time from metropolitan Baltimore, Maryland; Washington, D.C; Wilmington, Delaware; and Philadelphia, Pennsylvania, the refuge lies 22 miles southeast of the State capital of Dover (population 35,808). Historically, agricultural lands dominated the area around the refuge. However, residential development starting in the 1990s and continuing to the present is rapidly changing the watershed. Sussex County lost 14,000 acres of farm land to development from 2002 to 2007 (DDA 2007 Census of Agriculture).

The 10,144-acre refuge stretches along the southeastern coastline of Delaware just north of Cape Henlopen. The eastern boundary of the refuge runs next to three beachfront communities: Slaughter Beach, Prime Hook Beach, and Broadkill Beach. Eighty percent of the refuge's vegetation cover types are characterized by tidal and freshwater creek drainages that discharge into the Delaware Bay and associated coastal marshes. The remaining 20 percent is composed of upland habitats. The land uses near the refuge are intensive agricultural and developed residential.

The natural environment of Prime Hook NWR features several different wildlife habitats, as delineated in the Delaware comprehensive wildlife management plan (DeWAP 2005). They are based on the National Vegetation Classification System and the known existence of species of greatest conservation need. Key refuge habitats include unvegetated sandy beach, dune grasslands, interdunal wetlands, *Spartina* high salt marshes, intertidal mudflats, *Spartina* low salt marsh, bishop-weed mixed species, brackish marsh, freshwater impoundments, red maple/Atlantic white cedar/seaside alder swamps, mixed herb deep peat wetlands, forested uplands, early successional uplands, and ancient sand ridge forests. Those cover types provide habitat for 308 species of birds, 51 species of fish, 45 species of reptiles and amphibians, 37 species of mammals, and an array of rare insect and plant species.

The refuge is divided into four management units that include their wetlands and associated uplands (map 1-1). Unit I 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 Beach Road on the south, and an upland fringe

Map 1-1. Overview Map of Prime Hook National Wildlife Refuge

of scrub-shrub areas on the western boundary. There is currently no water level management capability in Unit I, which contains about 1,400 acres of salt marsh. Tidal saltwater is the primary source of water for the unit, which flows approximately 2 miles from the Delaware Bay through the Mispillion Inlet and into Cedar Creek, 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. Over the past 100 years, the dune line has been overwashed several times 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.

Unit II is just south of Unit I and has been managed as an impounded, nontidal freshwater system that is manipulated by water control structures. It is bounded on the north by Fowler Beach Road, barrier dunes and the Prime Hook beach community on the east, Prime Hook Road on the south, and an upland interface on the west.

During storm tides this sand dune system has been breached several times and washouts have deposited sand and saltwater into the Unit II impoundment. Freshwater input is from Slaughter 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 through the breached along the shoreline and freshwater flow enters Unit II on the west from Slaughter Creek and from Unit III to the south.

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 1930s 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 Beach Road, Oak Island, and near the bridge at Slaughter Creek to hold water.

Management Unit III is bounded by Prime Hook 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.

Unit III consists of roughly 3,600 acres, which include impounded freshwater emergent marsh, red maple-seaside alder swamp, low-lying farmed areas, brush, barrier beach on the east, and 140 acres of flowage easement (tract numbers 84R, 99F and 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. Twenty-five hundred acres of marsh were impounded in the 1980s to create the freshwater marsh it is today.

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). 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 two outlets drastically changed the daily tidal influence and hydrology of Unit III. Prime Hook Creek now flows through the Petersfield Ditch to empty into the Broadkill River, which drains into the Delaware Bay about 2 miles south of the present-day refuge.

Management Unit IV is surrounded by Route 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. 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.

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 saltwater into the Unit IV impoundment also occurs during peak tides from a ditch connected to the Broadkill Sound. Rainfall and runoff from Unit III are other sources that provide freshwater. However, normal runoff and tidal action are not sufficient to recharge the impoundment above its perimeter elevation.

The U.S. Fish and Wildlife Service, its Policies, and Legal Mandates

This section highlights the Service and Refuge System policies, laws, regulations, and mandates that directly influenced the development of the Prime Hook NWR CCP document.

The Service and its Mission

The Service administers the Refuge System. The Service is an agency under the Department of the Interior and its purpose is to conserve the nature of America. The Service's commitment to safeguard the Nation's fish, wildlife and their habitats is reflected in its vision statement and mission: *"We will continue to be a leader and trusted partner in fish and wildlife conservation, known for our scientific excellence, stewardship of lands and natural resources, dedicated professionals, and commitment to public service."*

Its mission is *"Working with others, to conserve, protect, and enhance fish, wildlife, and plants and their habitats for the continuing benefit of the American people."*

The Service is the primary Federal agency responsible for conserving, protecting, and enhancing America's fish and wildlife populations and their habitats. These include migratory birds, federally listed endangered or threatened species, interjurisdictional fish, wetlands, certain marine mammals, and national wildlife refuges. The Service oversees the enforcement of Federal wildlife laws and international treaties on importing and exporting wildlife, management and protection of migratory bird populations, restoration of national fisheries, administration of the Endangered Species Act, and restoration of native plant habitats. The Service also assists states with their fish and wildlife programs and helps other countries develop conservation programs.

The Service Manual, *http://www.fws.gov/policy/manuals/*, contains the standing and continuing directives to implement its authorities, responsibilities, and activities. Special Service directives that affect the rights of citizens or the authorities of other agencies are published separately in the Code of Federal

Regulations (CFR); the Service Manual does not duplicate them (see 50 CFR 1-99 at *http://www.gpoaccess.gov/cfr/index.html*; accessed November 2012).

The National Wildlife Refuge System, its Mission, and Policies

The Refuge System is the world's largest collection of lands set aside specifically for the conservation of fish, wildlife and plants. The Refuge System began in 1903, when President Theodore Roosevelt designated Pelican Island, a pelican and heron rookery in Florida, as a bird sanctuary. Today, this unique wildlife conservation system consists of over 560 national wildlife refuges. These refuges encompass more than 150 million acres of lands and waters in all 50 states and several island territories. More than 45 million visitors hunt, fish, observe and photograph wildlife, or participate in environmental education and interpretive activities on refuges across the Nation each year.

The Refuge System is home to more than 700 species of birds, 220 species of mammals, 260 reptile and amphibian species, and more than 200 species of fish. This unique network of conserved lands also provides critical habitat for more than 250 threatened and/or endangered plants and animals. As a result of international treaties for migratory bird conservation, such as the Migratory Bird Conservation Act, many refuges have been established to protect migratory birds. Refuges are also places where people can enjoy wildlife-dependent recreational and educational opportunities about the great outdoors, and the Refuge System provides some of the best places across the country where people can hunt, fish, observe, and enjoy wildlife throughout the year.

In 1997, the Refuge Improvement Act was passed. This law established a unifying mission for the Refuge System, a new process for determining compatible public use activities on the refuges, and the requirement to prepare a CCP for each refuge. The Refuge Improvement Act states first and foremost that the Refuge System must focus on wildlife conservation. This law established several new mandates to make the management of the Refuge System more cohesive and standardized to ensure that wildlife is considered first when managing refuges. The preparation of this CCP fulfills many of these mandates.

The Refuge Improvement Act directs the Secretary of the Interior to ensure that the mission of the Refuge System and purposes of the individual refuges are carried out. It states that the national mission, coupled with the purpose(s) for which each refuge was established, will provide the principal management direction for each refuge. It also requires the Secretary to maintain the biological integrity, diversity, and environmental health of the Refuge System. 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.*
>
> *—Refuge Improvement Act, Public Law 105-57*

The Refuge Improvement Act identifies six wildlife-dependent public uses – hunting, fishing, wildlife observation and photography, environmental education, and interpretation—that will receive priority consideration on refuges and in CCPs. The Refuge Improvement Act also declares that all existing or proposed refuge uses must be "compatible" with the refuge's purpose and consistent with public safety.

These Refuge System goals have been designed to help guide the development of CCPs and improve the administration, management, and growth of the Refuge System in a unified and consistent manner. These goals are:

- Conserve a diversity of fish, wildlife and plants and their habitats, including species that are endangered or threatened with becoming endangered.
- Develop and maintain a network of habitats for migratory birds, anadromous and interjurisdictional fish, and marine mammal populations that are strategically distributed and carefully managed to meet important life history needs of these species across their ranges.
- 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.
- Provide and enhance opportunities to participate in compatible wildlife-dependent recreation (hunting, fishing, wildlife observation, photography, environmental education, and interpretation).
- Foster understanding and instill appreciation of the diversity and interconnectedness of fish, wildlife, plants, and their habitats.

The Refuge System Manual provides a central reference for current policies governing the operation and management of the Refuge System not covered by the Service Manual, including technical information on implementing refuge policies and guidelines. This manual can be reviewed at refuge headquarters. A few noteworthy policies instrumental in developing this CCP follow.

Maintaining Biological Integrity, Diversity and Environmental Health Policy (BIDEH policy)
This policy provides guidance on maintaining or restoring the biological integrity, diversity, and environmental health (BIDEH) of the Refuge System, including the protection of a broad spectrum of fish, wildlife, and habitat resources found in refuge ecosystems. Refuge managers are provided with a process for evaluating the best management direction to prevent the additional degradation of environmental conditions and restoring lost or severely degraded environmental components. They accomplish this by assessing the current status of BIDEH on each refuge through baseline vegetation surveys and studies and by understanding historic conditions, (i.e., those which were/would be present and self-sustaining without human changes to the landscape). Historic conditions serve as a frame of reference to understand the functional processes that naturally shaped the refuge's ecosystem and the scale and frequency of such processes (e.g., fire, flooding, and plant succession) to ascertain the refuge's natural ecosystem. First and foremost, refuges are directed to preserve habitats that maintain a high degree of biological integrity and environmental health. Lost or severely degraded habitats shall be restored via natural processes or by using management measures that mimic natural ecosystem processes or functions. Guidelines are also provided for dealing with external threats to the BIDEH of a refuge and its ecosystem. The BIDEH policy (601 FW 3) can be viewed online at: *http://www.fws.gov/policy/601fw3.html* (accessed November 2012).

Appropriate Refuge Uses Policy
Federal law and Service policy provide the direction and planning framework for protecting the Refuge System from inappropriate, incompatible, or harmful human activities and ensuring that visitors can enjoy its lands and waters. This policy (603 FW 1) provides a national framework for determining appropriate

refuge uses in an effort to prevent or eliminate those uses that should not occur in the Refuge System. It describes the initial decision process the refuge manager follows when first considering whether to allow a proposed use on a refuge. An appropriate use must meet at least one of the following four conditions:

- The use is a wildlife-dependent recreational use as identified in the Refuge Improvement Act.
- The use contributes to fulfilling the refuge purpose(s), the Refuge System mission, or goals or objectives described in a refuge management plan approved after October 9, 1997, the date the Refuge Improvement Act was signed into law.
- The use involves the take of fish and wildlife under state regulations.
- The use has been found to be appropriate after concluding a specified findings process using 10 criteria.

This policy can be viewed online at: *http://www.fws.gov/policy/603fw1.html* (accessed November 2012).

Compatibility Policy

This policy (603 FW 2) defines a compatible use as a use "that will not materially interfere with or detract from the fulfillment of the mission of the Refuge System or the purposes of the refuge." The compatibility policy complements the appropriateness policy. Once a refuge manager finds a use appropriate, they conduct further evaluation through a compatibility determination assessment. The refuge manager must first find that a use is appropriate before undertaking a compatibility review of that use. If the proposed use is not appropriate, the refuge manager will not allow the use and will not prepare a compatibility determination.

The policy provides guidelines for determining compatibility of uses and procedures for documentation and periodic review of existing uses. Below is a summary of this policy:

- The Refuge Improvement Act and its regulations require an affirmative finding by the refuge manager on the compatibility of a public use before allowing it on a national wildlife refuge.
- The act defines six wildlife-dependent uses that are to receive enhanced consideration on refuges: hunting, fishing, wildlife observation and photography, environmental education, and interpretation.
- The refuge manager may authorize those priority uses on a refuge when they are compatible and consistent with public safety.
- When the refuge manager publishes a compatibility determination, it will stipulate the required maximum reevaluation dates: 15 years for wildlife-dependent recreational uses or 10 years for other uses.
- However, the refuge manager may reevaluate the compatibility of any use at any time, for example, sooner than its mandatory date, or even before we complete the CCP process if new information reveals unacceptable impacts or incompatibility with refuge purposes (602 FW 2.11, 2.12).

- The refuge manager may allow or deny any use, even one that is compatible, based on other considerations such as public safety, policy, or available funding.

- This policy (603 FW 2) and its regulations, including a description of the process and requirements for conducting compatibility reviews, can be viewed online at: *http://www.fws.gov/policy/603fw2.html* (accessed November 2012).

Wildlife-dependent Recreation Policy
The Refuge Improvement Act defines and establishes that compatible wildlife-dependent recreational uses (hunting, fishing, wildlife observation and photography, environmental education, and interpretation) are the priority general public uses of the Refuge System and will receive enhanced and priority consideration in refuge planning and management over other general public uses. The Wildlife-dependent Recreation Policy explains how we will provide visitors with opportunities for those priority public uses on units of the Refuge System and how we will facilitate these uses. The policy:

- Promotes safety of participants, other visitors, and facilities.

- Promotes compliance with applicable laws and regulations and responsible behavior.

- Minimizes or eliminates conflict with fish and wildlife population or habitat goals or objectives in an approved plan.

- Minimizes or eliminates conflicts with other compatible wildlife-dependent recreation.

- Minimizes conflicts with neighboring landowners.

- Promotes accessibility and availability to a broad spectrum of the American people.

- Promotes resource stewardship and conservation.

- Promotes public understanding and increases public appreciation of America's natural resources and our role in managing and conserving these resources.

- Provides reliable and reasonable opportunities to experience wildlife.

- Uses facilities that are accessible to people and blend into the natural setting.

- Uses visitor satisfaction to help to define and evaluate programs.

This policy can be viewed online at: *http://www.fws.gov/policy/605fw1.html* (accessed November 2012).

Refuge System Planning Policy
The planning policy provides guidance, systematic direction, and minimum requirements for developing all CCPs, and stipulates a systematic decision-making process that fulfills those requirements. This policy also establishes requirements and guidance for Refuge System planning, including CCPs and step-down management plans. It states that we will manage all refuges in accordance with an approved CCP which, when implemented, will achieve refuge purposes; help fulfill the Refuge System mission; maintain and, where appropriate, restore the ecological integrity of each refuge and the Refuge System; help achieve the goals of the National Wilderness Preservation

System; and meet other mandates (Service Manual [602 FW 1,2,3]). Additional information on the CCP planning process and other relevant mandates and plans is provided in chapter 2.

Refuge Establishment, History, and Purpose

In the early 1960s, the southeastern coastal marshes of Delaware were under the threat of industrial development by oil refinery and manufacturing industries. To help preserve those coastal wetlands, the refuge was established under the authority of the Migratory Bird Conservation Act (16 U.S.C. 715–715r), as amended, on August 21, 1963, *"for use as an inviolate sanctuary, or for any other management purpose, for migratory birds."*

We later expanded the boundaries of the refuge to include 934 acres of land purchased with funding from 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: *"[land] 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 refuge has acquired 10,144 acres encompassing 100 tracts ranging in size from 0.4 acres to 1,600 acres from 75 landowners (table 1-1).

Table 1-1. History of Refuge Land Acquisition

Date of Acquisition	Acreage
1963	101.35
1964	1,468.88
1965	2,283.39
1966	471.06
1967	356
1968	1,756.90
1972	516.22
1974	1,561.60
1975	317.60
1976	92.80
1981	140.10
1983	635
1987	1.10
1998	20.36
2001	343.73
2003	47.02
2007	11.20
2009	8.60
2012	11.69
TOTAL	**10,144**

The acquisition of land for the refuge was highly controversial. In 1963, Delaware Governor Elbert N. Carvel wrote to President Kennedy, requesting that acquisition not be carried out. Secretary Udall's reply to Governor Carvel advocated the continued Federal acquisition of Prime Hook wetlands to protect migratory bird resources for future generations.

Prime Hook NWR historically consisted of tidal marshes and agricultural lands cultivated in corn and small grains. These refuge areas were also grazed by cattle. The landscape surrounding the refuge was dominated by small farms producing vegetables and small grains. Today, resort and residential development increasingly surround the refuge. Agriculture is still one of Delaware's major industries, with more than 480,000 acres in croplands, mostly to support a considerable poultry industry located in Sussex County. The refuge's 10,000 acres are adjacent to three bay front communities: Slaughter Beach, Prime Hook Beach, and Broadkill Beach. Eighty percent of the refuge is dominated by emergent wetlands, mostly impounded freshwater marshes with various inclusions of red maple, Atlantic white cedar, and seaside alder swamps. The remaining area consists of 700 acres of upland mixed pine and hardwood forest, 600 acres of farmed fields, and 700 acres of early successional habitats.

The Service's management over the years was designed to foster freshwater habitats to maximize migratory waterfowl production. In the late 1980s, a water level management structure was constructed in Unit II, which allowed this unit as well as Unit III to be flooded with freshwater. These two impoundments rely upon three cross-marsh State roads (Fowler Beach Road, Prime Hook Road, and Broadkill Road) and sand manipulations on the barrier beach to separate these freshwater areas from the adjacent two salt marsh units (I and IV) and from the Delaware Bay.

Game agencies use farming to attract and provide forage for waterfowl on wildlife management areas. On the Delmarva Peninsula, crop or food plot management has been largely to attract Canada goose, and to a lesser extent, dabbling ducks. Cropland management has also historically been a traditional habitat management tool on national wildlife refuges nationwide. Refuges have used farming to attract and feed waterfowl species to support migrating goose and duck populations, as well as to provide hunting and viewing opportunities for the public. Some refuge visitors have come to expect vast acreages of row crops on refuges. Prime Hook NWR began a cooperative farming program when the refuge was created in the 1960s. At its peak in the 1970s, 1,070 acres were in agricultural production on the refuge. In 2006, the last year of the cooperative farming program, the refuge farmed 485 acres. The program ceased until the farming program could be formally evaluated through this CCP process.

The Delmarva fox squirrel was extirpated from Delaware the 1800s. The recovery team decided to reintroduce fox squirrels throughout the Delmarva area and beyond. Prime Hook NWR's translocations occurred in 1986 and 1987. A founder Delmarva fox squirrel population of 17 individuals, 4 from Dorchester County, Maryland, and the remainder from Blackwater NWR was introduced into the refuge. By 1993, the Prime Hook translocations were deemed "successful" as per the 1993 second Recovery Plan. Recent changes in land use surrounding Prime Hook NWR (i.e., development), a small scale of available habitats on Prime Hook NWR, climate change, and sea level rise modeling data, all suggest poor prospects for long-term viability and persistence for the refuge Delmarva fox squirrel population.

The wildland urban interface is defined as the line, areas, or zone where structures and other human development meet or intermingle with undeveloped wildland or natural vegetative fuels. Past marsh management practices along with deferred funding decisions have contributed to a buildup of highly flammable *Phragmites* fuels on refuge lands adjacent to private beach communities. The result is that fire hazards and higher associated risks, as well as increasing beach populations, have augmented the wildland urban interface fire hazard potential directly associated with refuge lands. In recognition of these facts, the refuge received funding to reduce fire hazards and risks associated with the refuge's current wildland urban interface situation. A large

majority of homes lie immediately adjacent to refuge wetland and upland habitats and would be directly affected by any marsh fires fueled by *Phragmites*. It was estimated that approximately 4,000 acres of *Phragmites* located on and off the refuge pose an extreme fire hazard at the wildland urban interface. The refuge initiated a plan to reduce the hazardous fuels on the refuge and other areas adjacent to the local beach communities. This program continues today.

Refuge Vision Statement

The vision statement below qualitatively describes our desired future character of Prime Hook NWR. It was refined throughout the planning process with input from our partners and the public, and it will guide program emphases and priorities at the refuge.

> *Prime Hook National Wildlife Refuge will comprise a variety of Delmarva coastal plain habitats, such as barrier island beach, freshwater wetlands, tidal salt marshes, grassland, shrubland, and forest. The refuge will manage, maintain, enhance, and, where appropriate, restore ecologically sustainable 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 natural changes as necessary to maintain the ecological integrity of the refuge and build a stewardship ethic for current and future generations.*

Refuge Goals

Goals describe the desired future condition of the refuge and provide a framework for what the refuge is trying to accomplish in adopting a CCP. Developing goals early in the planning process helped focus our thinking about management actions. Our goals are described below in three categories: habitat, public use, and other.

Habitat

We will preserve, restore, and enhance the biological diversity and ecological integrity of Prime Hook NWR's native plants and wildlife in wetland and upland habitats within the Delmarva coastal plain ecosystem with the following goals:

Barrier Island Beach 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 and restore the biological integrity, diversity, natural sustainability, and environmental health of North Atlantic high and low salt marsh habitats.

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 and increase quality habitat for the endangered Delmarva fox squirrel, forest interior breeding and wintering landbirds, reptiles, amphibians, and other resident wildlife.

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.

Early Successional Upland Habitats
Maintain, enhance, and/or restore the native vegetation, biological diversity, and ecological integrity of early successional upland habitats to create a mosaic of native grassland, herbaceous scrub/shrub habitats, and transitional young forest

to conserve migratory birds, breeding landbirds, and endangered species, and maximize benefits for other priority resources of concern.

Public Use

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.

Other

Collaborate with the local community and partners to complement habitat and visitor services programs on the refuge and the surrounding landscape.

Issues, Concerns, and Opportunities

We developed a list of key issues and opportunities from our issues workbook, public and focus group meetings, and planning team meetings. Along with the goals stated above, these key issues formed the basis for developing and comparing the management alternatives.

Key Issues and Concerns

Since a key purpose of this CCP is to develop management goals and strategies for the next 15 years, the CCP will focus on several key issues that have been identified by Service staff and through public input.

Climate Change/Sea Level Rise/Overwash

Climate Change

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 and the planet has been warming over the past 20,000 years, current changes are occurring at a greatly accelerated rate as compared to the relatively slow warming trend of the most recent 7,000 years. These accelerated rates are largely a result of the accumulation of greenhouse gases from human activities since the onset of the United States (U.S.) Industrial Revolution (USCCSP 2009). Across the continental U.S., climate change is affecting migratory phenology and body condition of migratory songbirds (Van 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 recognize that climate change is a continuing, ongoing condition, so we need to understand how natural systems have evolved in this context and predict how those changes will affect fish and wildlife at multiple scales. We need to develop, test, and implement conservation strategies to cope with 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 Delaware Department of Natural Resources and Environmental Control (DNREC), Ducks Unlimited, U.S. Geological Survey (USGS), National Oceanic and Atmospheric Administration (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 assist ecosystem adaptation to the refuge's changing environment.

Sea Level Rise
Sea level rise, 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 region is actually sinking as a result of geologic changes near the surface and deep within the Earth (Holdahl and Morrison 1974). This is known as shallow and deep zone subsidence. Thermal expansion, melting of the polar icecaps, and subsidence all 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, the Intergovernmental Panel for Climate Change (IPCC) was formed to assess sea level rise on a global scale. In its fourth assessment report, 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 emission scenarios. Some climatologists believe that these projections far underestimate the potential rise in sea levels and suggest that sea level rise may exceed 1.0 meters (Rahmstorf 2007) or substantially more if rapid polar melting is considered. 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. The third projection is consistent with the higher estimates suggested by recent publications (USCCSP 2009).

Potential impacts from sea level rise can vary significantly depending upon the scenario; therefore, different sea level rise scenarios should be evaluated to consider an entire range of potential effects. Sea level rise has the potential to significantly impact the refuge, Delaware's coastal resources and communities, and Delaware's overall economy over the next several decades. Because 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.

In 2008 and 2009, the Delaware Coastal Program conducted a Sea Level Rise Affecting Marsh Model (SLAMM) exercise, using high-resolution elevation data, at Prime Hook NWR. The SLAMM model that was used (version 5) incorporated inundation, erosion, overwash, and saturation processes into modeled predictions about land cover change under various sea level rise scenarios. However, the SLAMM model does not incorporate a dynamic accretion rate that changes with varying sea level rise, which could influence and possibly improve the ability of the wetlands to keep pace with sea level rise. It also does not account for potential accelerated bluff erosion, and may thus underestimate the availability of sediment to replenish wetlands in some cases. The model used estimated

minimum and maximum sea level predictions and incorporated a minimum and maximum accretion rate estimate, assuming that the actual values will probably fall somewhere within those ranges. Certain conditions are predicted by both scenarios and we assume they are good predictors of the future environment at the refuge, even in light of the limitations of the model. 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 percent to, at most, 12 percent 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 1 meter in the next 100 years, the impact will be much greater on the refuge. By the year 2050, open water and mudflats are predicted to constitute 26 percent of the refuge under conditions that would allow marshes to build at high accretion rates, or up to 58 percent of the refuge with low accretion rates. Under the worst case scenario, by the year 2100, up to 88 percent of the today's refuge could be open water or tidal mud flats and only 1 percent of the refuge would be uplands. Predicted land cover changes under each sea level rise scenario are fairly similar with or without the bay dunes remaining intact. It is worth noting, however, that as conditions on the refuge change in the predicted manner, the ability of the refuge to manage wetlands through water level manipulation and exclusion of saltwater from impoundments will be lost long before the full effects of sea level rise are realized. The more immediate effect of sea level rise on the management of refuge resources is a critical issue for the refuge to consider during planning. The full SLAMM modeling report (Scarborough 2009) can be found at: *http://www.swc.dnrec.delaware.gov/coastal/Pages/SeaLevelRiseAdaptation.aspx* (accessed November 2012). Additional information regarding climate change and sea level rise can be found on the Service's Web site: *http://www.fws.gov/home/climatechange/* (accessed November 2012).

Overwash

Overwash is a natural manifestation of rising sea levels; it is anticipated that the refuge will be confronted with an increasing frequency of these natural events. Overwashes are also critical to maintaining healthy emergent wetlands in barrier island systems of estuaries, such as the Delaware and Chesapeake Bays. Emergent marshes must, in part, receive periodic influxes of sediment to help build marsh elevation to keep pace with rising sea levels. When humans impede natural overwash and marsh building processes by constructing dunes or filling overwash areas, they impede back-bay marsh development. This natural process of migrating landward is a barrier island system's response to sea level rise as they would otherwise be inundated. Overwashes provide nutrients and sedimentation that are vital for tidal salt marshes and provide critical habitat for priority coastal migratory birds.

Notable storm-induced overwashes occurred on the refuge in 1982, 1988, and 1998. The dunes were artificially rebuilt in 1999. In 2006, Hurricane Ernesto caused a beach overwash just north of Fowler Beach Road on Prime Hook NWR. On May 12, 2008, a nor'easter brought flooding that overtopped or completely removed portions of the beach dunes extending from the Slaughter Beach community to the Prime Hook Beach community, which includes the 2006 overwash area. The overwash north of Fowler Beach Road (Unit I) joins the Delaware Bay to a lagunal tidal salt marsh. As explained in more detail in chapter 3, this area has experienced overwash events in the past, which form and heal naturally over time. For example, an overwash in nearly the exact same location was present in the 1930s (figure 1-1).

The beach immediately south of Fowler Beach Road has formed inlets the past few years, as well. The impacted area south of Fowler Beach Road (Unit II) covers approximately 4,000 linear feet of beach, with 30 percent of the breaches

on private land or a mix of private and refuge-owned lands. These inlets have flooded the formerly managed freshwater impoundment in Unit II with saline bay water. DNREC enhanced the dunes in this area when the Unit II impoundment was established in 1988, and DNREC and the Service have reconstructed them on several occasions between 1988 and 2008 to prevent high tides from entering the freshwater impoundment from the bay. The refuge reasoned that allowing the overwashes to continue could result in a shift in vegetation composition in Unit II, which would reduce value of the impoundments as waterfowl habitat and in the quality of the Prime Hook NWR hunt program. However, it should be noted that prior to the extensive alteration of hydrology in this area caused by construction of roads, ditches, and canals, the native vegetation consisted largely of salt marsh communities. A former salt marsh peat sediment layer persists beneath the upper sediment, despite more than 20 years of freshwater inundation.

Unit III has also been managed as a freshwater impoundment for the benefit of waterfowl. Although not directly impacted by overwashes and inlets as Unit II is, the two units share water exchange through culverts under Prime Hook Road. Increased salinity in Unit II will influence the salinity in Unit III, even as freshwater inputs reduce the salinity in at least the central portion of Unit III. The impacts of the coastal overwashes on Unit III are not as direct as in Unit II, but they are present. Management challenges associated with the overwashes and inlets will ultimately affect both of these freshwater impoundment units.

The refuge's response to recent overwashes has been controversial, particularly within local beachfront communities. Some believe that overwashes, inlet formation, and subsequent flooding of the road and impoundment system are the fault of the refuge, and have suggested that the refuge should be managed to prevent flooding of private properties. Others, including some waterfowl hunters, insist that maintenance of the freshwater impoundments is critical to meet the refuge's management objectives for migrating and wintering waterfowl. However, also at issue is the recognition that management of freshwater wetlands through water level manipulation and repeated dune reconstruction over the long term is at odds with the BIDEH policy and with the Service's climate change strategic plan. The refuge also faces ecological uncertainty regarding how the impounded wetland will respond to rapidly increasing tidal flow, given its physical condition after decades of saltwater exclusion, and must consider how best to address that uncertainty. At the current rate of overwash, the refuge would be restoring dunes on average every 5 years, if not more often, in order to prevent tidal waters from entering the impoundments directly. Even with dunes along Unit II in place, saltwater intrusion would continue to impact freshwater habitats on the refuge periodically, as bay water enters the Unit II impoundment either through or over Fowler Beach Road.

Chapter 3 of this CCP provides further details about the various factors that influence freshwater impoundment management in the face of the three coastal processes of climate change, sea level rise, and overwash. The status of the physical environment and the condition of the management infrastructure are described to set the stage for the future management actions as outlined in chapter 4. Shortly following the formation of the major breaches in 2009, the refuge proposed to fill inlets and reestablish dunes along Unit II to maintain short-term stability of wetland habitats until the CCP was finalized and to prevent break-up of the peat layer, which protects the upland shoreline from direct wave action and is vital to an effective marsh restoration effort. The size of these breaches elevated the situation from that of minor dune repair to a more substantial management activity. Thus, an environmental assessment was prepared to conduct dune repair one more time (USFWS 20120). Legal challenges delayed the dune repair until 2011. By the time the repair was conducted, Hurricane Irene (August 2011) had reduced the amount of onsite material available significantly. The repair was conducted by the Shoreline Section of DNREC to the best of their ability, but the breaches reopened merely

days later. Daily tidal flow of saltwater through the breaches and into Unit II continues. Ultimately, the options that the refuge can reasonably consider in managing the impounded coastal wetlands will be guided by the challenging dynamic coastal conditions.

Mosquito Control

Balancing the needs of wildlife and people is becoming more difficult as residential developments encroach upon wild areas and more visitors participate in wildlife-dependent recreational opportunities on Prime Hook NWR. Providing quality habitat at sufficient quantities for an increasing number of species and individuals is challenging to wildlife managers and biologists. Another critical factor to take into account is the threat of disease to wildlife and humans and how to gauge this threat in making decisions. Numerous factors must be considered before actions are implemented to ensure that all precautions and long-term consequences of those actions are considered.

Mosquito control has a long history in Delaware. The Service has worked cooperatively with the DNREC Mosquito Control Section to provide access and permits to control mosquitoes on Prime Hook NWR for nearly 40 years. Numerous techniques have been employed to reduce nuisance mosquitoes on the refuge, including the use of open marsh water management to allow biological control of mosquito larvae and pesticide application of larvicides and adulticides.

The aim of the refuge is to work in cooperation with the Mosquito Control Section to establish appropriate and compatible mosquito control activities on the refuge based on sound science. This includes relying on Center for Disease Control guidelines, the Service's BIDEH and compatibility policies, Interim Guidance for Mosquito Management on National Wildlife Refuges (USFWS 2005), the State's best management practices, and American Mosquito Control Association/Environmental Protection Agency's Pesticide Environmental Stewardship program.

Mosquitoes are a part of the natural environment and a food source for a variety of wildlife. Insecticides, in particular adulticides, used to control mosquitoes can have significant impacts on insects, including nontarget insects, that are used by fish, amphibians, and migratory birds as important food sources.

The refuge will continue to work with the State while striving to protect the biological integrity, diversity, and environmental health of the refuge. This working relationship will eventually lead to the development of a mosquito control plan for the refuge. The refuge's strategies associated with mosquito control, along with their impacts, are discussed further in the chapters to follow.

Cooperative Farming Program

Agriculture, more than any other human activity, has had a profound influence on North American waterfowl and other wildlife (Ringelman 1990). In the past, farming has been an effective wildlife management tool as crops were used to supplement native food resources. When wildlife objectives were not being met through the maintenance of native vegetation, the more intensive method of cropland management was employed. Migratory waterfowl fed on waste crops left behind after harvest, and the refuge used farming as part of a cooperative farming program. Today, even though the potential agricultural production of row crops can be high for wildlife, improvements in combine headers and other farm equipment have resulted in harvest efficiencies of greater than 95 percent and rapidly approaching 99 percent (Gliem et al. 1990). As harvesting has taken place earlier, what waste grain remains usually germinates before migratory Canada geese arrive.

The refuge's overall contribution to the dietary consumption of agricultural foods by trust resources has been insignificant when considering the available cropped acreage on the local and regional scale. Prime Hook NWR has never tilled more than 870 acres in any year. This farmed acreage was incrementally reduced over the years to a total 544 acres in 2006. Presently, there are 40,565 acres of production cropland in the watershed. Waterfowl are not sedentary. Geese especially will make lengthy foraging flights between roosts and suitable feeding habitats. The State of Delaware maintains 490,000 acres of production farmland, while the Delmarva Peninsula as a whole has 1.5 million acres.

Major concentrations of wintering snow geese use Prime Hook NWR; in excess of 100,000 snow geese have been found during the fall and winter season. Extensive wetland acreage used by snow geese as safe loafing and roosting sites. In 2007, the final EIS for light goose management was published. The preferred management alternative supports the reduction of farming and sanctuary for snow geese on the refuge. In 2008, Delaware House Joint Resolution No. 12 was signed, asking the Service to issue the final rule of the light goose management EIS and the implementation of the conservation measures it recommends. The final rule on the EIS was issued by the Service in 2008, and is referred to as the snow goose conservation order. This conservation order is a special management action authorized by the Migratory Bird Treaty Act to control certain wildlife populations when traditional management programs are unsuccessful in preventing overabundance. It is consistent with this CCP's management plan to reduce overabundant snow geese populations on the refuge that can destroy marsh habitats and displace other species.

We know today that fragmenting native habitats has contributed substantially to the decline in many trust resources, including numerous species of migratory birds. In addition, fertilizers required to maintain farming, which is a relatively sterile, nearly monotypic habitat by ecological standards, may have substantial negative impacts on the local ecosystem. Sediment and nutrient runoff have affected fish and wildlife species far downstream, and aquifers once used as sources of human drinking water on Delmarva are now deemed unsafe for consumption due to applied nitrate leaching from the surface.

Under the Migratory Bird Conservation Act and Refuge Recreation Act, Prime Hook NWR 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. Agricultural lands were not of primary importance. Additionally, lands were acquired under the Migratory Bird Conservation Act "for use as an inviolate sanctuary, or for any other management purpose, for migratory birds." For lands acquired under the Refuge Recreation Act states 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…" Although agricultural practices were viewed as a common management tool at the time the refuge was established, it is apparent that the intent of the refuge's establishing legislation gives no undue weight or particular mandate to agricultural activity.

Two acts of Congress also play a role in the cropland management program: NEPA and Refuge System Improvement Act (1997). NEPA requires the government to evaluate the impacts of its management actions on the affected environment. The Refuge Improvement Act requires Prime Hook NWR to ensure that cooperative farming is compatible (see section 1.423 in this chapter) with the purpose for which the refuge was established. Cooperative farming is also considered an economic use, refuge policy 5 RM 17 also plays a role in the formation of cropland management planning.

In 2006, the Delaware Audubon Society, Center for Food Safety, and Public Employees for Environmental Responsibility filed suit against the Service alleging the refuge's failure to comply with these acts and policies. The refuge ceased all farming operations in 2006. In 2009, the judge enjoined the refuge from farming and planting genetically modified organisms until the refuge completed compatibility determinations and environmental assessments dealing with the impacts. We are now complying with the court's directive by assessing the impacts of agriculture in this CCP and the attached compatibility determination.

Hunting

Hunting on the Delmarva Peninsula is a traditional outdoor past time and is deeply rooted in 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 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. In preparation of the CCP, the refuge closely examined aspects of the current hunting program that some have described as inefficient, overly complex, and requiring a significant amount of staff resources. It has also addressed whether increasing opportunities for one user group, i.e., hunters, might appreciably reduce opportunities for non-consumptive wildlife-dependent uses, such as wildlife observation and photography.

Opportunities

The refuge should seek to establish new and strengthen current partnerships with conservation organizations, such as the Service's Partners for Fish and Wildlife program, the coastal program, private individuals, etc. The refuge relies on partnerships with several organizations and individuals for help with refuge programs, biological surveys, environmental education, and habitat restoration on private lands that support the refuge's purpose. Opportunities exist to establish an outstanding research and monitoring site, develop wetland and hydric soil indicator reference sites, expand the environmental education program, etc.

Chapter 2

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Field sparrows

The Planning Process

- Introduction
- The Comprehensive Conservation Planning Process
- Conservation Plans and Initiatives Guiding the Project
- Existing Refuge Operational Plans
- Formulating Alternatives Using Refuge Resources of Concern and Focal Species Management

Introduction

This chapter explains the planning process in developing the CCP; describes the influences of other national, regional, ecosystem, and State plans; and identifies refuge operational or step-down plans.

Refuge System Planning Policy

The planning policy provides guidance, systematic direction, and minimum requirements for developing all CCPs, and stipulates a systematic decision-making process that fulfills those requirements. This policy also establishes requirements and guidance for Refuge System planning, including CCPs and step-down management plans. It states that we will manage all refuges in accordance with an approved CCP which, when implemented, will achieve refuge purposes; help fulfill the Refuge System mission; maintain and, where appropriate, restore the ecological integrity of each refuge and the Refuge System; help achieve the goals of the National Wilderness Preservation System; and meet other mandates [Service Manual (602 FW 1,2,3)].

The Refuge Improvement Act of 1997 stipulates that each CCP shall identify and describe:

(A) The purposes of each refuge comprising the planning unit *(found in this chapter)*.

(B) The distribution, migration patterns, and abundance of fish, wildlife, and plant populations and related habitats within the planning unit *(Chapter 3, Existing Environment)*.

(C) The archaeological and cultural values of the planning unit *(chapter 3)*.

(D) Such areas within the planning unit that are suitable for use as administrative sites or visitor facilities *(Chapter 4, Management Direction and Implementation)*.

(E) Significant problems that may adversely affect the populations and habitats of fish, wildlife, and plants within the planning unit and the actions necessary to correct or mitigate such problems *(chapters 1, 2, 3,and 4)*.

(F) Opportunities for compatible wildlife-dependent recreational uses *(chapter 4)*.

The use of sound science is also mandated by the Refuge Improvement Act and subsequent Service policies. The Refuge System planning policy specifically requires that CCPs be based on a *"comprehensive assessment of the existing scientific literature."* Refuge planning policy also states that *"refuge planning will reflect conservation goals and objectives for the landscapes in which refuges are located. Refuges must review goals and objectives of existing ecosystem plans and determine how the refuge can best contribute to the functioning of the ecosystem."* A great deal of study and effort has been devoted to this task and is extensively outlined and reviewed on page 2-4 through 2-18, Conservation Plans and Initiatives Guiding the Project.

Other Mandates

Although Service and Refuge System policy plus each refuge's unique legislated purposes provide foundation for its management, other Federal laws, executive orders, treaties, interstate compacts, and regulations on the conservation and protection of natural and cultural resources also affect how national wildlife refuges are managed. The *Digest of Federal Resource Laws of Interest to the USFWS* lists many of them, and can be accessed at: *http://fws.gov/laws/lawsdigest.html* (accessed January 2012).

Federal laws also require the Service to identify and preserve its important historic structures, archaeological sites, and artifacts. NEPA mandates our consideration of cultural resources in planning Federal actions. The

Refuge Improvement Act requires that the CCP for each refuge identify its archaeological and cultural values.

The National Historic Preservation Act (Pub. L. 102–575; 16 U.S.C. 470) requires Federal agencies to locate and protect historic resources—archaeological sites and historic structures eligible for listing or listed in the National Register of Historic Places and museum property—on their land or on land affected by their activities. It also requires agencies to establish a program for those activities and carry them out in consultation with state historic preservation offices.

The act also charges Federal agencies with locating, evaluating, and nominating sites on their lands for the National Register of Historic Places. We maintain an inventory of known archaeological sites and historic structures in the Northeast Regional Office and file copies of the sites at each refuge. Our regional historic preservation officer in Hadley, Massachusetts, oversees our compliance with the act and our consultations with state historic preservation offices. We must also comply with the Archaeological Resources Protection Act (pub. L. 96–95, 16 U.S.C. 470aa-mm) which requires that we protect our archaeological sites from vandalism or looting and issue permits for site excavation.

The Service also owns and cares for museum properties. The most common are archaeological collections, art, zoological and botanical collections, historical photographs, and historic objects. Each refuge maintains an inventory of its museum property. Our museum property coordinator in Hadley, Massachusetts, guides the refuges in caring for that property, and helps us comply with the Native American Graves Protection and Repatriation Act (25 U.S.C. 3001, et seq.) and Federal regulations governing Federal archaeological collections. Our program ensures that Service collections will continue to be available to the public for learning and research.

Chapter 5, Environmental Consequences, of the draft and final CCP/EIS evaluates this plan's compliance with the cultural and historic acts cited above, as well as the Clean Water Act, Clean Air Act, and Endangered Species Act. We designed the CCP/EIS to fulfill our NEPA compliance.

The Comprehensive Conservation Planning Process

Service policy establishes an 8-step planning process that also facilitates compliance with NEPA (figure 2-1). Each of the individual steps is described in detail in the planning policy and CCP training materials (602 FWS 3, "The Comprehensive Conservation Planning Process"). The planning policy can be accessed at: *http://www.fws.gov/policy/602fw3.html* (accessed January 2012).

Planning Process

The key to effective conservation begins with community involvement. To ensure future management of the refuge reflects the issues, concerns, and opportunities expressed by the public, a variety of public involvement techniques were used.

Open houses and public information meetings were held throughout the area at three different locations (Milton, Dover, and Lewes) during November 2005. Meetings were advertised locally through news releases, Web sites, and through our mailing list. For each meeting, the open house session was planned where people could informally learn of the project, and have their questions or concerns addressed in a one-on-one situation. The evening public information meeting sessions usually included a presentation of the refuge, a brief review of the Refuge System and the planning process, and a question and answer session. Participants were encouraged to actively express their opinions and suggestions. The public meetings allowed us to gather information and ideas from local residents, adjacent landowners, and various organizations and agencies.

A visitor survey and community survey were developed to encourage written comments on topics such as wildlife habitats, exotic nuisance species, and public access to the refuge. The visitor survey was distributed to 435 individuals

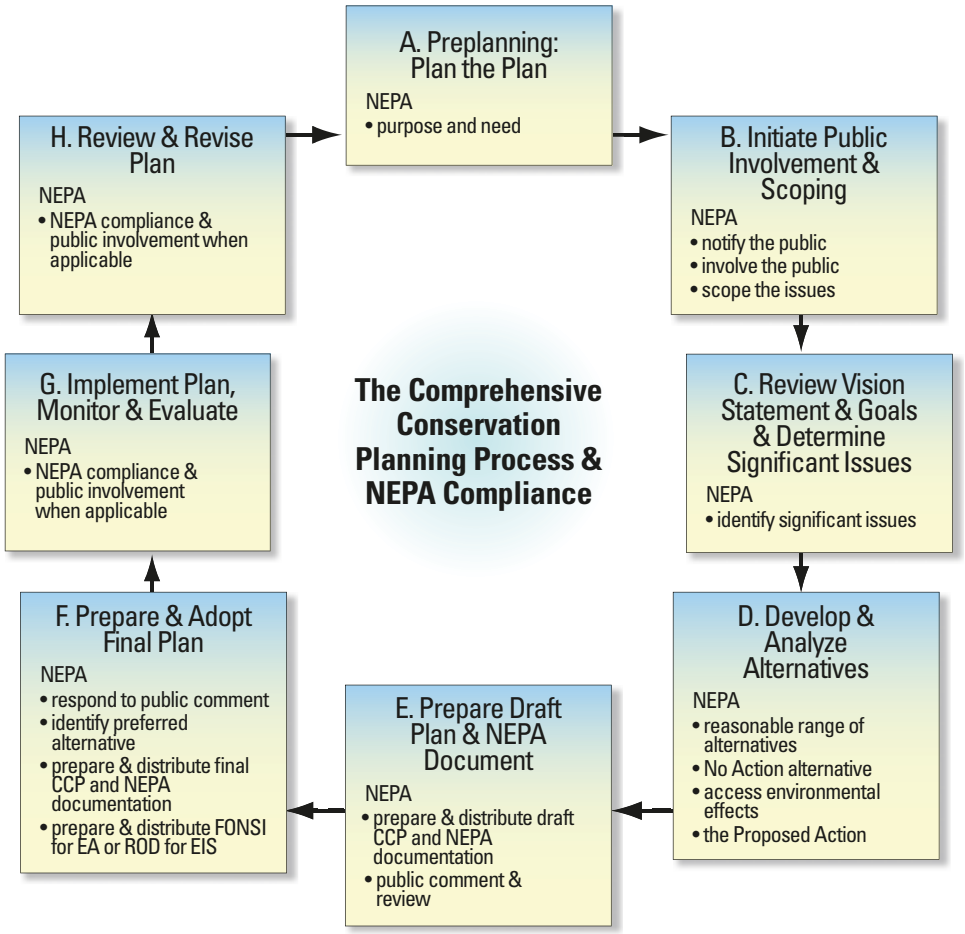
representing various user groups on the refuge. The community survey was distributed to 1,430 members of the local community using a stratified random sampling design. The response rates for the visitor and community surveys were 79 percent and 39 percent respectively.

We completed the draft CCP/EIS and initiated a public comment period that totaled 89 days, from May 31, 2012 to August 27, 2012. We also held seven public meetings in Milford, Milton, and Lewes, Delaware. We evaluated all the letters and e-mails sent to us during that comment period, along with comments recorded at our public hearing. Appendix M summarizes all of the substantive comments we received and provides our responses to them.

We completed the final CCP/EIS and initiated a 30-day review period on December 28, 2012.

At its completion, the CCP will be reviewed, evaluated, and subsequently updated approximately every 15 years in accordance with the Refuge Improvement Act and Service planning policy (602 FWS 1, 3, and 4). However, when significant new information becomes available, ecological conditions change, major refuge expansion occurs, or when we identify the need to do so, the plan will be reviewed sooner. All plan revisions will require NEPA compliance. If minor plan revisions are required and they meet the criteria of a categorical exclusion, then an environmental action statement, in accordance with (550 FW 3.3C) will only be needed. But if the plan requires a major revision, then the CCP process starts anew at the preplanning step [602 FW 3.8(B)].

Figure 2-1. Steps in the Comprehensive Conservation Planning Process and its relationship to the National Environmental Policy Act of 1969



Conservation Plans and Initiatives Guiding the Project

Service Migratory Bird Strategic Conservation Initiative

The 1988 amendment to the Fish and Wildlife Conservation Act mandates the Service to "identify species, subspecies, and populations of all migratory nongame birds that, without additional conservation actions, are likely to become candidates for listing under the Endangered Species Act (ESA) of 1973." Publication of the Birds of Conservation Concern (BCC) 2008 is the most recent effort to carry out this mandate (USFWS 2008a). The goal of the BCC report is to accurately identify the migratory and non-migratory bird species (beyond those already designated as federally threatened or endangered) that represent our highest conservation priorities. The underlying philosophy behind BCC 2008 is that proactive bird conservation actions are necessary at a time when human impacts are at an all-time high to ensure the future of healthy avian populations and communities. BCC 2008 data and information serve as a barometer of the condition of the Nation's avifauna from a national landscape scale funneled down to regional details.

The national BCC 2008 priority bird list provides an early warning of what birds species have the potential to decline to levels requiring ESA protection; it is to be consulted before actions are taken on Federal lands, and for research, monitoring, and management funding in accordance with Executive Order #13186 (Responsibilities of Federal Agencies to Protect Migratory Birds). This list contains 147 bird species of which 13 nest on the Prime Hook NWR and 26 are migrants utilizing refuge habitats during some part of the year. The national list serves as an outreach tool for educating the public about the precarious status of selected bird species across the U.S. As a general rule, the list is not used to foster bird conservation at smaller geographic scales; that is the purpose of the Bird Conservation Region (BCR) 30 and Service region lists.

Funneling the national bird list down to regional levels, the BCC 2008 report generates two other lists that include the refuge geographically: the BCR of New England/Mid-Atlantic (BCR 30) and the Service Region 5 list. The BCR 30 list identifies 45 species of conservation concern, of which 37 occur on the refuge; the Region 5 list identifies 52 species of concern, of which 40 occur on the refuge as either nesters or migrants in their annual life cycle (see High Priority BCR 30/R5 Composite Lists of Bird Species breeding or migrating on Prime Hook NWR below). These bird species in need of additional conservation actions were targeted as resources of concern in the development of this CCP and were also incorporated in upgrading of goals and objectives that will direct and guide the future of refuge management.

High Priority BCC 2008 Bird Species Nesting on Prime Hook NWR Based on BCR 30/R5 Composite lists:

Pied-billed grebe
American bittern
Least bittern
Black rail
American oystercatcher
Least tern
Whip-poor-will
Wood thrush
Prairie warbler
Worm-eating warbler
Henslow's sparrow
Salt marsh sharp-tailed sparrow
Seaside sparrow

High Priority BCC 2008 Migrant Bird Species on Prime Hook NWR Based on BCR 30/R5 Composite lists:

Red-throated loon
Snowy egret
Peregrine falcon
Yellow rail
Short-billed dowitcher
Gull-billed tern
Black skimmer
Red-headed woodpecker

Solitary sandpiper
Lesser yellowlegs
Whimbrel
Hudsonian godwit
Marbled godwit
Red knot
Semipalmated sandpiper
Buff-breasted sandpiper
Olive-side flycatcher
Sedge wren
Blue-winged warbler
Golden-winged warbler
Cerulean warbler
Kentucky warbler
Canada warbler
Nelson's sharp-tailed sparrow

In tandem with the BCC 2008 effort, the Service has also developed a 10-year national strategic migratory management plan to collaborate with its partners to recommit and set a successful course for migratory bird conservation over the next decade. The finalized plan, A Blueprint for the Future of Migratory Birds: A Strategic Plan 2004-2014, describes the challenges facing migratory bird conservation, with associated management strategies to meet these future challenges. The Service's plan formulates a strong recommitment to migratory bird conservation with the following vision statement: "*Through careful management built on solid science and diverse partnerships, the Service and its partners will restore and sustain the epic sweep of bird migration and the natural systems on which it depends—fostering a world in which bird populations continue to fulfill their ecological roles while lifting the human spirit and enriching human lives in infinite ways, for generations to come.*"

The blueprint document points out that "birds enrich people's lives and have intrinsic value as threads in the earth's ecological tapestry, as pollinators, predators, and prey. Birds serve as excellent indicators of the health and quality of the environment as clean air, clean water and abundant, diverse natural habitats are essential for birds to survive and flourish." The plan also recognizes that birds are enjoyed by a large proportion of Americans, as more than 82 million residents of the U.S. (39 percent of adult population) participate in wildlife-related activities, and 64 million pursue bird-related recreation, contributing substantially to local economies throughout the Nation by spending more than $40 billion dollars annually on these pursuits (Blueprint 2004).

Also identified were the major future challenges to conserve migratory birds. Declines in abundance of many landbird, shorebird, and waterbird populations are indicative of ecosystems that have been highly stressed and altered. Reductions in natural habitat quantity and quality are acknowledged as the primary causes of negative population trends in many bird species and are exacerbated by the direct loss of bird life from an array of environmental contaminants. Pesticides continue to poison birds and their food supplies. Invasive species and disease outbreaks also contribute to migratory bird mortality. Global climate change and demand for freshwater supplies pose current and future threats.

The Blueprint document explains that meeting these challenges will require consistent adherence to the principles of sound science. Many of these threats will be addressed in this CCP and we will use the best available scientific information to mitigate environmental dangers to migratory birds. The refuge and its partners will focus on these challenges in the most cost-effective manner to perpetuate avian populations.

Strategic Habitat Conservation/National Ecological Assessment Team Report Guidance

The Regional Director has stated that, "The Service is looking at a new way of doing business. The goal is to focus our work on conservation priorities and outcomes and less on program and regional organization." Recent advances in the field of conservation science are leading the Service toward a new direction of "strategic pursuit of sustainable landscapes." In the past, the Service relied more on conservation opportunities; however, the strategic habitat conservation

approach features more scientific ecosystem-level analysis used to better coordinate local, on-the-ground habitat conservation actions.

Strategic habitat conservation (SHC) is a science-driven framework for the strategic pursuit of defining and implementing conservation priorities for sustainable landscapes. This framework provides a scientific approach in identifying habitat conservation deficits on the landscape and filling in the gaps. SHC involves both cross-programmatic Service groups and non-Service conservation science partners' participation to restore, enhance, and manage local wildlife habitats. It features stepping down ecosystem-level Geographic Information System (GIS) analysis to coordinate local, on-the-ground conservation actions. SHC is trust resource centric, which focuses on under-represented habitats across the landscape, and relying on cross-pollination from all Service programs, state partners, and other conservation science expertise.

The SHC approach has been used in development of this CCP to formulate proposed refuge-specific habitat objectives and management strategies. This was done by stepping down the combined habitat goals of the Delaware River/ Delmarva Coastal ecosystem plan and Delaware wildlife action plan. We focused on conservation target species of greatest conservation need and under-represented habitats identified in both ecosystem and State comprehensive wildlife plans, and used ecosystem-level GIS analysis and refuge vegetation mapping for to produce refuge-specific habitat objectives and management strategies. These objectives include conservation assessment elements of measurable biological outcomes, so we can develop an effective inventory and monitoring step-down plan after finalization of the CCP. Development of an inventory and monitoring plan will enable us to monitor and assess successes and failures of future conservation actions, and adjust or adapt new management strategies accordingly.

SHC provides an iterative framework of planning, implementation, and evaluation actions. It is an adaptive conservation management scheme that rotates around five main functions: strategic biological planning, conservation design, conservation delivery, monitoring, and research. The framework provides for continual refinement of management strategies at each iteration, constantly improving the achievement of desirable outcomes and examining the consequences of site-scale actions on landscape-scale functions.

The practice of SHC provides improved and defensible methods of habitat management planning and execution, with the greatest transparency possible to explain the rationale for refuge-specific habitat objectives and management strategies contained in this document. Prime Hook NWR has built into this CCP a working capacity for SHC and will continue to build SHC working capacity in subsequent stepped-down management plans.

"Conserving the Future and Fulfilling the Promise" Document Guidance and Wildlife-Habitat-Process Report

Fulfilling the Promise

The 1999 report, Fulfilling the Promise, The National Wildlife Refuge System: Visions for Wildlife, Habitat, People, and Leadership (USFWS 1999), was a culmination of a year-long process by teams of Service employees to evaluate the Refuge System Nationwide. This report was a result of the first-ever Refuge System conference held in Keystone, Colorado, in October 1998. It was attended by every refuge manager in the country, other Service employees, and scores of conservation organizations. The report contains 42 recommendations packaged with three vision statements dealing with wildlife and habitat, people, and leadership. We often looked to the recommendations in the document and subsequent promise team reports, when writing the CCP. For example, the 1999 report recommends forging new alliances through citizen and community partnerships and strengthening partnerships with the business community. One of the goals in our CCP is devoted almost entirely to the development of

community partnerships, while several of our strategies focus on forging new partnerships or strengthening existing ones.

Conserving the Future: Wildlife Refuges and the Next Generation
Published in October 2011, Conserving the Future: Wildlife Refuges and the Next Generation establishes the Refuge System's new vision as it moves into the next decade of conservation following Fulfilling the Promise (USFWS 1999). This document builds upon the framework of Fufilling the Promise. It is the result of 18 months of study and public conversation about conservation and the future of the Refuge System. It was drafted by Service employees and their conservation partners with input from Service employees, other state and Federal agencies, tribes, conservation agencies, and private citizens. When developed, this new course had to consider changes that occurred since Fulfilling the Promise was published, such as, an increasing and more diverse population, a challenged economy, a changing climate, and U.S. involvement in war. The report contains 24 recommendations packaged with eight vision statements. It seeks not only to further the Refuge System's mission, but also to raise the Service's profile in the broader national conservation effort. This new vision embraces bold new ideas to realize the full conservation potential of the Refuge System. It relies strongly on utilizing partnerships with both traditional and non-traditional partners. It also acknowledges that strategic, collaborative, science-based landscape conservation - along with effective public outreach, education, and environmental awareness, is the only path forward to conserve America's wildlife. As with the Fulfilling the Promise document, we have looked to the recommendations in this document when writing the CCP.

National Wildlife Refuge System Wildlife Habitat Goals Report
Another important Fulfilling the Promise team effort focused on the need to have clear objectives on how the Refuge System will contribute to biological diversity in North America. In January 2004, the wildlife habitat goals team completed its final report, A Process for Integrating Wildlife Population, Biodiversity, and Habitat Goals and Objectives of the NWR System: Coordinating with Partners at all Landscape Scales. The report recognized the conservation biology principles that would be used by each refuge on how to best contribute to maintaining biodiversity and the process to determine biodiversity objectives and indicators for each individual refuge. These included native plant and animal species richness as important and useful indicators of biodiversity; species as a function of habitats; animal habitats as characterized by plant species composition, and plant habitats as characterized by physiographic features; and conservation of a broad range of physiographic features and plant communities to ensure the conservation of a wide range of species and other components of biodiversity.

The process describes how to compile national wildlife population, habitat, and biodiversity goals, and then step those down through regional, ecosystem and refuge levels. During the development of the CCP, we adopted the report's vegetation-based coarse-filter approach to identify habitat objectives, coupled with wildlife population-based fine-filter approach for biodiversity conservation (Berendzen et al. 2004).

Prime Hook NWR relied heavily on many partners when establishing refuge-specific conservation priorities, habitat objectives, and alternatives included in this document. These partners included Service Delaware Bay Estuary Project, USGS Water Resources Division Office, the Delaware Natural Heritage and Endangered Species Program, and the NatureServe Network.

The North American Waterfowl Management Plan

The North American Waterfowl Management Plan (NAWMP) was originally written in 1986 to help protect continental habitat conditions that could sustain and improve waterfowl populations. It was updated in 1994, 1998, and 2004. This plan outlines the strategy among the U.S., Canada, and Mexico to protect North America's remaining wetlands and restore waterfowl populations through habitat

protection, restoration, and enhancement actions. The intent in preparing the 2004 plan was to define and update the needs, priorities, and strategies with a 15-year planning horizon; increase stakeholder confidence in the direction of plan actions; and guide partners in strengthening the biological foundation of North American waterfowl conservation (USFWS 2004). The 2004 update can be accessed at: *http://www.fws.gov/birdhabitat/NAWMP/Planstrategy.shtm* (accessed January 2012).

Implementation of this plan is accomplished at the regional level within designated regional habitat joint venture areas. Planned recovery actions identified in the plan, such as habitat restoration and enhancement, occur through these regionally based, self-directed partnership joint ventures that involve Federal, state, and provincial governments; Tribal nations; local businesses; conservation organizations; and individual citizens for the purpose of protecting habitat within joint venture areas. Prime Hook NWR is located within the Atlantic Coast Joint Venture (ACJV) area, which covers all Atlantic Flyway states from Maine to Florida, as well as Puerto Rico.

Atlantic Coast Joint Venture

The mission of the ACJV has continued to evolve with the decision to embrace a more comprehensive approach that addresses all-bird conservation, with an emphasis on waterfowl 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."*

The ACJV implementation plan was revised June 2005 (USFWS 2005). The purpose of this plan is to step-down the continental and regional goals of the 2004 NAWMP to the ACJV area, present a current status assessment of waterfowl and their habitats within the joint venture, update focus area data for each state, and present habitat conservation goals and population indices for the ACJV consistent with the NAWMP. This revised version of the implementation plan also provides baseline information needed to move forward with a thorough approach for setting future habitat goals. The 2005 update of the implementation plan can be accessed at: *http://www.acjv.org/wip/acjv_wip_main.pdf* (accessed January 2012).

In order to capture the conservation needs of the diversity of landscapes within the ACJV, a three-tiered, hierarchical approach to mapping and defining areas, from coarsest to finest, was used. These include planning areas, focus areas and sub-focus areas, which target more than 113 million acres for conservation action to benefit waterfowl and other wetland-dependent species. The State of Delaware contains four focus areas and three sub-focus areas delineating 924,069 acres for intensifying waterfowl conservation management actions. Prime Hook NWR lies within the Bayshore focus area, which encompasses approximately 407,857 acres of land.

The best waterfowl breeding and wintering habitats in the State of Delaware are found in the Bayshore focus area, which encompasses the coast of central Delaware, from the Cedar Swamp wildlife areas in northern Kent County to Lewes in Sussex County. During the fall and winter, hundreds of thousands (251,706 in January 2004) of waterfowl use the area for feeding and roosting; there are significant numbers of Canada goose, snow goose, pintail, black duck and mallard. Over 80 percent (200,000) of the Atlantic Flyway's snow goose population winters in this focus area (Delaware 2004). In addition, this area also contains the largest concentration of northern shoveler, American widgeon, and gadwall in the State and is also noted 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 Delaware, it provides some of the most critical habitat (e.g., beach, dunes, adjacent marshes and impoundments) for migratory shorebirds. More specifically, this focus area is the major stopover refueling site for over a million shorebirds during the spring migration, including 80 percent of the Western Hemisphere's red knot population and significant numbers of dunlin, ruddy turnstone, semipalmated sandpiper, least sandpiper, short-billed dowitcher, and others.

Major threats to waterfowl in the Bayshore focus area include increasing development, decreasing water quality, oil spills, and invasive species. Vast areas of forest and wetland habitats are being lost to facilitate agriculture and residential development. Conservation recommendations focus on protecting, restoring, and enhancing wetlands and associated upland habitats to form larger contiguous blocks of natural habitats along with connections to undisturbed habitat within the Bayshore area. With respect to Delaware's portion of the ACJV plan, 3,000 acres have been targeted for protection, 40,000 acres for enhancement, and 500 acres for restoration. We have used this ACJV information when developing the various alternative scenarios with respective future management goals, objectives, and strategies.

North American Waterbird Conservation Plan

The North American Waterbird Conservation Plan is the product of an independent partnership of individuals and institutions wanting to conserve waterbirds and their habitats (version 1.0 – 2002). The plan provides a continental framework for the conservation and management of 210 species of waterbirds utilizing aquatic and wetland habitats. It sets goals and priorities for waterbirds during nesting, migration, and non-breeding periods. The plan provides an overarching framework for regional conservation planning, provides focused guidance for local conservation planning and action, and gives a larger context for local habitat protection. The plan can be accessed online at: *http://www.waterbirdconservation.org* (accessed January 2012).

Partners in Flight North American Landbird Conservation Plan

The Partners in Flight (PIF) North American Landbird Conservation Plan reviewed the conservation status of 448 native landbird species that regularly breed in the U.S. and Canada. The purpose of this continental plan is to provide an overview of the highest priority landbirds in North America. These birds include not only those species that are of conservation concern due to population declines and small ranges, but those that are characteristic of major habitat types and are essential to the biological integrity and long-term ecological stability of entire eco-regions. Following the lead of the NAWMP, PIF has made the commitment to conserve the resident, short-distance, and neotropical migrant landbirds and their regional habitats on the continental landscape (Rich et al. 2004). The PIF vision states *"Populations of native birds will occur in their natural numbers, natural habitats, and natural geographic ranges, through coordinated efforts by scientists, government, and private citizens."*

Two groups of bird species were identified as having high conservation importance: the PIF Watch List, made up of species with the greatest conservation need, and stewardship species that are particularly characteristic of regional avifauna. Watch list species are considered to be in immediate trouble and are at risk of extinction or serious decline, while stewardship species are native bird species that are characteristic of unique ecosystems.

Of the 100 watch list species, 66 are also stewardship species. Examples of high-priority watch list species that Prime Hook NWR manages for include salt marsh sparrow, seaside sparrow, Nelson's sparrow, Henslow's sparrow, black rail, prairie warbler, prothonotary warbler, short-eared owl, willow flycatcher, red-headed woodpecker, and wood thrush. Significant stewardship species that can

be managed for on the refuge include Acadian flycatcher, pine warbler, yellow-throated warbler, eastern towhee, chuck-will's widow, and white-eyed vireo.

Mid-Atlantic Coastal Plain–Physiographic Area 44 Plan
Several regional PIF plans have been stepped down from the national effort and the regional plan pertinent to the refuge is the Mid-Atlantic Coastal Plain Area 44 Plan, which covers about 13 million acres including portions of Virginia, Maryland, Pennsylvania, New Jersey, and all of Delaware (Watts et al. 1999). The PIF 44 plan identifies that managing human population growth (more than 11 million) while maintaining functional natural ecosystems is the greatest conservation challenge in Area 44.

The pace of habitat loss within this area suggests that future success of conservation planning will require swift identification and preservation of remaining habitat patches. Priority bird species were sorted by habitat to delineate the highest priority habitats in need of critical conservation attention to conserve regionally important PIF bird populations. Priority habitats pertinent to Prime Hook NWR conservation planning with keystone bird species are: salt marsh–black rail, salt marsh sparrow, seaside sparrow, and American black duck; forested wetlands–prothonotary warbler and Acadian flycatcher; mixed upland forest–wood thrush, eastern wood-pewee, scarlet tanager, red-headed woodpecker, Cooper's hawk, and barred owl; and early successional–prairie warbler and Henslow's sparrow.

Specific conservation recommendations for this physiographic area include strict protection of beach and barrier dune habitat to minimize productivity losses of priority species, prioritize and protect all sites with greater than 125 acres of high marsh, protect forest blocks that support significant populations of prothonotary warbler or wood thrush, and manage or restore early successional habitats greater than 125 acres to support Henslow's sparrow. We considered the restoration and maintenance of identified priority habitats and habitat requirements of the highest priority species in the development of the CCP.

U.S. Shorebird Conservation Plan

The U.S. Shorebird Conservation Plan was developed with the purpose of creating conservation goals, identifying critical habitat, and promoting education and outreach programs to facilitate shorebird conservation. Several groups and individuals, including local, state, and Federal agencies, non-governmental organizations, business-related sectors, researchers, educators, and policymakers helped craft the plan document, which summarizes all the latest hemispheric and national population shorebird estimates and recommendations for regional step-down plans along with conservation goals and critical habitat identification. The plan can be accessed at: *http://www.fws.gov/shorebirdplan/USShorebird/downloads/USShorebirdPlan2Ed.pdf* (accessed January 2012).

At the regional level, Prime Hook NWR is part of the North Atlantic planning region within the Atlantic Flyway, which includes 12 states and encompasses Biological Conservation Regions numbers 30 and 14. The Northern Atlantic Regional Shorebird Plan (version 1.0–Clark et al. 2001) identified the major habitat types supporting shorebirds in this region, which include beachfront and high beach dune, intertidal mudflats, vegetated intertidal marshes, and managed impoundments. Inland habitats such as forested wetlands and peninsulas that concentrate migrants, as well as managed uplands are also included. The North Atlantic region is extremely important for transient shorebirds during both northbound and southbound migrations.

The region is critical for the Western Hemisphere population of red knot, which is highly concentrated in Delaware Bay each spring. It also supports most of the Atlantic Flyway's breeding piping plovers. Shorebird species of the highest regional priority that can be managed for on refuge lands by habitat type include:

beachfront–red knot, piping plover, ruddy turnstone, and sanderling; intertidal mud–semipalmated sandpiper, American golden plover, greater yellowlegs; intertidal marsh–willet; and earlier successional habitats–American woodcock and buff-breasted sandpiper.

The Emergency Wetlands Resources Act

The Emergency Wetlands Resources Act was enacted in 1986 to Regional Wetland Concept Plan, Northeast Region to promote the conservation of wetlands nationwide. Through this act, the Department of the Interior was directed to develop a national wetlands priority conservation plan identifying the location and types of wetlands that should receive priority attention for acquisition by Federal and state agencies using Land and Water Conservation Fund appropriations. In 1990, the Service's Northeast Region completed a regional wetlands concept plan that complemented the national plan by providing more detailed information about the wetland resources of the Northeastern states (USFWS 1990).

The regional wetlands concept plan identifies 850 wetland sites that warrant consideration for acquisition. It also describes wetland functions and values as well as identifies habitat loss and threats to wetlands remaining in the region. Of the 16 wetland sites identified in the State of Delaware, 8 sites are located in Sussex County. Two sites are immediately adjacent to the refuge: 300 acres (Huckleberry Swamp) and 200 acres (Sowbridge Branch) in Milton/Ellendale, while the remaining six sites are scattered throughout the county. We used this information as we develop our land protection strategies.

Partners in Amphibian and Reptile Conservation

Partners in Amphibian and Reptile Conservation (PARC) is a diverse partnership of public and private organizations, and is the most comprehensive herpetofauna conservation effort undertaken in the U.S. PARC, which is a unique national and international conservation network of comprehensive information on all reptiles and amphibians, is solely habitat focused. It provides the best available science to conserve and protect herpetofaunal habitats and species.

PARC keys in on endangered and threatened species but also advocates keeping common native species common. Their mission is "to conserve amphibians, reptiles and their habitats as integral parts of our ecosystem and culture through proactive and coordinated public and private partnerships." PARC's partners include Environmental Protection Agency (EPA) Office of Wetlands, Service-Northeast Region, USGS Biological Resources Division, and many more: *http://www.parcplace.org* (accessed January 2012).

In 2000, the Northeast regional working group of PARC (NEPARC) began work to assess factors contributing to the risk and potential vulnerability of northeastern amphibians and reptiles. Their Web site serves as a repository of biological attributes for Anura (frogs and toads), Caudata (salamanders and newts), Squamata (snakes and lizards) and Testudines (sea and freshwater turtles): *http://www.northeastparc.org/* (accessed January 2012)

This information, along with Habitat Management Guidelines for Amphibians and Reptiles of the Northeast (Mitchell et al. 2006) and Southeast (Bailey et al. 2006), was used to develop habitat management objectives and strategies to maintain the common native species and protect some of the rarest Delaware herpetofaunal species documented on the refuge.

Delaware Comprehensive Wildlife Conservation Strategy

In 2001, new funds appropriated by Congress known as the state wildlife grants program, were used to challenge the states to demonstrate wildlife conservation management in complete terms—not just game, sport fish, and endangered species, but comprehensive wildlife conservation (i.e., all species and all habitats). The Delaware Division of Fish and Wildlife developed its Delaware Wildlife Action Plan (DEWAP 2005). The plan is a compilation of comprehensive strategies for conserving the full array of native wildlife and habitats, both common and uncommon, as vital components of the State's natural resources.

This plan recognizes development pressure and loss of wildlife habitats as threatening the existence of many of Delaware's indigenous species of concern, such as the hooded warbler, carpenter frog, Bethany firefly, Delmarva fox squirrel, coastal plain swamp sparrow, and hundreds of others. The State is implementing a new comprehensive approach to wildlife conservation to keep common species common and healthy ecosystems healthy. The plan was developed with the participation of several Statewide conservation partners, which included refuge staff.

The plan identifies 457 species of greatest conservation need and 50 different types of habitats. Habitats of conservation concern are highlighted in yellow in chapter 3 and featured as key wildlife habitats. These habitats are rare and under-represented within the State's landscape, have special significance in Delaware, are particularly sensitive to disturbance, or have a high diversity of rare plants. Habitats with any of these factors are known, or expected, to harbor species of greatest conservation need, especially insects that are often dependent on specific host native plants.

Large blocks of unfragmented forests and wetlands were also designated as key wildlife habitats because of their importance to area-sensitive species, particularly invertebrates. A minimum size of 250 acres, criteria established by the State for the Delmarva conservation corridor demonstration program, has been used. Key wildlife habitats consist of any areas with species of greatest conservation need occurrences, habitats of conservation concern, forest blocks greater than 250 acres, and wetland blocks greater than 250 acres.

The Delaware Wildlife Action Plan identified and summarized 90 different conservation issues affecting State species or habitats of conservation concern. Implementation steps have included listing 230 different conservation actions to remedy these conservation issues. We have relied heavily on the plan and conferring with our State partners when developing habitat objectives and management strategies during the CCP process. We have incorporated State information in the development of this document, and will continue to coordinate conservation actions for both plans (Delaware Wildlife Action Plan and refuge CCP) in the future.

Sussex County Comprehensive Plan

The Sussex County comprehensive plan update, a 5-year plan that outlines Sussex County's vision for itself in the future and how best the county and its people can make that vision a reality, was adopted June 24, 2008, and certified by Governor Ruth Ann Minner on October 27, 2008. This plan considers parks, natural areas, forests, wildlife habitats, greenways, and waterways as important components of Delaware's quality of life. The objective of the strategies in the revised plan is to direct new growth toward existing communities and avoid unplanned sprawl and loss of open space (*www.sussexcountyde.gov/*; accessed January 2012).

The conservation element of the Sussex County plan has the stated goal of "protecting critical natural resources by documenting their locations and developing growth management strategies that limit development in these areas." This chapter of the plan describes State ownership (5 parks, 8 wildlife management areas, 19 ponds, nature preserves, and cultural sites), Redden State Forest, and Federal lands (Prime Hook NWR) in Sussex County, which collectively define the excellent examples of Delaware's remaining natural and cultural heritage. These include productive wetlands, mature forests, rare plant and animal habitats, geological and archeological sites, and open space for recreation and greenway connectors.

Sussex County's open space program has multiple sources of funding targeted to protect additional acres planned for natural resource area protection. Seven resources areas have been delineated with proposed acreage add-ons. The

program activity in the plan's summary identifies 42,259 acres as currently protected and an additional 44,441 acres to be included in the future. Topping the list is the Prime Hook area, which is currently listed as 11,668 acres protected with a proposed addition of 14,678 acres. Three other areas (Ellendale/Redden, Great Cypress, and Nanticoke River additions) have important implications for the Service and the Delaware Division of Fish and Wildlife's joint venture of developing a proposed endangered species habitat conservation plan for Sussex County for the Delmarva fox squirrel.

Broadkill River Watershed Pollution Control Plan

Water quality assessments performed by DNREC have shown that more than 90 percent of Delaware's waterways are considered impaired. For example, 2,506 miles of rivers and streams have been tested for water quality attainment, and 2,490 miles have been documented as impaired. Likewise, 2,954 acres of lakes, ponds, and reservoirs have been tested Statewide, and 2,796 acres were found to be impaired. Impaired waters are deemed polluted waters that could be suffering from excess nutrients, low dissolved oxygen, toxins, bacteria, or any combination of these problems.

The most common impairments in Delaware are pathogens and nutrients (nitrogen and phosphorus). The majority of impairments come from hard-to-control nonpoint sources. Sources of impairments in the State are agricultural runoff, municipal (urbanized, high-density areas) impervious runoff, land disposal, decentralized septic systems, municipal point source discharges, industrial point discharges, Resource Conservation and Recovery Act hazardous waste sites, and combined sewer overflows (National EPA Assessment Database for State of Delaware Year 2002; available at: *http://iaspub.epa.gov/waters10/w305b_report_v2.state?p_state=DE*; accessed January 2012).

Impervious cover, such as blacktop and concrete, prevents water from permeating the ground. Many scientists look to impervious percentages as an indicator of water health. Research has consistently shown that once a watershed exceeds a threshold of 10 percent imperviousness, water and habitat quality irreversibly decline (Broadkill watershed land-use trend data at: *http://broadkill.ocean.udel.edu*; accessed January 2012). Currently, the Broadkill River watershed's impervious cover is 6.7 percent, but DNREC notes that surface waters are already impaired within the watershed. During a 10-year period from 1992 to 2002, there was a 40.2 percent increase in residential development, while agricultural and forested land area each decreased by 7.1 percent during this same period.

Wetlands are estimated to occupy about 16,000 acres of the watershed's land base. These include 8,361 palustrine acres, 6,786 estuarine acres, 539 lacustrine acres, and 146 riverine acres. Prime Hook NWR contributes approximately 8,000 acres of wetland habitats to the watershed total. Wetlands are critically important for helping achieve water quality standards and are useful for reducing nonpoint source pollutants. The Town of Milton is the urban center of the watershed with small portions of the city of Lewes and the Town of Georgetown lying on the outer edges of the watershed boundary. Protecting the natural resources and the water quality of the Broadkill River watershed is currently being addressed by the State and local governments and citizens.

As the problem is very complex, DNREC and the University of Delaware Sea Grant Program have coordinated a group of stakeholders (refuge is a participant in this process) to develop a comprehensive Broadkill River pollution control plan. Section 303(d) of the Federal Clean Water Act requires states to develop a list (303(d)-List) of waterbodies for which existing pollution control activities are not sufficient to attain water quality criteria and to develop total maximum daily loads (TMDLs) for pollutants causing impairments. A TMDL sets a limit on the amount of pollutant that can be discharged into a waterbody and still protect healthy water conditions. DNREC has listed the Broadkill River on

several of the State's 303(d) listings and has set various TMDLs regulating nitrogen, phosphorus and enterococcus bacteria (section 7418–Total TMDLs for the Broadkill River Watershed DNREC 2004, *http://broadkill.ocean.udel.edu*; accessed January 2012).

Other Scientific Information Guiding the Project

Sea Level Affecting Marshes Model (SLAMM)

The Service is addressing the potential for significant changes that will be felt by all coastal refuges due to climate change and sea level rise. A comprehensive modeling effort using what is called the SLAMM has been used to generalize gross effects of sea level rise on coastal national wildlife refuges. SLAMM was first developed by the EPA in the 1980s (Park et al. 1986) and attempted to simulate the dominant processes (inundation, erosion, overwash, and saturation) involved in wetland conversion and shoreline modification from long-term sea level rise in an effort to predict future land cover changes in response to sea level rise. The model has been continuously refined and updated; the results incorporated into this planning effort used SLAMM version 5 in 2007. An updated version of SLAMM (6.0.1) is now available, but was not available at the time the analysis was completed for the refuge. However, the refuge analysis did use high-resolution elevation data not typically utilized for applications of SLAMM at that time (Scarborough 2009). The limitations of the modeling analysis conducted in 2009 are acknowledged in Scarborough 2009, below, and elsewhere in the CCP. Although modeling data should be considered with caution, as high levels of uncertainty and unforeseeable factors can significantly alter model output projections and habitat predictions for the future, the results of this modeling effort can give us a general sense of how climate change and sea level rise will likely affect refuge habitats in the future. The potential land cover changes predicted by the SLAMM modeling are incorporated into the discussion of the existing environment (chapter 3) and were considered in the development of management objectives and strategies (chapter 4). However, these modeling results are certainly not the primary factor driving proposed changes in shoreline and wetland management regimes on the refuge, as the refuge increasingly has current locally collected data to rely upon.

Prime Hook NWR was included in an initial SLAMM simulation of the Chesapeake Bay region contracted by the National Wildlife Federation in 2008. SLAMM model accuracy depends on available elevation data. Because the 2008 report used very coarse elevation measurements (5-foot contours), the results provided minimal information containing questionable value for the refuge. Therefore, a second SLAMM simulation for Prime Hook NWR was conducted by the Delaware Coastal Program (Scarborough 2009). The simulations done by the Delaware Coastal Program used Light Detection And Ranging (LiDAR) data with a vertical accuracy better than 15 cm, or less than 6 inches, which is a significant improvement over the 2008 simulation. The results of this modeling effort show 2007 conditions, and project future conditions in 2025, 2050, 2075, and 2100 (Scarborough 2009).

In the 2009 SLAMM modeling effort, two sea level rise conditions were used as inputs, representing the range of predicted local sea level rise levels (0.50 meters and 1.0 meters). The SLAMM model does not incorporate a dynamic accretion rate that changes with varying sea level rise, which could influence and possibly improve the ability of the wetlands to keep pace with sea level rise. Delaware salt marshes generally have been keeping up with the rate of sea level rise over the past century, but it is uncertain whether the marshes may experience increasing accretion rates as sea level rise occurs. Therefore, two rates for the accretion of salt marsh were used in model simulations: 3.1 mm/year, which represents keeping pace with current sea level rise, and 5.0 mm/year, which represents an increase in accretion rates in response to increased sea level rise. Tidal range was also incorporated into the model at two levels. A 50 percent coastal tide value (0.79 m) approximates the tidal range at the refuge's wetland complex at the

time the modeling was conducted in 2007, and assumed that the bay dunes would remain intact. The 100 percent coastal tide value (1.58 m) assumes the expansion of the existing dune breaches along the bay front so that the full tidal range of the bay occurs in the refuge's impoundments. The model used these estimated minimum and maximum input values, assuming that the actual values will probably fall somewhere within those ranges.

By the year 2050, the SLAMM 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 percent to, at most, 12 percent 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 1 meter in the next 100 years, the impact will be much greater on the refuge. By the year 2050, open water and mudflats are predicted to constitute 26 percent of the refuge under conditions that would allow marshes to build at high accretion rates; up to 58 percent of the refuge would covert to open water or mudflats under the condition of low accretion rates. Under the worst case scenario, by the year 2100 up to 88 percent of the today's refuge could be open water or tidal mud flats and only 1 percent for the refuge would be uplands. Predicted land cover changes under each sea level rise scenario are fairly similar with or without the bay dunes remaining intact. Although these long-term predictions are helpful for refuge planning, it is worth noting that as conditions on the refuge change in the predicted manner, the ability of the refuge to manage wetlands through water level manipulation and exclusion of saltwater from impoundments will be lost long before the full effects of the sea level rise impact are realized. The full SLAMM modeling report (Scarborough 2009) can be found at: *http://www.dnrec.delaware.gov/coastal/Documents/PHNWR%20SLAMM.pdf* (accessed August 2012).

NatureServe: Terrestrial Ecological Classifications, Vegetation Alliances, and Associations of Prime Hook NWR

The inventory and creation of vegetation mapping of the Prime Hook NWR was conducted during the pre-planning and planning phase of this CCP. The Refuge System planning policy notes that all Federal agencies are required to comply with data standards established by the Federal Geographic Data Committee. The policy comments on the use of two standards important to refuge planning: National Vegetation Classification Standard (NVCS) and Classification of Wetlands and Deep Water Habitats (*http://www.fgdc.gov*; accessed January 2012).

The Service contracted with the Delaware Natural Heritage Program (DNHP) and NatureServe to develop vegetation cover maps of Prime Hook NWR for the CCP. The NVCS classifies vegetation on a national scale for the U.S. and is linked to an international vegetation classification. NVCS for terrestrial vegetation is classified within a nested, seven-level hierarchy of plant communities. The finest floristic unit of the classification standard is called the association, characterized by diagnostic species of vegetation. An alliance represents an aggregation of associations that share at least some primary dominant species. NatureServe completed a NVCS vegetation alliances and associations report of refuge cover-types in December 2006, which complemented the refuge-mapping project undertaken by DNHP. NatureServe resolved some classification problems of several communities unique to Prime Hook NWR that were not adequately described in previous community keys.

The NatureServe report included vegetation descriptions and global conservation rankings for natural communities that were found on the refuge. These vegetation coverages included 5 NVSC classes and 38 alliances and associations. Eight associations were ranked globally rare (G2 and/or G3) with distinctive native plant assemblages and unique vegetation communities restricted to the Coastal Plain of the Mid-Atlantic. This data and information has been used in the development of this CCP document. The maps can be found in chapter 3 and in the habitat management plan in appendix B.

Natural Heritage and Endangered Species Program (DNREC): Final Report on Botanical Zoological and Natural Community Surveys for Prime Hook NWR

The primary focus of botanical surveys at Prime Hook NWR was to locate and identify State and Federal rare plant species within refuge boundaries. Surveys in 2004 and 2005 focused on a variety of upland and wetland habitat types and built upon work conducted by the Delaware Division of Fish and Wildlife in the past. All rare plant species discoveries were Global Positioning System (GPS)-located with detailed habitat and population notes recorded. In addition, trees of exceptional size (as compared to State records) were documented, an extensive general Prime Hook NWR flora list was catalogued, zoological surveys were conducted for reptiles, amphibians, and rare insects and management recommendations for protecting and enhancing habitat occupied by rare species and/or unique plant communities were detailed (McAvoy et al. 2007).

Notable rare and unique communities found at the refuge included Atlantic white cedar/seaside alder, red maple/seaside alder woodlands, slender seaside purslane *(Sesuvium maritimum)* community, and a peat mat community. The twig-rush peat mat community is extremely rare in Delaware and on the East Coast and contains the largest array of the rarest plant species of any community mapped on the refuge. It is a distinctive community that forms in open-water depressions, impoundments, and seeps within a freshwater shrub-dominated swamp matrix. Prime Hook NWR NVCS mapping and community survey data were used to develop habitat objectives and associated management strategies during the CCP planning process (McAvoy et al. 2007).

Maryland, Delaware New Jersey GAP Project

Gap analysis provides an overview of the distribution and conservation status of several components of biodiversity. There are five major objectives of the national GAP analysis program:

- Map actual vegetation as closely as possible to the alliance level.
- Map predicted distribution of animals, habitat associations, and habitat variables.
- Document occurrence of vegetation types that are inadequately represented (GAPS) in special management areas.
- Document occurrence of animal species that are inadequately represented (GAPS) in management areas.
- Make all information available to resource managers and land stewards in a readily accessible format.

The Maryland-Delaware-New Jersey Gap Analysis Project (MDN-GAP) involved a 10-year effort of researchers from various government natural resource agencies and universities in all three states, with the bulk of the work and project administration carried out by the Service, Delaware Bay Estuary Project, University of Maryland Eastern Shore, USGS–Biological Resources Division Gap Analysis Program and the New Jersey Department of Environmental Protection. The three-state project area includes a complex mixture of habitats, ranging from coastal beaches and estuarine tidal marshes to upland forests and bogs, and human-dominated urban and agricultural landscapes.

Data from the project was used to develop maps to conduct refuge habitat analysis discussions during CCP public and technical meeting forums. Maps were developed at three scales: refuge-specific (10,000 acres), Statewide (1.3 million acres), and an intermediary-scale of an immediate impact zone surrounding the refuge (88,000 acres). The impact zone map encompassed acreage from

two watersheds where Prime Hook NWR is located: the Mispillion River and Broadkill River watersheds.

Habitat analysis layers depicted on these maps were derived from several sources, including the MDN-GAP project, National Wetlands Inventory Data, and National Land Cover Data set developed by the EPA. Approximately 100 habitat classes were clumped into 10 habitat-types, providing a coarse-filter analysis across all three scales. These habitat-types included: upland herbaceous, upland shrub, upland forest, wetland herbaceous, wetland shrub, wetland forest, sparsely vegetated, aquatic, agricultural, and urban. Impact zone maps also depicted municipal boundaries, State agricultural preservation districts, and agricultural easements (appendix A).

Delmarva Fox Squirrel Recovery Plans

The Delmarva Peninsula fox squirrel *(Sciurus niger cinereus)* was listed as federally endangered in 1967 because of concerns for a reduction in its distribution to only 10 percent of its historic range. There have been three recovery plans written for this subspecies with the most recent completed in 1993. The recovery plans emphasized two action objectives: identify critical Delmarva Peninsula fox squirrel habitat requirements and translocate Delmarva Peninsula fox squirrel into suitable habitat outside occupied areas within their historical range. The range of the Delmarva Peninsula fox squirrel has expanded since the 1993 recovery plan, as the squirrel is now considered likely to occur in approximately 25 percent of the Delmarva Peninsula. This expansion has occurred through 11 successful translocations, of which one was on Prime Hook NWR.

By 1995, the refuge translocations were deemed successful as per the recovery plan definition, (i.e., a new reproductive population established on the release site had persisted for at least 5 years and increased beyond the original group size; the founder population at Prime Hook NWR was 15 individuals). Refuge management recommendations by the recovery team in 1995/1996 emphasized the need to augment the current Delmarva Peninsula fox squirrel refuge population with additional translocations, reforest fallow fields to add to the refuge's base acres of forested upland habitat, and conduct a population viability analysis to estimate the minimum viable population needed to prevent inbreeding, problems of genetic drift, and loss of heterozygosity, and then manage accordingly.

Today, the effective Delmarva Peninsula fox squirrel population size on Prime Hook NWR is very small, estimated at approximately 15 squirrels. The population size has remained small even after three decades of persistence with minimal recruitment. The chronically small population size of squirrels within refuge boundaries contributes to unmitigated inbreeding depression and genetic drift and is a major conservation concern. Limited recruitment coupled with small population size negatively affects long-term survival of the squirrels on the refuge.

Currently, new data and a population viability analysis are available. The analysis was constructed for Delmarva Peninsula fox squirrel that developed a basic model using estimates of life history parameters to identify the minimum viable population. Under model scenarios, analysis suggests that a population with 65 females or 130 animals has a less than 5 percent chance of extinction in 100 years. Using an average density calculated 0.3 squirrels/acre, 435 acres are needed to minimally support 130 Delmarva Peninsula fox squirrel. The analysis estimates that a contiguous 435-acre block could establish a minimally secure population. We have used this information when developing refuge habitat objectives and future conservation strategies for endangered species management on the refuge.

Other Recovery Plans

Atlantic Coast Piping Plover Recovery Plan
Federally threatened piping plovers use the refuge during spring and fall migrations. Up to half a dozen piping plovers have been observed using refuge impounded marsh habitats during late August and September. Nesting has not yet occurred on refuge beaches, but an increase in overwash habitats is occurring in our Unit I salt marsh management area. State endangered species personnel and refuge staff conduct periodic shorebird surveys and are alert to piping plover nesting possibilities, and will follow standard protocol if nesting occurs.

In 1996, a revision was made to the original 1988 Atlantic Coast piping plover recovery plan (USFWS 1996). The primary objective of the revised recovery program is to remove the piping plover population from the List of Endangered and Threatened Wildlife and Plants. The plan hopes to do this by achieving well-distributed increases in numbers and productivity of breeding pairs and providing for long-term protection of breeding and wintering plovers and their habitat. The strategies within the plan provide for the ensured long-term viability of piping plover populations in the wild. Documented piping plover breeding sites in Delaware occur immediately south of the refuge.

In Delaware for the past 17 years, a range of 8 to 12 pairs have successfully fledged young and DNREC has been working to halt the species' population decline by adopting a State piping plover management plan, implemented by the Division of Parks and Recreation, Division of Fish and Wildlife, and Division of Soil and Water Conservation. We have incorporated both the Atlantic Coast piping plover recovery plan and State plan information into this CCP document and will coordinate with the State in all Delaware conservation actions to manage and monitor piping plover use of the refuge.

Chesapeake Bay Region Bald Eagle Recovery Plan
National improvements in bald eagle recovery have led to Federal delisting, though eagles are still protected by the Migratory Bird Treaty Act and Bald and Golden Eagle Protection Act; and are still listed as State endangered in Delaware. The first successful bald eagle pair fledged two young on the refuge in 1993. This pair uses several nests they have constructed through the years in Unit II, and has continued to produce young in recent years. During winter 2006, a second pair established a nest near the headquarters area in Unit III and successfully fledged three young in fall 2006, although nesting activity has been inconsistent each year since then. We have also incorporated the guidelines of the Chesapeake Bay Recovery Plan and the Service's and State's bald eagle management guidelines in this document when developing habitat conservation strategies and managing public use to protect bald eagles.

Archaeological, Historical, and Geomorphological Study of Prime Hook NWR
The Service, Region 5 contracted with Tetra Tech FW, Inc., to provide a set of interrelated studies of Prime Hook NWR, including lands within its acquisition boundary that have not yet been acquired. The resulting effort fulfilled the Service's responsibilities to cultural resources under the National Historic Preservation Act (P.L. 102-575, Sec. 110), NEPA (P.L. 91-190), and Department of the Interior-Service regulations. The archaeological, historical, and geomorphological study of the refuge provided a comprehensive background of data and analysis to improve our understanding of the refuge's prehistory and history, and assist in both visitor interpretation and long-term management of cultural resources.

NEXRAD (Radar) Data Of Critical Stopover Habitat For Songbirds Along The Delmarva Peninsula.
The New Jersey Audubon Society and Service partnered on a project in fall 2003. With the goal of developing products that would assist land acquisition and management strategies to conserve stopover habitats used by songbirds during migration passage through the Delmarva Peninsula. This project was unique

because of its methodological approach and operational scale. The National Weather Service's Doppler weather surveillance radar system was used to delineate the spatial distribution of songbird migrants.

The objectives of the project were to use the radar data identify areas that contain high rates of occupancy; investigate relationships between high-use stopover sites and specific habitat types and landscape features; determine spatial congruence between season-specific stopover occupancy models; and identify specific songbird species or species groups involved in migration events during passage through the Delmarva Peninsula (Mizrahi 2006).

Flight call recording systems were installed at both Prime Hook NWR and Blackwater NWR during the spring (April 3 to June 6) and fall (July 24 to November 15) 2003 migrational periods. We applied and utilized significant refuge songbird use with species identification and correlated habitat use data in this CCP when we developed migratory songbird conservation strategies and associated habitat objectives.

Neotropical Migratory Songbird Coastal Corridor Study

This study examined the distribution and habitat associations of fall migrating landbirds within the coastal regions of four states along the Atlantic Coast (McCann et al. 1993). These states of New Jersey, Delaware, Maryland, and Virginia make up the Cape May and Delmarva peninsulas. These two areas are well-known for their contribution of stopover habitat for migratory birds. The study revealed that neotropical migrants are not randomly or evenly distributed over the Cape May and Delmarva peninsulas during stopover, but rather are concentrated in particular geographic areas within the region.

More specifically, the study suggested that migrant birds are more abundant in areas close to the coastlines than in equivalent areas farther from the coast. Other distribution patterns discerned were that bay coastal zones have higher densities of migrants than seaside coastal zones or interior regions; migratory songbirds are more abundant on barrier islands than the coastal mainland, and migrants are associated with particular habitats on a species-specific basis. The refuge used this information in developing habitat objectives and strategies and shaping various alternative scenarios. We also assimilated and dove-tailed the habitat objectives and conservation strategies for migratory songbirds of other refuges within the coastal Delmarva Peninsula corridor that have completed CCPs.

USGS Visitor and Community Frequency Results Report for Prime Hook NWR

Refuge-specific visitor use and community opinions research was conducted by the Policy Analysis and Science Assistance Branch of the USGS/Fort Collins Science Center. This report summarized community and visitor surveys conducted at Prime Hook NWR in fall 2004 through fall 2005, and its purpose of this study was to determine how current and future CCP planning strategies for the refuge could affect visitor use, experiences, and spending, and community residents' perceptions and opinions about the refuge. Much of the research results have been included in chapter 3 of this document and were also used in developing visitor management objectives.

State Comprehensive Outdoor Recreation Plan

Delaware's State Comprehensive Outdoor Recreation Plan (2003 to 2008) identifies State and individual counties' outdoor recreation needs and issues and provides recommendations on how to meet those needs. The State Comprehensive Outdoor Recreation Plan also maintains Delaware's eligibility to receive Federal Land and Water Conservation Fund grants and is also required by the Delaware Land and Conservation Trust Fund Act. The plan directs funding for both grant sources into open space acquisition and facilities that best meet Delaware's outdoor recreational needs.

In order to remain eligible to receive Land and Water Conservation Fund grants, states are required by the National Park Service to develop an outdoor recreation plan every 5 years. We have incorporated much of the plan's information into the refuge's visitor service objectives and public use strategies to complement some of the State's recreational needs and programs.

Existing Refuge Operational Plans

Step-Down Management Plan

The Service Manual (602 FW 4, Refuge Planning Policy) lists more than 25 step-down management plans that may be appropriate to ensure safe, effective, and efficient operation on every refuge. These plans contain specific strategies and implementation schedules for achieving refuge goals and objectives. Some plans require annual revisions; others are on a 5- to 10-year revision schedule. Some require additional NEPA analysis, public involvement, and compatibility determinations before they can be implemented.

Two step-down plans will be available in conjunction with the CCP:

- Habitat management plan (HMP) (2012) (appendix B)
- Hunt plan (2012) (appendix C)

The following plans are available, but need updating. Listed below are those plans and the anticipated revision dates.

- Inventory and monitoring plan (2013)
- Fishing plan (2013)
- Law enforcement plan (2013)
- Visitor services plan (2014)
- Animal damage control plan (2014)
- Furbearer management plan (2014)

The following step down plans are complete and/or updated annually:

- Safety plan (2009)
- Avian influenza plan (2008)
- Hurricane action plan (updated annually)
- Fire management plan (2009)

Formulating Alternatives Using Refuge Resources of Concern and Focal Species Management

Defining Refuge Resources of Concern and Management Priorities

As described in the Service's policy on habitat management planning (620 FW 1) resources of concern are defined as:

> *All plant and/or animal species, species groups, or communities specifically identified in refuge purpose(s), [Refuge] System mission, or international, national, regional, State, or ecosystem conservation plans or acts. For example, waterfowl and shorebirds are a resource of concern on a refuge whose purpose is to protect migratory waterfowl and shorebirds. Federal or State threatened and endangered species on that same refuge are also a resource of concern under terms of the respective endangered species acts.*

Habitats or plant communities are also resources of concern when they are specifically identified in refuge purposes, when they support species or species

groups identified in refuge purposes, when they support Service trust resources, and/or when they are important in the maintenance or restoration of BIDEH (USFWS 2007b).

We used the process outlined in Identifying Refuge Resources of Concern and Management Priorities: A Handbook (USFWS 2007a) to develop the refuge's management goals and objectives for the CCP and HMP. The handbook draws from legislative mandates, Service and Refuge System policies, manuals, and Promises recommendation reports. This process enabled us to:

- Meet our specific legal mandates as directed in statute and policy.
- Determine resources of concern and management priorities specific to the refuge using focal species management strategies.
- Contribute to wildlife and habitat priorities at all scales.

This process of identifying refuge resources of concern entailed analyzing specific planning steps divided into three stages that included various action items. These three planning stages encompassed the following tasks:

(1) Understanding refuge-specific management mandates.
   - *Action 1: Identify refuge purposes.*
   - *Action 2: Identify Service trust species.*
   - *Action 3: Identify refuge-specific elements of biological integrity, diversity, and environmental health.*

(2) Identifying resources of concern and management priorities on the refuge.
   - *Action 4: Compile a comprehensive list of resources of concern.*
   - *Action 5: Filter out focal species, consider site capabilities, response to management, and expert analysis, and then list priority resources of concern.*
   - *Action 6: List priority habitats.*

(3) Establish final assumptions for the future direction and management agenda for the refuge.
   - *Action 7: Write goals.*
   - *Action 8: Write objectives.*

Focal Species Management

To understand the above process and how it was incorporated into our CCP effort, the idea of focal species management and the definition of focal species must be appreciated. A focal species is a species or group of species (guild) that is directly targeted for conservation and habitat management actions. The selection of focal species is associated with important habitat elements or ecosystem attributes of identified species with the greatest and most urgent conservation needs. These needs are based on the Service's BCC (2008), national, ecoregional, and regional plans, and the State of Delaware's Wildlife Action Plan.

Focal species for the refuge have been determined to be those specific species requiring immediate conservation action due to declining populations and other factors. Vulnerability to threats has limited the life history requirements needed to ensure their persistence into the future. Once identified, these species were used to define our habitat management objectives, strategies, and conservation actions contained in this CCP.

The use of focal species facilitated the complex tasks of writing habitat objectives for refuge purpose species (e.g., migratory birds and endangered species) and other Service trust species (e.g., interjurisdictional fish), while incorporating legal mandates of maintaining and enhancing BIDEH on refuge lands.

Identifying focal species served as a shortcut to simplify dealing with a huge list of wildlife species (birds, native plants, insects, fish, reptiles, amphibians, etc.) that currently reside or seasonally use the refuge, and focus habitat management objectives on a shortened list of migratory birds and other wildlife species.

For example, there are over 900 species of migratory birds in North America that are trust species for the Service. The Service's national focal species strategy in its strategic migratory bird management plan (2004 to 2014) has shortened this list to 412 focal bird species. The selection of focal species is a subset of the bird species protected by the Migratory Bird Treaty Act. In 2008, the Service's BCC list narrowed to 139 focal species, targeted for conservation actions based on declining trend data. This list and other ecoregional and State plans, these lists reduced our CCP and HMP biological planning efforts to 45 refuge focal bird species and 4 focal bird guilds. These bird focal guilds and species are listed below.

Refuge Focus Guilds

- Fall migrating and wintering dabbling ducks
- Spring migrating dabbling ducks
- Migratory landbirds
- Migratory shorebirds

Refuge Focal Bird Species

- American oystercatcher
- Sanderling
- Whimbrel
- Wood thrush
- Black-and-white warbler
- Yellow-throated vireo
- Kentucky warbler
- Great crested flycatcher
- Northern flicker
- Bay-breasted warbler
- Bald eagle
- Acadian flycatcher
- Prothonotary warbler
- Black rail
- Clapper rail
- Least tern
- Gull-billed tern
- Black skimmer
- Willet
- Sharp-tailed sparrow
- Seaside sparrow
- Coastal plain swamp sparrow
- American black duck
- Snow goose
- Virginia rail
- Forster's tern
- Least bittern
- American bittern
- Piping plover
- Dunlin
- Short-billed dowitcher
- American avocet
- Greater yellowlegs
- Lesser yellowlegs
- Prairie warbler
- Blue-winged warbler
- Brown thrasher
- Willow flycatcher
- Eastern towhee
- Field sparrow
- Northern bobwhite
- Henslow's sparrow

The focal species approach was then used to write CCP and HMP wildlife and habitat objectives that linked focal species to habitat management strategies and new conservation actions targeting these wildlife species. It is a multispecies management approach in which the life history and habitat structural requirements of focal species and guilds have been used to define the future management direction and desired conservation outcomes for the refuge, based on the best contribution the refuge makes to both State and regional landscape conservation scales.

In addition to migratory birds, we have included other focal species that include one federally endangered mammal species, four fish species, and four insect species. All focal species and guilds characterize the various NVCS habitat types mapped on the refuge that are also representative of a healthy Delmarva Coastal Plain ecosystem.

It should be noted that with the exception of snow geese, our conservation objectives in this CCP are to increase the population size of all focal bird species. However, due to the disproportionate negative impacts that overabundance of snow geese are having on the functioning of ecosystems on both the breeding and wintering grounds that are adversely impacting other waterfowl and shorebird species, our conservation objectives and strategies in this case are designed to decrease their population size and curtail their use of refuge habitats.

Targeting conservation actions to a few focal species, specifically in habitat management objectives, is made with the assumption that hundreds of other fish, wildlife, and native plant species will benefit (see appendix D–table D-6 for benefiting species list related to focal species and NVCS vegetation communities.) The total tally for the refuge of focal species (54) and guilds (5) includes the birds mentioned above and the following.

Other Refuge Focal Species

Endangered species
- Delmarva Peninsula fox squirrel

Fish
- Striped bass
- Alewife
- Blueback herring
- American eel

Invertebrate
- Beach dune tiger beetle
- Little wife underwing
- Long-horned beetle
- Maritime sunflower borer

The work products generated from the resources of concern handbook took more than 1 year to develop with input from State, Federal, private and local partners, and the public. The information provided was used in the developing of our goals and habitat objectives for the CCP and subsequent step-down plans that reflect the conservation needs of these focal species. The first product that served as the foundation for subsequent products or tables was a comprehensive list of biological resources found on the refuge. A species matrix was then developed of these potential refuge resources of concern and how they ranked on a State, regional, and national scale (see appendix D).

Other products included summary tables describing all current elements of biological integrity, diversity, and environmental health for each of the natural habitat types found on the refuge. Four tables were generated that describe specific habitat attributes and natural processes responsible for current habitat conditions representing the elements of biological integrity, diversity, and environmental health for barrier beach island, forested upland, wetland forest, and emergent wetland habitats and their associated focal species (appendix D–tables D-1 to D-4).

The next product was a habitat management prioritization table that identified refuge NVCS habitat priorities, listed reasons for their rankings, and described limiting factors and threats that would hinder the conservation of these resources of concern (appendix D–table D-5).

The last resources of concern product was a final comprehensive list of the priority resources of concern for Prime Hook NWR that identified the specific focal species or focal group with associated prioritized habitat-types, their life history and habitat requirements, plus other benefiting wildlife species that would profit by managing for a specific focal species or focal group (appendix D–table D-6).

When reviewing table D-6 within appendix D, it should be noted that some focal species have also been chosen as "umbrella" and "indicator species". 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, 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 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, saving 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 ongoing 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.

Chapter 3

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Seaside sparrow

Refuge Resources

- Introduction
- Refuge Management Units
- Physical Environment
- History of Vegetation on and Around the Refuge
- Prehistoric Climatic Influences on Delmarva Landscape Vegetation
- Refuge Vegetation Resources
- Influence of Climate Change on Physical Environment and Refuge Management
- Biological Resources of Delaware Bay Estuary
- Refuge Biological Resources
- Socioeconomic Environment
- Refuge Administration

Introduction

We begin this chapter with a brief description of the refuge management units to provide a context for the discussions that follow. Then we describe the surrounding physical environment, which includes the refuge's geographic setting, its hydrogeomorphic features, soil information, and air and water quality. Next we describe the role of prehistoric and historic climatic influences, cultural setting and land use history in and around the refuge. We also review Delaware's remaining natural habitats and the historic context of the refuge's wetlands as they have been influenced by human activity and management. We finish the description of the physical environment by summarizing the vegetation communities on the refuge.

Rapid climate change is proving to be the defining conservation issue of the 21st century, and climate change adaptation strategies used by the refuge must anticipate an increasingly different physical environment than the one we have managed in the 20th century. To that end, this chapter also contains extensive reviews of the relevancy of global climate change, sea level rise, local coastal storm activity, refuge shoreline dynamics, and vulnerability assessments of some of the refuge's coastal habitats. These factors influence the physical environment of the refuge, but also are directly related to the conservation and management of the refuge's fish, wildlife, and plant resources in the near future. We also investigate, throughout the remaining chapters of this CCP, how sea level rise is likely to affect the refuge's wetland habitats and clarify how managing for and facilitating ecological transitions in the refuge's physical environment will be an increasingly significant part of our adaptation to climate change.

Next we represent the biological environment of the surrounding area. We describe the biological resources within the context of the Delaware Bay Estuary, associated with the current condition of the refuge's plant and animal populations. We also map out the different vegetation communities found on the refuge and their associated rare plant species relationships. We end with an analysis of the socioeconomic environment of the refuge, including the economic benefits of refuge visitation to local communities and refuge administration details.

Refuge Management Units

The refuge can be described as an elongated coastal strand covering 10,144 acres that lies parallel to the Delaware Bay. For management purposes and to facilitate understanding of the descriptions of habitats and biological resources within management areas, Prime Hook NWR is divided into four management units delineated by four State roads which transect the refuge and run perpendicular to the bay (map 1-1).

UNIT I. 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 Beach Road on the south, and an upland fringe of scrub-shrub areas on the western boundary. There is currently no water level management capability in Unit I, which contains about 1,400 acres of salt marsh. Tidal saltwater is the primary source of water for the unit, which flows approximately two miles from the Delaware Bay through the Cedar Creek at the Mispillion Inlet and into Slaughter Canal. An overwash formed on the coast of Unit I in 2006, creating a small inlet, creating more direct flow of saline bay water into Unit I.

UNIT II. This management unit is just south of Unit I. It is bounded by Fowler Beach Road on the north, artificial barrier dunes and a sand dike connected to the Prime Hook beach community on the east, Prime Hook Road on the south, and an upland interface on the west. During storm tides, this sand dune system has been breached several times and washouts have deposited sand and saltwater into the Unit II impoundment.

UNIT III. 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. Unit III consists of roughly 3,600 acres, which include impounded freshwater emergent marsh, red maple-seaside alder swamp, low-lying farmed areas, brush, barrier beach on the east, and 140 acres of flowage easement 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.

UNIT IV. Management Unit IV is surrounded by Route 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. The majority of water and tidal action associated with Unit IV is provided by the Broadkill River, whose salinity ranges from 10 to 30 ppt. Prior to Service ownership, this marsh had been excessively drained by man-made ditches. Rainfall and runoff from Unit III are other sources that provide freshwater. Due to the strong influence of the Broadkill River, this impounded area has a more brackish character with salinities ranging from 5 to 20 ppt.

Further details regarding the soils, hydrological features, wetland and management history, and vegetation of each of these four management units are provided later in this chapter.

Physical Environment

Geographic Setting

The refuge is located in Sussex County, Delaware, within the Atlantic Coastal Plain Province, along the southwestern shore of the Delaware Bay. It is part of BCR 30, which encompasses the New England/ Mid-Atlantic Maritimes and the PIF Physiographic Region 44. Prime Hook NWR is one of two refuges of the Coastal Delaware NWR Complex. The refuge was established in 1963 and historically consisted of tidal marshes and agricultural lands that were grazed by cattle. The landscape surrounding the refuge was dominated by small farms producing vegetables and small grains. From the 1990s to present day, beach and residential development and intensive agricultural operations (corn, soybean, and poultry production) are the dominant land uses bordering the refuge.

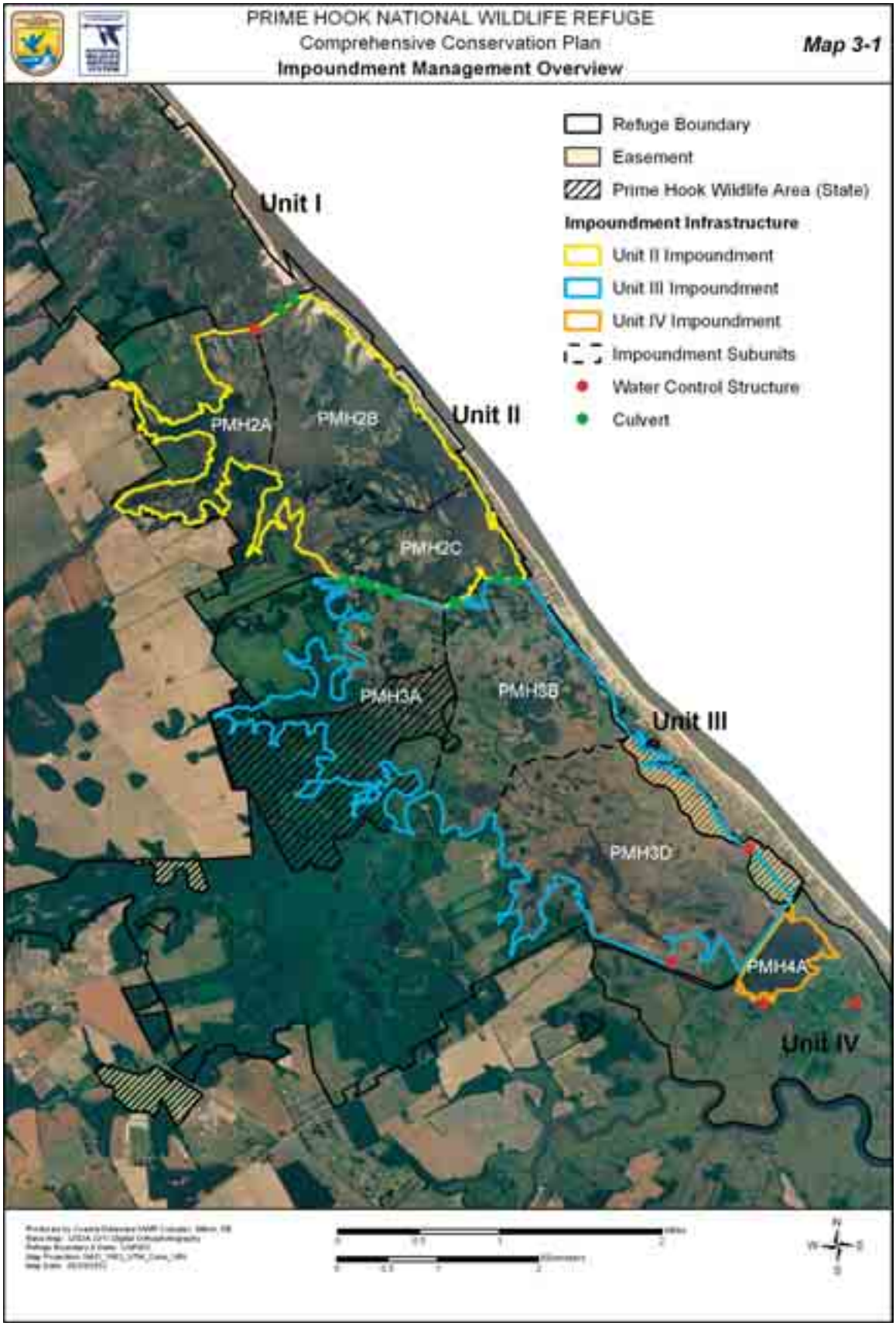
The four roads that bisect the refuge have significantly altered the hydrology and other ecological processes of the refuge's wetland habitats. The two interior roads, Fowler Beach and Prime Hook roads have the greatest hydrological impacts on the refuge's impounded marsh complex and management actions. These roads, with their associated culverts and water control structures located in Units II, III, and IV, are directly linked to the refuge's water level management capabilities (map 3-1).

The refuge is representative of the natural vegetation of the Delmarva Coastal Plain ecosystem which is dominated by emergent wetlands interspersed with swamp and forested upland, grasslands and open water habitats. Eighty percent of Prime Hook NWR's vegetation cover types are shaped by tidal and freshwater creek drainages that discharge into the Delaware Bay with associated coastal barrier island habitats. The remaining 20 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 (map 3-2).

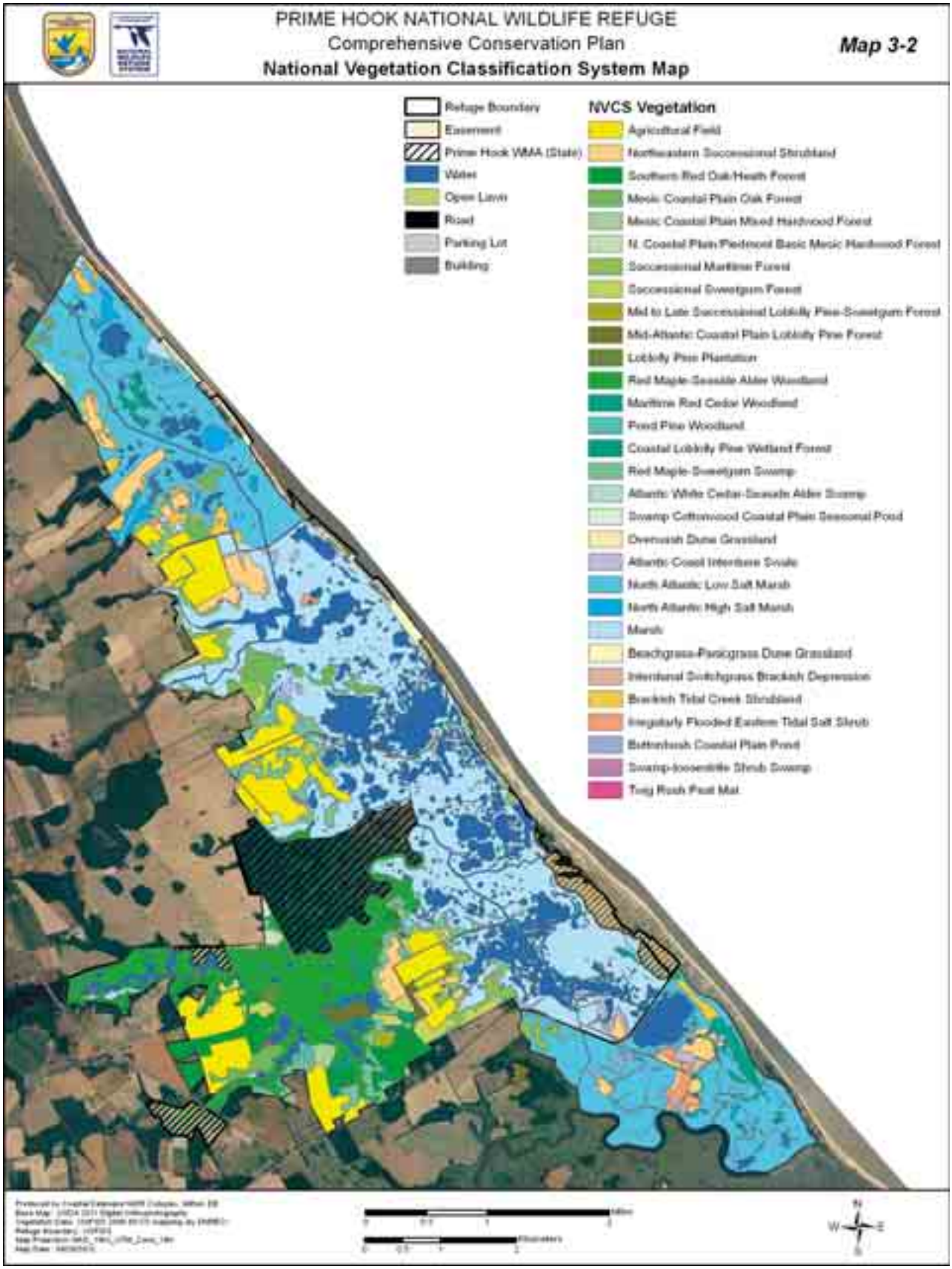
Other natural wildland habitats and managed wetlands immediately adjacent to or near Prime Hook NWR include:

- The Great Marsh (1,000 acres of salt marsh, owned by the town of Lewes) located just south of the refuge.
- Milford Neck Wildlife Management Area (WMA) (5,459 acres), 3 miles north of the refuge above Mispillion Inlet.

Map 3-1. Impoundment Management Overview



Map 3-2. Vegetation Community (NVCS) Overview



- Ted Harvey Conservation Area (2,661 acres), 9 miles north of Prime Hook NWR above Bower's Beach.
- Little Creek WMA (4,721 acres), 15 miles north of Prime Hook NWR above Port Mahon.
- Prime Hook WMA (698.2 acres), adjacent to Prime Hook NWR.
- Bombay Hook NWR (16,000 acres), 25 miles north of the refuge.

Geology and Hydrology

Past geological events in Delaware have created two distinct physiographic provinces; the northernmost 5 percent is in the Appalachian Piedmont Province and the Atlantic Coastal Plain Province covers the remaining 95 percent. Appalachian mountain building episodes between 500 and 200 million years ago formed the Piedmont, which is composed of metamorphosed, igneous, and sedimentary rocks. The Piedmont region is characterized by low, rolling hills and steeply incised stream valleys. A fall zone occurs at the junction of the Piedmont and Coastal Plain in the proximity of Route 2, Kirkwood Highway, in New Castle County, which is an ecological transition area between these two provinces (Thompson 1976) (map 3-3).

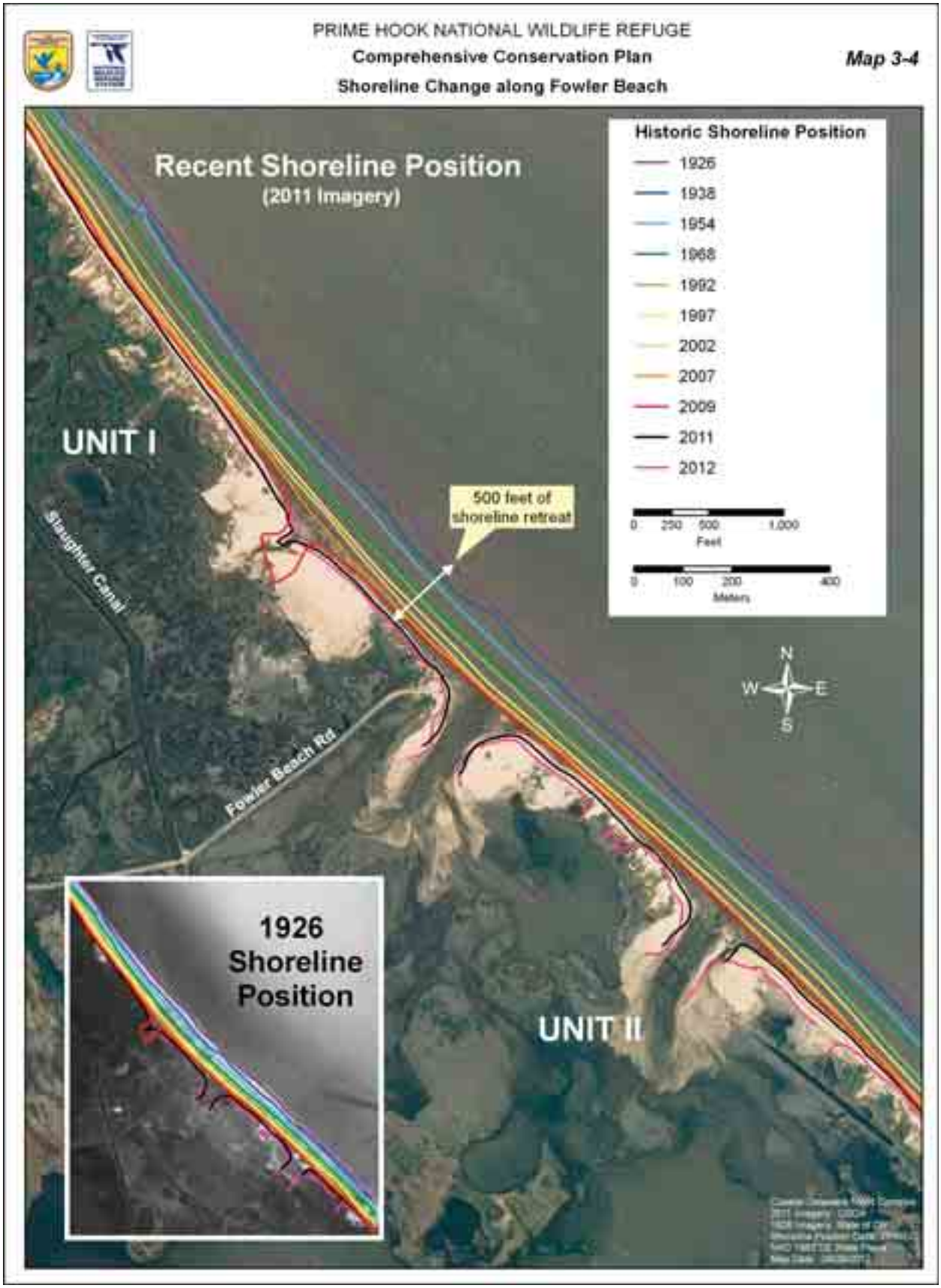
The Coastal Plain Province lies south of the fall line and makes up the vast majority of the State's land area, including the refuge. Much younger than the Piedmont, the coastal plain consists of unconsolidated sediments that have accumulated as a result of erosion of the Appalachian Mountain chain, and marine sediments deposited as a result of frequently fluctuating sea levels. The deposition of the unconsolidated sediments of the coastal plain began 120 to 150 million years ago. Eroded waterborne sands, silts, and clays were deposited, followed by marine sediment shifting during periods alternating between sea encroachment and retreat. With the advance and retreat of continental glaciers and dramatic changes of sea levels, the flowing sediments were capped by fluvial sands and gravels during the Pleistocene (1.8 million years ago). During the past 10,000 years, rising sea level has filled coastal valleys with sediment, forming extensive tidal marshes. The coastal plain today is a region of little topographic relief, with broad, slow-moving streams and extensive tidal estuaries (Hess et al. 2000).

About 5,000 years ago, the current refuge shoreline was located 3 to 4 miles east of its current position, resting what is now in the middle of the Delaware Bay. Retreating shorelines and rising sea levels systematically began to drown the ancient Delaware River valley, gradually transforming the narrow river into the wide Delaware Bay as it is currently shaped. Atlantic Coastal Plain creeks and streams meander broadly in shallow channels and the landscape is generally flat, with elevations ranging from sea level to 125 feet. The highest point in Delaware is 448 feet, located north of Wilmington near the Pennsylvania State line (Ebright Azimuth). Prime Hook NWR has very flat terrain typical of Atlantic Coastal Plain areas. The highest point within the refuge is about 15 feet mean sea level but the majority of refuge lands lie below the 9-foot contour. The uplands are gently sloping with very few steep grades; these are mostly limited to areas immediately adjacent to drainage ditches and creeks.

Along the immediate shoreline of the refuge's barrier island habitats from Slaughter Beach to Prime Hook Beach, the topography is highly variable. Natural dune ridge areas sloping away from mean high water level of the Delaware Bay vary from 1 to about 10 feet, interspersed with overwash areas ranging from 0.5 to 3-foot elevation contours based on DNREC topographic maps of Delaware beaches (1979). Short-term geological events like coastal storms and long-term geological processes of marine transgression and landward movement of the coastline have and will continue to constantly change coastline position and elevations along the refuge's sandy beach ecosystem (map 3-4).

Map 3-3. Delmarva Peninsula Hydrology and National Wildlife Refuges

Map 3-4. Shoreline Change Along Fowler Beach



The directional flow of Delaware's rivers south of the Piedmont is dictated by a dividing ridge, which is a visually unimpressive land form that rises only a few feet above the surrounding countryside. Acting as the watershed of central and southern Delaware, the dividing ridge bisects the State so that all of flat Delaware's significant river systems flow eastward into the Delaware Bay or the Atlantic Ocean, with the exception of the Nanticoke River, which drains into the Chesapeake Bay (map 3-3).

The directional flow of water bodies and upland runoff drainage patterns traveling eastward toward the Delaware Bay places the refuge at the receiving end of watershed runoff and stream flows. Therefore heavy rainfall events not tied to coastal storm events can also have significant impacts on the refuge's physical environment.

The geology of the Delaware Bay's coastline is part of larger geological structure known as the Atlantic coastal plain-continental shelf geosyncline. This shoreline of the entire lower Delaware Bay is migrating in geologic time, in a landward direction. This is caused by many geological processes. The first is subsidence or sinking. The continental shelf and Atlantic Coastal Plain are known to be subsiding. The second process is sea level rise relative to the land. A third coastal process is the erosion and redistribution of sediments in the active coastal littoral zone as the shoreline shifts in a landward and upward direction (Kraft et al. 1976).

The Beers Atlas (1868) showed the two creeks (Prime Hook and Slaughter) feeding freshwater through the marsh system flowing directly through the barrier beach into the Delaware Bay. These outlets provided unimpeded flows of freshwater from the uplands to the west; they also provided ample primary inlets for the saline waters of the Delaware Bay to inundate the lowland marshes on each high tide.

Overtime, however, with changes in the Delaware Bay shoreline, these inlets would occasionally close with sand, stopping the general eastward flow of water from the uplands. This interferred with the drainage and ultimate cultivation of the lands bordering the marshes. Around 1911, both outlets were sealed shut by a storm. The Broadkill River meandered to a new outlet two miles south. This new outlet was later improved by man and called the Rossevelt Inlet. Prime Hook Creek ended, which histocially flowed near California Avenue in the Broadkill community, in Unit III marsh with the Petersfield Ditch then taking over as the major water outlet emptying into the Broadkill River.

Attempts were made, first at the outlet of Slaughter Creek on the northern end of the marsh, to build structures that would keep the natural outlets of the creek open to the Delaware Bay. This project was subsequently abandoned and a new, man-made channel, Slaughter Ditch, was dug. This ditch carried the waters of Slaughter Creek and Cedar Creek into the Mispillion River.

As with Slaughter Creek, the mouth of Prime Hook Creek also closed premanently. With no major draingage outlet, therefore the freshwaters flowing off the uplands backed up over the marsh extending flood waters from Broadkill Road to Fowler Beach Road.

Origin and Evolution of Estuarine Washover Barriers of Delaware Bay and the Refuge

Initiation of sandy barriers along the shoreline of the Delaware Bay requires a source of coarse-grained sediment, and sufficient wave and current energy to redistribute sediments to the nearshore zone. Evolution of the estuarine barrier island habitats along the bay varies spatially and temporally as factors change in space and time. Field observations and analysis of historic data suggest that wave erosion of pre-Holocene headlands and longshore transport of sediment are the principal mechanisms for estuarine barrier formation. A conceptual model representing three stages of the development of estuarine barrier

islands along the western shore of the Delaware Bay, including the project area, has been described (Maurmeyer 1978). This sequence is controlled by pre-Holocene topography and variable rates of sea level changes represented by the following stages:

(1) Initial formation of barrier as a beach abutting a pre-Holocene headland.

(2) Salt marshes surround the headland as sea level rises and long-shore transport of sand forms barriers against marshes.

(3) Burial and/or erosion of headland as sea level rises; barrier migrates landward and upward across marshes by overwash.

At the present time, stage one occurs on the northern barriers of the bayshore to Bowers Beach. Stage 2 occurs in the vicinity of headlands surrounded by marshes such as Woodland Beach, Kitts Hummock, and Big Stone Beach, along centrally located barriers along the bay shorelines. However, most of the southern barriers along the western shore of the bay are in the third stage and are dominated by overwash processes, including the refuge (Maurmeyer 1978).

Rates of Coastal Change of the Delaware Bay Shoreline
Hydrogeomorphic studies conducted by University of Delaware coastal scientists provide a baseline about the rates of shoreline transgression or migration landward of Delaware Bay shorelines. Over the 120-year period from 1834 to 1954, the bay shoreline from Slaughter Beach to Roosevelt Inlet retreated at a rate of from 1 to 25 feet per year. The refuge lies just below the Slaughter Beach community location, and the shoreline position bracketing the refuge has experienced a total change of -1,100 feet or roughly a loss of about 10 feet/year on average (Kraft et al. 1976).

This is one of the higher erosion rates along the bayshore and similar to Slaughter Beach coastal change rates. The only two areas along this stretch of the Delaware Bay shorelines that have been or are presently accreting are the Broadkill Beach groin field and the area behind Cape Henlopen near the Lewes Breakwater. Most shoreline erosion in the Delaware Bay is caused by waves generated across the Bay by local winds. Wave velocities during normal and storm events push excessive water onto the shore. The highest rates of erosion tend to occur in areas where marsh sediments and old remnant peat covered by sand form the shoreline (Kraft et al. 1976). These coastal change rates serve as a fairly precise baseline indication of the present and future refuge shoreline rates of erosion. However, a 10-foot/year rate may be too conservative in light of recent and predicted future climate change and sea level rise rates as discussed later in this chapter.

Refuge Water Level Information
Throughout the refuge, water levels change on time scales that range from minutes to thousands of years. Daily water level changes due to astronomical tides for both Mispillion and Roosevelt inlets vary from -0.7 to 5.8 feet. Even on short time scales (minutes, hours, days), wind energy and wind stress can increase water level changes to deviate significantly from astronomically predicted levels. The coastal geology of an area, bay morphology, and bathymetry are factors that influence and constantly change the periodicity and magnitude of refuge water level changes from day to day under normal conditions and with large variations during storm events. Even coastal storms that never make landfall can cause refuge water levels to change in excess of those normally predicted monthly variations in the lunar phase.

Based on averaged predicted tidal fluctuations and other geological factors, the refuge coastal zone can be characterized as a mesotidal (between 2 to 4 meters) coastal area. Massilink and Huges (2003) define coastal zone tidal ranges as microtidal (0 to 2 meters), mesotidal and macrotidal (greater than 4 meters).

Water level ranges are much more restricted within refuge impounded marshes. However, correlations between impoundment water levels are difficult to make because the Unit II water control structure was surveyed in its present location in 1988, referencing the National Geodetic Vertical Datum of 1929 (NGVD 29), and the Units III and IV water control structures were surveyed into location, including staff gauge positioned on the concrete structures, in 1984 and 2005 respectively, using a tidal (mean sea level) datum. Because the water gauges used to measure water levels in the impoundments do not all reference the same elevation datum, it is currently difficult to make direct comparisons between water level measurements in different impoundments for water management purposes.

Soils

The soils of Delaware are made up of differing combinations of sand, silt, and clay. Sand was the most abundant of the three components, proportionally increasing from the Christiana Valley to Sussex County. The soils of eastern Kent and Sussex Counties from the coast to 10 miles inland tend to have more clay and less sand components than soils located further west, especially those areas flanking the dividing ridge.

The soils of the Piedmont, which are derived from the underlying gneiss and schist bedrock, are older and tend to be more fertile than soils of the coastal plain. Piedmont soils in the valleys are rich and loamy, while the soils at higher elevations are often eroded and stony. The soils of the coastal plain vary a great deal depending on geography and habitat. Sandy soils dominate much of the region, but areas of clay or loamy texture are not uncommon. Soil drainage ranges from that which is excessively drained in beach sands and on sand ridges, to very poorly drained soils in tidal marsh and swamp muck (Matthews and Ireland 1974).

Delaware's soils are classified into four major soil orders: Ultisols (well developed, acidic mineral soils), Histosols (organic soils), Inceptisols (mineral soils in early development) and Entisols (mineral soils in late development). They are grouped into associations by location, drainage characteristics, and parent material. A soil association is a landscape that has a distinctive proportional pattern of soils. It consists of one or more major soils and at least one less extensive soil, and it is named for the major soils. Two major associations found within the refuge include the Broadkill-Mispillion-Acquango Association and the Unicorn-Carmichael Association (USDA/NRCS – D. Shields, personal communication).

Broadkill-Mispillion-Acquango Association consists of mineral and organic soils that are regularly subject to tidal flooding by saltwater, and narrow areas of loose, salty beach and dune sands. This association occupies about 80 percent of the refuge and about 5 percent of the total land area in Sussex County. The Broadkill, Mispillion, and similar soils occur on open grassy tidal marsh areas dissected by tidal creeks and streams and crisscrossed in places by mosquito-control ditches. In many places there is a brush border adjacent to higher ground. The soils consist of mostly peat or mucky remains of vegetation, some loamy soil material, and large amounts of sulfate. The marshes range from strongly saline to almost fresh along the upper reaches of streams.

A smaller portion of this association includes the Acquango soils and associated beach areas. It occupies a narrow band separating the tidal marsh areas from open water. This part of the association consists of shifting, loose, salty sand that is moved by waves and wind. The part regularly washed by waves and tides is smooth and slopes gently up from the water. That part above normal high tide consists of dunes and hummocks constantly changed by the wind. The vegetation is a sparse cover of beach grass, a few forbs, and scattered low shrubs. The beaches and dunes are used intensively for summer recreation activity and as sites for beach houses. The marshes are on the Atlantic Flyway of migratory waterfowl. Recreational activities in these marshes include waterfowl hunting, crabbing and fishing. Less extensive in this association are Purnell, Sunken, and Saltpond soils (USDA/NRCS – D. Shields, personal communication).

Unicorn-Carmichael Association consists of well-drained and poorly drained soils that have a moderately permeable subsoil of loam to sandy loams. This association accounts for about 15 percent of the total refuge area and occupies about 10 percent of the total land area in Sussex County. This association consists of approximately 55 percent Unicorn soils, 25 percent Carmichael soils, and 20 percent less-extensive soils.

Unicorn soils have a surface layer of grayish-brown loam and subsoil of strong-brown sandy loam or loam. In most areas they are nearly level to gently sloping and are moderately permeable and well-drained. Carmichael soils have a surface layer of gray to dark grayish-brown loam and a subsoil of gray loam or sandy loam. They are nearly level, moderately permeable, and poorly drained. The water table is at or near the surface for long periods during the year. Less extensive in this association are Greenwich, Pineyneck, and Longmarsh soils. Longmarsh soils are on flood plains. Well-drained Greenwich soils and moderately well-drained Pineyneck soils are intermingled with areas of the major soils and do not appreciably affect overall land use. They differ primarily in drainage class (USDA/NRCS – D. Shields, personal communication).

Coastal plain soils vary widely in the proportions of sands, silts, and clays in their location relative to the water table. Soils with high amounts of clays and silts have a tendency to be wetter because water percolates poorly. The mineral organic materials of tidal and freshwater marshes comprise three associations of very poorly drained soils rimming Delaware's coastline from Wilmington down to Fenwick's Island, surrounding the inland bays and the confluence of the Broadkill River (Matthew and Ireland 1974).

Soil associations are further delineated into more specific soil map units (map 3-5). Additional information about soils of the refuge can be found in the Prime Hook NWR Final CCP/EIS, Volume 1, chapter 3 *(http://www.fws.gov/northeast/planning/Prime%20Hook/finalccp.html)*.

Air Quality

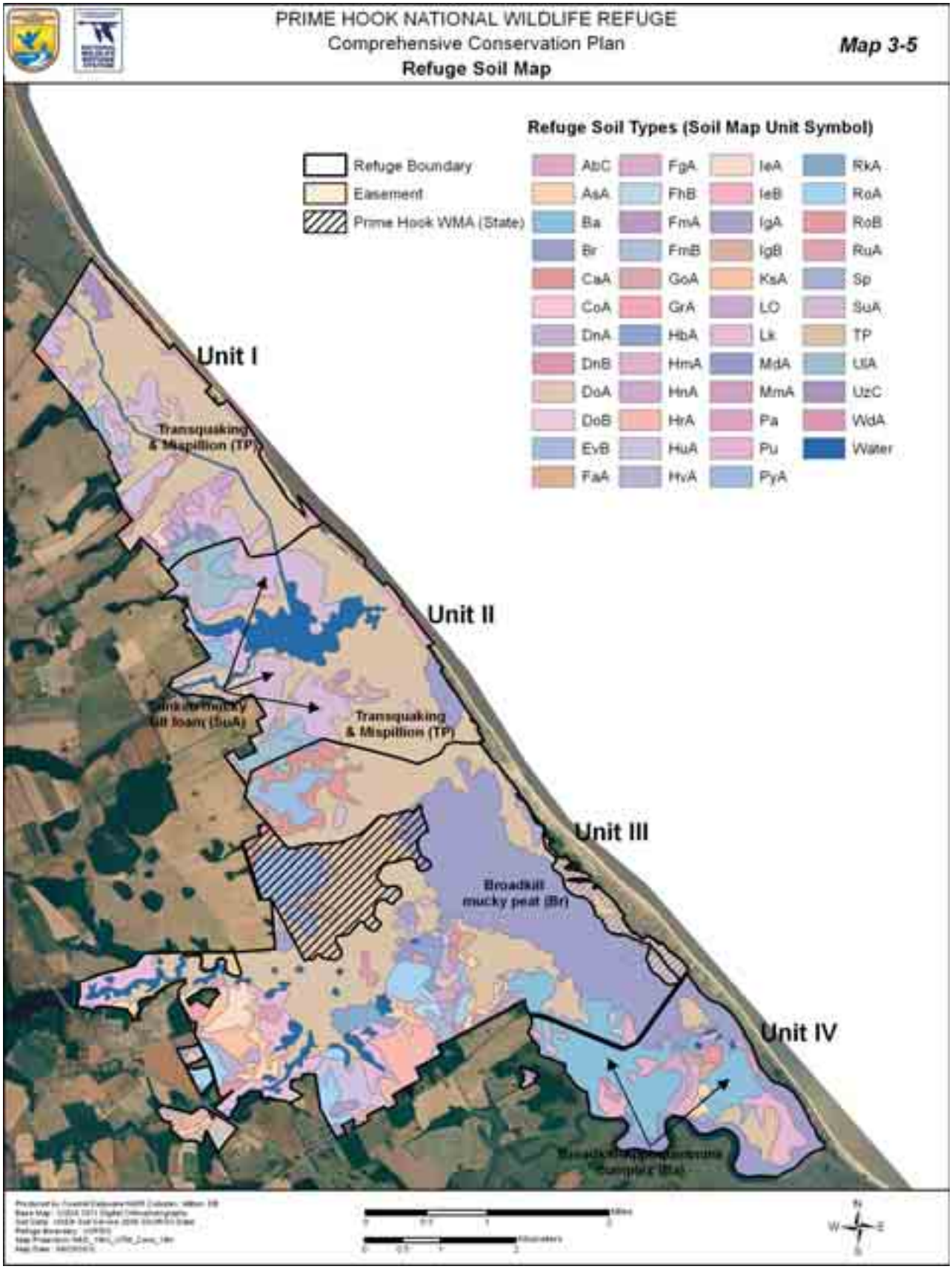
The mission of the Service's air quality program is to protect and enhance air quality in support of ecosystem management in the Refuge System. The Service's vision "is a Refuge System free of impacts from human-caused air pollution and is consistent with the Refuge System Improvement Act, which requires that 'the biological integrity, diversity, and environmental health of the [Refuge] System are maintained…'" *(http://www.fws.gov/refuges/AirQuality/index.html;* accessed January 2012).

Prime Hook NWR's greatest contribution from human-caused air pollution would occur from prescribed fire activities as a short-term intermittent source of fine particulate concentrations. Prescribed fire is an important tool to decrease dead fuel load accumulations of wildland vegetation for public safety and to improve the health of natural ecosystems. Full consideration of air quality values has been made in Prime Hook NWR's fire management plan for all prescribed fire planning and operations (see Smoke Management Section 4.2.1.5 of Prime Hook NWR's Wildland Fire Management Plan (March 2009)).

The Air Quality section of DNREC's Division of Air Quality and Waste Management monitors levels of ozone and particle pollution from nine locations throughout the State. The Lewes monitoring station is the closest to the refuge. These sites have been monitoring air quality since the late 1960s. Air monitoring stations are used to house continuous monitoring instruments that measure criteria air pollutants.

A criteria air pollutant has a national ambient air quality standard (NAAQS) established for it by the EPA. There are currently seven criteria pollutants: sulfur dioxide, nitrogen dioxide, carbon monoxide, ozone, lead, particulate matter less than 10 microns in diameter (PM10) and particulate matter less than 2.5 microns (PM 2.5).

Map 3-5. Refuge Soil Types



Local air quality is affected by regional issues. In general, air quality in Sussex County is good during the winter and spring, but only fair in summer and fall. From Memorial Day to Labor Day, Sussex County is often in non-attainment state for NAAQS, meaning pollution limits set by the EPA have been exceeded for several consecutive years. Limiting smoke impacts resulting from prescribed fire is important to protect public health and safety. For this reason, prescribed refuge burns usually occur in late winter or early spring.

Water Quality

DNREC's Division of Water Resources manages and protects the State's water quality through seven sections. The Water Assessment Section protects water from nonpoint source pollution and plans monitoring and management actions to improve water quality on a watershed scale to protect human health and the State's environment. There are 45 delineated watersheds in Delaware and Prime Hook NWR is influenced by three: Mispillion River, Cedar Creek, and Broadkill River watersheds. The most recent water quality assessments performed by this Section (State of Delaware 2008 Combined Watershed Assessment Report 305(b) and Determination for the Clean Water Act Section 303 (d) List of waters needing TMDLs) indicates that a majority of the State's water resources are suffering from poor water quality.

Water quality monitoring has shown that more than 92 percent of Delaware's waterways are considered impaired. Impaired waters are defined as polluted waters based on EPA water quality standards. Of 2,506 miles of rivers and streams tested for water quality attainment, 2,497 miles have been documented as impaired. Of the 2,954 acres of lakes, ponds and reservoirs, 2,798 acres were found to be impaired (State of Delaware 2008 303(d) Impaired Waters List pp. 89 to 125).

Pathogenic indicators (bacteria) are the most widespread pollutants in the State. The pathogen indicator monitored by DNREC for primary contact recreation is *Enterococcus* bacteria. Other pathogen indicators (total and fecal coliform bacteria) are monitored to regulate shellfish harvesting areas.

Although pathogenic indicators are the most widespread in Delaware, nutrients and toxics pose the most serious threats to water quality. All of the State's estuarine waters are considered nutrient-enriched. Water quality and negative impacts to aquatic organisms from nutrient enrichment include eutrophication and low dissolved oxygen levels. Large portions of nutrients are transported to estuaries and ponds via rivers and ground water.

The presence of toxic substance concentrations above EPA standards for human health triggers the publication of fish advisories by the State. In 2007, the State fish consumption advisories included, for the first time, waterways within Prime Hook NWR or immediately adjacent to the refuge. These included Prime Hook Creek, Slaughter Creek, and Waples Pond (see table 3-1 below).

Table 3-1. State of Delaware Fish Consumption Advisories

State of Delaware Fish Consumption Advisories			
Waterbody	**Species**	**Geographic Extent**	**Contaminants**
Mouth of Delaware Bay	Striped Bass White Perch American Eel White Catfish	South of C and D Canal entire Delaware Bay to Mouth of Atlantic Ocean	PCBs, Mercury
Waples Pond	All Finfish	Entire Pond	Mercury
Prime Hook Creek	All Finfish	Entire Creek	Mercury
Slaughter Creek	All Finfish	Entire Creek	PCBs, Dioxin, Furans

Multiple sources are cited for poor water quality of Delaware's waterways. These include nonpoint sources of agricultural runoff, septic system failures, animal feed lot operations, urban runoff, and municipal and industrial point sources as the primary origins of nutrients and toxic substances.

The Delmarva Peninsula is one of the largest poultry production areas in the U.S., generating more than 600 million chickens and 1.6 billion pounds of manure annually. The State of Delaware ranks 7th in the Nation in the number of broilers produced. Statewide, this industry is represented by about 900 chicken farms with the largest portion found in Sussex County. There are four chicken farms immediately adjacent to Prime Hook NWR that produce 500,000 to 1 million birds per year. Within a 6-mile radius of the refuge, about 19 poultry farms are located that produce 3 to 5 million birds annually (DDA 2007).

Water quality problems associated with the animal feeding operations were investigated on Prime Hook NWR by contaminant biologists in the Chesapeake Bay Field Office concerned that excessive land application of poultry litter has resulted in severe water quality problems in surface and groundwater on the Delmarva Peninsula (McGee et al. 2003). The study provided direct evidence for transport of tetracycline compounds found in waterbodies from poultry litter applied on the fields in the Delmarva peninsula. It should be noted the data are very limited, both in terms of the number of samples and the geographic coverage.

***Cladophora* Algal Bloom Event During Winter, Spring, and Summer of 2010**

Large mats of native *Cladophora* algae began to develop in early February in the Unit II impoundment. By April, the bloom expanded to encompass 700 acres immediately adjacent to Prime Hook Road. Since the algal mats emerged in late winter, robust thick mat growth developed by early spring, effectively allowing the *Cladophora* to out-compete other marsh plants during the growing season.

The bloom remained confined to the southern portion of Unit II until early May when it spread into the northern part of the Unit III impoundment adjacent to Prime Hook Road. The spread was probably facilitated by the hydrological connection between Units II and III via several road culverts. By mid-July, the algal mats began to decrease in size and disappear. This was the first time that such an algal bloom event occurred on the refuge, and was probably triggered by a combination of changing environmental conditions in Unit II and climatic influences.

The breaching of Unit II dune line in 2009 changed the salinity conditions of the impoundment where ranges of 20 to 25 ppt became the norm throughout the entire 1,500-acre impoundment. Then heavy snowfall in January and early February triggered extensive runoff from upland areas into the refuge. Marine *Cladophora* species have an optimal temperature range that maximizes development (50 to 77 ^{0}F). Snow melt and extensive runoff spiked phosphorus loading into the system and perfect growth conditions triggered the bloom. When temperatures exceeded 80 ^{0}F by August, algal mats began to disappear.

As a result of the algal bloom, refuge staff was concerned about excessive nutrient loads within Unit II. Water samples were taken at three locations on May 19, 2010. The samples were analyzed by the University of Maryland, Center of Environmental Science, Chesapeake Biological Laboratory in Solomons, Maryland. Two of the samples were located on the refuge and one on upper Slaughter Creek, which flows into the refuge.

Delaware has no numeric water quality standards for total nitrogen or different forms of phosphorus. For ammonia (NH4), the numeric values are pH and temperature-dependent. The results for the three water bodies (pH 8; 25 ^{0}C) are found in table 3-2.

Table 3-2. Results of water quality testing in May 2010

Sample Id	CBL	NO2	NH4	PO4	NO23	TDP	TDN
	NUMBER	(mg N/l)	(mg N/l)	(mg P/l)	(mg N/l)	(mg P/l)	(mg N/l)
UNIT II	1	0.0009	0.016	0.0027	1.094	0.0336	2.36
SLAUGHTER CREEK	2	0.0495	0.746	0.0530	4.940	0.1213	6.70
UPPER SLAUGHTER CREEK	3	0.0594	0.091	0.0476	5.640	0.1423	6.81

Total dissolved nitrogen (TDN), total dissolved phosphorus (TDP), nitrite plus nitrate (NO23), phosphate (PO4), and nitrite (NO2) are all nearly equal in the creek, but Slaughter Creek is nearly 10 times higher in ammonia content. The bloom in Unit II does not correspond with high nutrient concentrations, as the concentrations for all nutrients in Unit II are the lowest of the three areas.

Geochemical changes associated with the intrusion of saltwater back into these wetland areas are potentially evident in these water quality findings. Sediment subsidence is of particular concern in diked flooded marshes following tidal restoration, which could lead to prolonged flooding and sulfide toxicity (Portnoy et al. 1997). Plant death and peat collapse have been noted after saltwater intrusion in Louisiana brackish marshes. Ferrous iron toxicity, which may also inhibit *Spartina* growth, is also a concern. As for sulfide, however, FE (II) and Al phytotoxicity could be offset by abundant nutrients, especially NH4. The potential large mass of nutrients mobilized by increased decomposition, cation exchange, and phosphate mineral dissolution during saltwater intrusion could depress dissolved oxygen in surface waters by promoting algal production and organic loading (Portnoy et al. 1997).

Portnoy's research emphasizes that saltwater intrusion can substantially affect estuarine plants and animals. These changes include sulfide accumulation, metal increases, and nutrient mobilization as well as subsidence.

Concerns were also raised regarding the algal mats containing *Enterococcus* and *E. Coli* bacteria. These bacteria are naturally occurring in the environment. The refuge contracted with DNREC's Division of Water Resources to analyze water samples from July through August. The results concluded that neither bacteria exceeded State or EPA standards.

Ground-Water Contamination from Lead Shot

For 37 years, the Broadkiln Sportman's Club, which is adjacent to Prime Hook NWR on the southwestern corner of the headwaters of the Prime Hook Creek, operated a trap-shooting range. Clay target launchers were oriented so that expended lead shot dropped into a forested wetland and upland grassland areas on Prime Hook NWR. 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 many areas on the refuge lands adjacent to the Club.

The club was founded in 1962 in Pikes Neck, Sussex County. The club used five trap houses, each with 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, fell to the ground, and accumulated through the years.

The portion of Prime Hook NWR bordering the club, which is down range from the trap-shooting area, consists of a forested wetland along a small tributary or slough draining into Prime Hook Creek. The slough varies in size and shape with the seasonal rise and fall of the water table, and dries up completely on occasion.

This slough is heavily forested and used by migratory birds, small mammals, and amphibians.

The trap-shooting range was operated from 1962 to 1998 until a proposed land swap with the Service was initiated by the club. Upon this request, the Service initiated a level one contaminant survey of refuge lands. In August and October of 1998, Service personnel collected soil samples to determine the extent of lead shot deposition and lead soil concentrations. Results showed significant lead contamination. The Service ordered the club to discontinue depositing lead shot onto refuge lands, and in 2000 initiated a 3-year refuge cleanup 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 zone approximately 26,200 square feet referred to as the drop zone (Crowley and Richardson 2001), as part of an environmental risk assessment prepared by Service contaminants biologists and USGS investigated the potential for lead soaked soils to leach into the groundwater.

Results from 2 sampling rounds of 19 wells (May 2000 and April 2001) showed that elevated levels of dissolved lead were present in the groundwater on Prime Hook NWR. The USGS study was designed as a field screening to give the Service some indication of the scope of the groundwater lead problem. Lead transport through shallow ground is an unusual occurrence, as metallic lead is generally considered immobile. USGS further investigated the chemistry of the process of lead mobilizing from the surface down to the groundwater.

Study results verified that low pH values were recorded in the groundwater ranging from 4.8 to 6.4. These acidic environmental conditions were responsible for dissolving the lead carbonate from the pellets. Because of the lack of buffering capacity and adsorption sites in the silica-rich sediments of the area, the dissolved lead was mobilized and moved into the groundwater on the refuge.

A biomonitoring study was initiated in the spring of 2002, prior to removal of the contaminated uplands that occurred in 2003. The study was repeated the following 2 years to document changes in the levels and bioavailablity of lead in the downgradient wetland sediments. Southern leopard frog *(Rana sphenocephala)* tadpoles at Gosner stage 24 were collected from an unimpacted pond on the NWR and placed in enclosures in wetlands at a reference site and at two wetland sites within the shooting trajectory with different concentrations of lead. The amphibians were removed when those at the reference site completed metamorphosis. The gut was removed, and the body analyzed for lead and the liver analyzed for amino levulinic acid dehydratase (ALAD) activity. We found statistically significant differences in ALAD in 2002 among the three sites, indicating inhibition at both the hot and warm locations (less than 0.015 nmol porphobilinogen/per gram liver per hour) relative to the reference (0.20 nmol). In 2004, both sites had significantly lower activity than the reference. The warm site improved in 2005 (0.18 nmol) but was still significantly lower than the reference (0.25 nmol). The hot location average also improved to an average of 0.086 nmol, about five times the initial average. Lead concentrations were significantly different at sites (p less than 0.001) in each of the 3 years. In 2002, the average whole body lead concentration was 59.9 ppm at the hot location, 1.34 ppm at the warm location, and 0.176 ppm at the reference location. At the hot site, there was a steady decrease in whole body lead concentrations from 2002 to 2004 and 2005, but average concentrations were still 350 times that for the reference. Warm site average concentrations decreased and then increased back to the 2002 concentration, which was about 17 times the reference. The study is planned to be repeated in 2011 to note any changes.

The Service has physically excavated and removed part of the pellet-contaminated soils on Prime Hook NWR, which has since re-vegetated with native plants. The major source of groundwater contamination has been remediated on Prime Hook NWR. The attenuation of high lead concentrations in the ground water will require long-term monitoring to confirm the potential of natural attenuation of the system (Soeder and Miller 2003). Water quality monitoring by the Service's Chesapeake Bay Field Office is still ongoing. The refuge has not acquired any of the lands owned by the shooting club, so it does not control all of the impacted or unremediated lands affected by the lead shot deposition. Today, the gun club is no longer operating as such, and the private lands remain unremediated.

History of Vegetation on and Around the Refuge

Prehistoric Climatic Influences on Delmarva Landscape Vegetation

Prehistoric climatic influences that shaped the landscape of the Delmarva Peninsula and refuge lands revolved around the rise and fall of sea levels. All of the Delmarva Peninsula south of Elkton, Maryland and Newark, Delaware is essentially a large sandbar built from sediment left by the sea or eroded off the ancient Appalachian continent over the past 150 to 200 million years. The peninsula is located in the Atlantic Coastal Plain, itself a relatively recent emergence of the continental shelf (Scott 1991).

For tens of millions of years, the sea continued to rise and fall and the rivers washed sediments off the land creating today's features of the Delmarva Peninsula. The last Ice Age on Delmarva occurred about 25,000 years ago with the Wisconsin Glacier. Each time the climate warmed, the amount of water released by this melting ice floe caused sea levels to rise high enough to flood the entire peninsula. During these melting phases the water rose 30 to 40 feet above its present levels, depositing a thick layer of maritime sediment sandy soil on southern Delmarva.

During freezing periods, so much of the earth's available water was incorporated into ice that the sea dropped hundreds of feet below current sea level. The receding of the sea from the peninsula often left behind the poorly drained depressions that are now known as Delmarva bays (Scott 1991). A well-known Delmarva bay adjacent to the refuge (Huckleberry Swamp) and several similar depressional swamp areas on the refuge (total of six depressional wetlands) have been recently mapped by DNHP botanists in 2005 and 2006 (McAvoy et al. 2007).

These depressional wetland types are an important natural resource in Delaware and are considered a top priority for protection by DNREC. They are today becoming rare because they are not regulated and are easily destroyed by ditching, draining and filling. Important groundwater recharge areas also provide habitat to State rare plant species and are extremely valuable to amphibians that utilize refuge depressional wetlands for breeding purposes (McAvoy et al. 2007).

Delaware Bay and adjacent land surfaces have undergone substantial environmental and vegetative changes. During the Late Pleistocene geological epoch, approximately 15,000 years before present (BP), continental ice sheets of the Late Wisconsin Glacier advanced south to New York and northern Pennsylvania. The glacier stopped just north of Trenton, New Jersey. It was a veritable mountain of ice, several thousand feet thick. Ice sheets, which covered the entire globe, incorporated so much of the earth's available water that the sea dropped more than 300 feet and caused the continental shelf to emerge from the sea east of the Delmarva Peninsula. Pollen samples dating 11,500 BP when the Wisconsin Glacier was at its height, show that extensive grasslands covered its

exposed face and were interspersed with patches of pine, spruce, fir, and hemlock tree species representative of a boreal forest stand (Scott 1991).

During the 1970s, John Kraft and his students from the University of Delaware conducted stratigraphic coring on and near the refuge. These studies indicated the magnitude of coastal changes during the Holocene period of human occupation of the southern Delaware coastal environments. Slaughter Beach is underlain by 40 feet of soft mud deposited by estuaries during the early and middle Holocene. From Prime Hook Beach south to Broadkill Beach, modern barrier beaches cover estuarine mud from depths of 10 to 60 feet. At Fowler Beach, Pleistocene sand and gravel of the former Slaughter Neck headland occur at depths of 8 feet below present mean sea level (Kraft et al. 1976).

Hoyte (1980) extracted nine stratigraphic cores on the refuge along Slaughter Creek and has suggested that lagoons behind barrier beaches changed from freshwater marshes to brackish marshes over the past five centuries. In upland area, core samples near the creek (Slaughter Neck) contained Delmarva fox squirrel bone fragments, identified by their unique feature of glowing under black light. In March 2004, Tetra Tech Research, Inc. extracted six additional vibracores from streamsides and near-shore wetlands, and excavated four machine trenches on adjacent refuge uplands to examine erosion and sediment accretion related to sea level rise and associated vegetative changes.

Prehistoric and Historic Cultural and Environmental Setting and Human Land Use History

While the Service's mission is conserving wildlife, all Federal agencies are responsible for stewardship of the important archaeological sites and historic buildings on Federal land. The Service's Regional Historic Preservation Officer reviews activities which include alterations to historic buildings or ground disturbing activities for their potential to affect sites and structures. Based on this review and consultation with State Historic Preservation Offices, the Service may conduct archaeological and architectural surveys and may mitigate impacts to these cultural resources. The Service maintains an inventory of known archaeological sites and historic structures on its land in the Regional Office and at refuges.

In 2004, the Service contracted an archaeological overview of Prime Hook National Wildlife Refuge. The Report, "Archaeological, Historical and Geomorphological Study of Prime Hook National Wildlife Refuge," includes information about the dates and rates of sea level rise at Prime Hook, as well as information about where people used the refuge land at different points during the past. At Prime Hook NWR, we know of 44 archaeological sites, and there are likely to be many more. There are no historic structures at the refuge. Fifteen of the refuge's 44 known archaeological sites are in what is today the salt marsh.

People may have been at the refuge at least 10,000 years ago, based on the recovery of an Early Archaic Kirk spear point from the salt marsh during Open Marsh Water Management by the State of Delaware in 1989 and 1990. At that time, the refuge was far from the shore of the ocean, and people would have oriented themselves to sources of fresh water on the refuge. Cara Blume, then of the Delaware Department of Parks and Recreation, developed an archaeological site sensitivity map based on a model of former fresh water sources at the refuge (Tetra Tech FW 2004:Figure10). Both sea level rise and land subsidence have affected the refuge. The refuge's archaeological sites also provide evidence of Native American occupation through the Woodland II Period 1000–500 years ago. European settlers' land ownership records for the refuge can be traced to the 1680s. Many of these locations are now located in seasonally wet soils or in actual salt marsh. As sea level and ground water rose, and the land subsided, once-dry locations became no longer habitable. The loss of salt marsh to erosion will not only affect habitat at the refuge, but also archaeological sites.

Understanding what the historic natural vegetation types were in refuge areas, how they were distributed, and what ecological processes influenced them prior

to major human-induced influences provides a reference point to manage for BIDEH. These can pinpoint a baseline framework to evaluate future restoration and management options. However, we have noted that, when considering the restoration of areas to native vegetation, ecologists caution against selecting one point in time and instead recommend managing for a historical range of variation for each habitat type (Egan and Howell 2001).

Historic range of variability is a method used in restoration ecology to describe how natural ecosystems have a range of historic conditions in which they are self-sustaining and beyond which they move to a state of unsustainability due to degraded biological integrity, low biodiversity, or impoverished environmental health (Egan and Howell 2001).

Agriculture was the primary cause of deforestation and draining of wetlands. Soil fertility over much of the Delmarva Peninsula continued to decline as the soils had no time to recover from tobacco cultivation followed by the intensive plantings of wheat and corn. Many of Delmarva's rivers became clogged with silt as deforestation and agriculture facilitated erosion of uplands, so once prosperous shipping and coastal towns became economically stranded.

Negative impacts to wildlife continued as natural habitats were destroyed. With the elimination of natural predators, squirrel populations increased. Bounties were established for squirrels, which were damaging crops. Deer numbers were drastically reduced due to overharvesting. Wild turkeys, estimated at more than 10,000 birds in Delaware before the advent of European settlement (Williams 2008), were hunted nearly to extinction by the early 19th century, along with Delmarva fox squirrels.

Sussex County underwent substantial development during the 20th century. The advent of the automobile funneled large numbers of tourists and vacationers to coastal areas. Most 19th century structures continued to be occupied into the 20th century. The Service has identified several sites constructed during the 20th century, including sport-hunting camps and other historic sites on the refuge (Tetra Tech 2004).

Increased beach resort development and beach home construction continued in the latter part of the 20th century and into the 21st, shrinking the size of undeveloped sandy beach ecosystems remaining in the State. Undeveloped bay and ocean shorelines represent a disappearing natural habitat type in Delaware.

History of Agricultural Management on and around the Refuge

In pre-settlement North America, waterfowl were dependent on aquatic, marsh, and shoreline vegetation and the mast and seeds of terrestrial plants of seasonally flooded bottomland forests for food. The conversion of North American forests and wetlands to agricultural lands, and the degradation and loss of wetland habitats to development, drainage, and pollution, gradually changed North American waterfowl feeding habits. As wetlands diminished and farmlands increased, many waterfowl adapted to foraging in croplands, i.e., in crop stubble, on waste grain, and on the weedy herbs that colonize fields between crop rotations.

Game agencies use farming to attract and provide forage for waterfowl on wildlife management areas. On the Delmarva Peninsula, crop or food plot management has been conducted largely to attract Canada geese, and to a lesser extent, dabbling ducks. Cropland management has also been a traditional habitat management tool on national wildlife refuges nationwide. Refuges have used farming to attract and feed waterfowl species to support migrating goose and duck populations, as well as to provide hunting and viewing opportunities for the public. Prime Hook NWR began a cooperative farming program when the refuge was created in the 1960s. At that time, the refuge also managed the farming program to support duck production, with croplands in grass/clover stages of

rotations designed to provide nesting habitats for ducks. At its peak in the 1970s, 1,070 acres were in agricultural production on the refuge. In 2006, the last year of the cooperative farming program, the refuge farmed 485 acres.

Historically, waterfowl were the most closely monitored and managed bird populations on national wildlife refuges. Much of the Refuge System's land acquisition and management capability was funded by an interest in game birds. Emerging status and trends data on many migratory bird groups, such as songbirds, colonial waterbirds, shorebirds, and raptors, as well as other wildlife, including mammals, fish, herpetiles, insects and plants, has expanded the conservation mission of the Refuge System beyond waterfowl alone. The current purposes and mission of Prime Hook NWR include conserving all processes and organisms comprising healthy ecological communities of coastal Delaware.

At its peak, the cooperative farm program at Prime Hook NWR managed 48 small fields averaging 22.3 acres each, for a total of 1,070 acres, or 0.073 percent of the total cropland (2007 acres) on the Delmarva peninsula. As part of a cooperative agreement on Prime Hook NWR, farmers historically planted several hundred acres of nonnative cover crops (barley, clover, or wheat) as green browse for geese after the harvest of the corn or soybean crop. In 2007, Sussex County alone managed nearly 35,000 acres of green browse; there was a total of 306,120 acres of green browse on Delmarva.

Prior to establishing a cropland management program, Refuge Policy 6 RM 4 states the refuge must develop a cropland management plan. The plan must describe how refuge wildlife population objectives will be achieved through the production of grain. Prime Hook NWR's cropland management plan was approved in 1970. Since its development, the refuge cropland management expanded to include additional lands acquired in the 1970s to the present. Farming techniques, pesticides, best management practices, etc., have changed tremendously since the original cropland management plan. Prime Hook NWR's cropland management plan has been outdated and obsolete for many years; it did not include the use of more advanced agricultural techniques and best management practices, such as integrated pest management.

In addition to Refuge Policy 6 RM 4, two acts of Congress also play a role in the cropland management program: NEPA and Refuge System Improvement Act (1997). NEPA requires the government to evaluate the impacts of its management actions to the affected environment. The Improvement Act requires the refuge to ensure that cooperative farming is compatible with the purpose for which the refuge was established. Cooperative farming is also considered an economic use and Refuge Policy 5 RM 17 plays a role in the formation of cropland management planning.

In 2006, the Delaware Audubon Society, Center for Food Safety, and Public Employees for Environmental Responsibility filed suit against the Service for the refuge's failure to comply with these acts and policies. In 2009, the judge enjoined the refuge from farming and planting genetically modified organisms until the refuge completed compatibility determinations and environmental assessments dealing with the impacts. The refuge ceased all farming operations in 2006, and this CCP serves as the required NEPA analysis of farming as a management option.

History of Refuge Wetlands and Wetland Management

The wetlands on and around the refuge have been shaped by many natural and human-caused factors over the last century. Table 3-3 provides a summary of wetland history.

Table 3-3. Summary of Historic Wetland Survey Findings in the Prime Hook NWR Area. 1976 DE Wetland Atlas Designations: Zone I dominated by salt marsh cordgrass *(Spartina alterniflora);* Zone II dominated by salt hay *(Spartina patens)* and spike grass *(Distichlis spicata)*; Zone III dominated by salt bush species *(Iva frutescens* and/or *Baccharis halimifolia)* mixed with salt hay or spike grass; Zone IV dominated by giant reed grass *(Phragmites australis);* Zone V is a transitional wetland type with no dominant species.

	Early 1900s	1951 Survey of Delaware Wetlands Findings			Wetland Survey Work Conducted by the University of Delaware and DNREC in the 1970s	
Refuge Unit(s)	**Compiled from early narratives and accounts**	**Dominant Vegetation Species**	**Salinity Range**	**Additional Comments**	**1973 Vegetation Map Dominant Species**	**1976 DE Wetland Atlas Zone(s)***
Unit I	Slaughter Canal was dug by landowners to improve drainage on nearby uplands, thus altering and limiting tidal flow in the salt marsh.	big cordgrass, salt marsh cordgrass, salt hay, cattail, *Phragmites,* three-square, panic grass, marsh mallow, high tide bush, groundsel bush; **In the brackish portions:** duckweeds, pondweeds, bur-reed, cattail, water willow, wild rice, pond lilies, rushes, smartweeds	1.7 – 38.8 ppt	In spite of the large acreage encompassed by this marsh survey unit, use of the area by waterfowl was low compared to other parts of the State.	*Spartina patens* *Spartina alterniflora* *Phragmites australis* *Iva frutescens* *Spartina cynosuroides* *Typha* spp. *Panicum virgatum* *Hibiscus palustris*	Zone I Zone II Zone III Unit I shoreline categorized as Zone IV
Unit II	Slaughter Creek flowed through this marsh directly into the Delaware Bay until the outlet was closed by a storm. Much of the marsh was grid-ditched for mosquito control.				*Phragmites australis* *Spartina alterniflora* *Spartina patens* *Iva frutescens* *Spartina cynosuroides* *Hibiscus palustris*	Zone I Zone II Unit II shoreline categorized as Zone IV
Unit III	Prime Hook Creek flowed through this marsh and through the barrier beach directly into the Delaware Bay. It brought tidal water into this salt marsh daily, until the outlet was closed by a storm.	**In the saline portions:** *Phragmites,* big cordgrass, salt marsh cordgrass, cattail, salt hay, groundsel bush, marsh mallow; **In the fresher portions:** cattail dominates; also, bur-reed, pondweeds, smartweeds, chufa, wild millet, three-square, sweet pepper bush, rushes, common ragweed	0.1 – 18.6 ppt	A high barrier along the coast is cited as the reason there as less true salt marsh vegetation in this unit than in areas north and south. Occasional influx of saltwater through breaks in the dune are also noted. Expansion of *Phragmites* is noted. Survey unit contains areas recommended for future water level management.	*Phragmites australis* *Spartina alterniflora* *Iva frutescens* *Spartina patens* Mixed Species *Typha* spp. *Hibiscus palustris*	Zone IV Zone V Southern portion of Unit III categorized as Zone II
Unit IV	Much of this marsh was grid-ditched in the 1930s for mosquito control.	**In the coastal portion:** salt hay, big cordgrass, salt marsh cordgrass, high tide bush, groundsel bush, marsh mallow, panic grasses **In the small fresher areas:** cattails, smartweeds, swamp dock, water willow, pondweeds, *Phragmites*	1.4 – 29.0 ppt	Low muskrat production was attributed to presence of mosquito control ditches that were cleaned each year.	*Spartina patens* *Spartina alterniflora* *Iva frutescens* *Phragmites australis* *Typha* spp. *Hibiscus palustris* *Spartina cynosuroides*	Zone I Zone II

Refuge Vegetation Resources

Mapping Refuge Vegetation

Mapping of vegetation communities was conducted from 2005 to 2007 by DNHP and NatureServe on the refuge, excluding about 827 acres of easements. Mapping was conducted according to the NVCS, which is the Federal standard. This system classifies vegetation on a national scale for the United States and is linked to the international vegetation classification. The NVCS provides a uniform name and description of vegetation communities found throughout the country and helps determine relative rarity. The NVCS classification standard is organized into a natural vegetation hierarchy that consists of eight levels based on floristic and physiognomic criteria that include:

(1) Formation class
(2) Formation subclass
(3) Formation
(4) Division
(5) Macrogroup
(6) Group
(7) Alliance
(8) Association

The NatureServe group generated a report summarizing a subset of the international classification standard covers of vegetation associations attributed to Prime Hook NWR in 2006. Their report includes vegetation community element descriptions, element distributions along the Mid-Atlantic and Northeast, and global rarity rankings of refuge communities (McAvoy et al. 2007). Vegetation communities were described using 2002 aerial photography and field studies.

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.

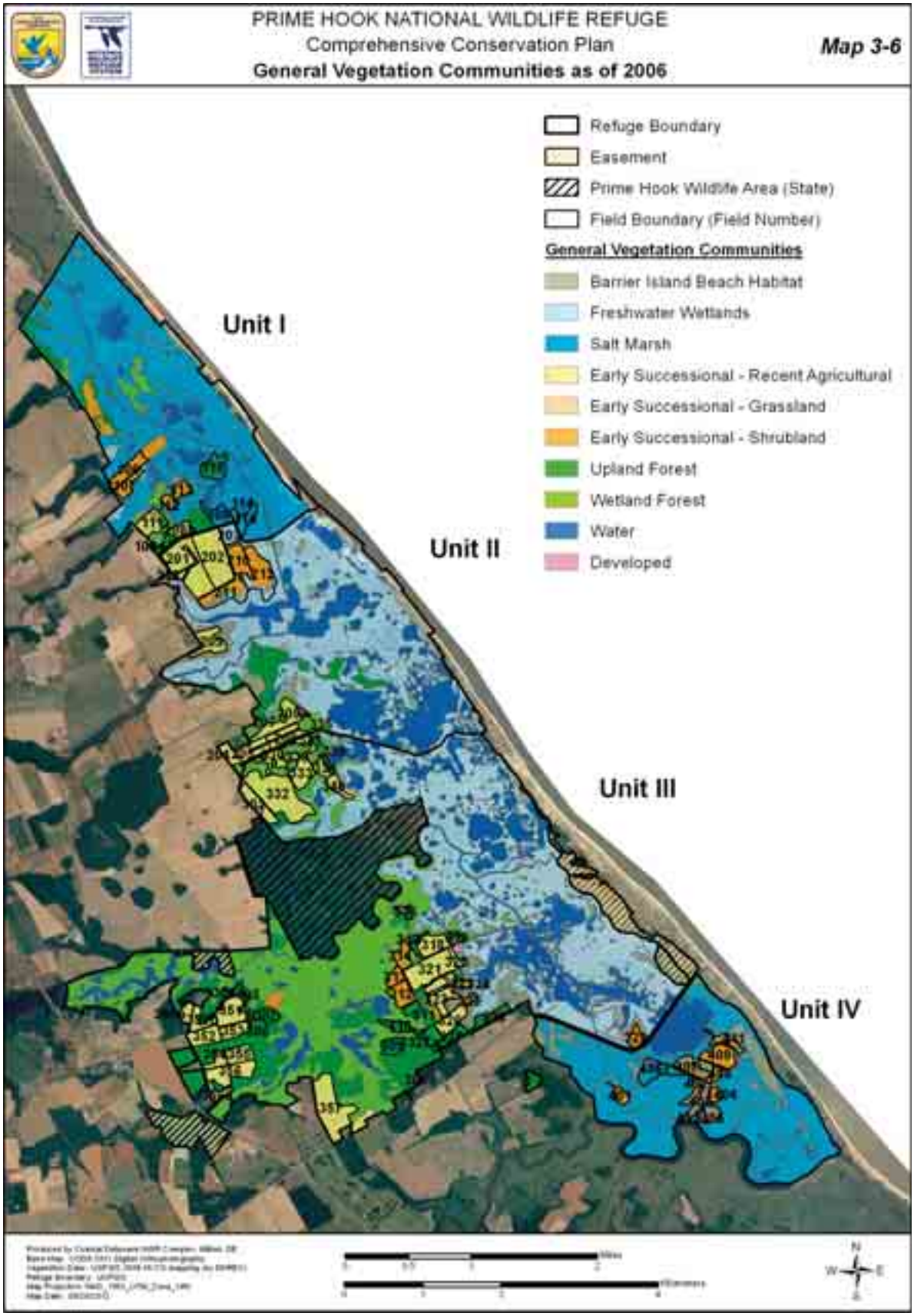
Prime Hook NWR General Flora Description

Refuge plant surveys conducted in 2004 and 2005 by DNHP botanists provided data on vegetation conditions and species composition at that time (McAvoy et al. 2007). Natural habitats dominate refuge vegetation. Approximately 80 percent of habitat cover types represented by emergent wetlands are shaped by tidal and freshwater creek drainages that discharge into the Delaware Bay. These coastal marsh habitats are also interspersed with swamps, upland forests, shrublands, and grasslands representative of the Delmarva coastal plain ecosystem. NVCS cover typing delineated 37 distinct vegetation community types, including anthropogenic communities and water surface coverages (map 3-2). For more general discussions during the CCP development, a less detailed map combined the NVCS communities into 10 broad vegetation and land cover classes (map 3-6).

The flora of Prime Hook NWR is represented by 100 families and 247 genera. 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* (nine taxa), *Eleocharis* (eight taxa), *Polygonum* (eight taxa), *Bidens* (seven taxa), *Eupatorium* (seven taxa), *Juncus* (seven taxa), *Asclepias* (six taxa), *Cyperus* (six taxa), and *Rhynchospora* (six taxa) (McAvoy et al. 2007).

The majority of refuge plants are perennial broadleaf herbs with 131 taxa, followed by annual broadleaf 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

Map 3-6. General Refuge Vegetation Communities



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. Documented rare plants included 44 species (seven-S1, 20-S2, and 17-S3).

National Vegetation Classification Standard Refuge Communities

Thirty-four natural NVCS vegetation communities were found on Prime Hook NWR in addition to three anthropogenic communities (open lawn, agricultural field, and loblolly pine plantation) (table 3-4; map 3-2). The *Spartina* low marsh (1,685 acres) was the largest association and the buttonbush coastal plain pond was the smallest (1 acre). 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.

Table 3-4. List of NVCS Associations Mapped on Prime Hook NWR

Habitat Type Common Name	NVCS Association
Overwash dune	*Spartina patens, Schoenoplectus pungens, Solidago sempervirens* Herbaceous vegetation
Beachgrass/panicgrass dune grassland	*Ammophila breviligulata, Panicum amarum* Herbaceous vegetation
Atlantic Coast interdune swale	*Morella cerifera, Spartina patens* Shrubland
Interdunal switchgrass brackish depression	*Morella cerifera, Panicum virgatum, Spartina patens* Herbaceous vegetation
Mid-Atlantic maritime salt shrub	*Baccharis halimifolia, Iva frutescens, Spartina patens* Shrubland
Maritime red cedar woodland	*Juniperus virginiana, Morella pensylvanica* Woodland
Successional maritime forest	*Prunus serotina, Sassafrass albidum, Amelanchier Canadensis, Quercus velutina, Smilax rotundifolia* Forest
Southern red oak/heath forest	*Quercus alba, Q. falcate (Pinus taeda), Gaylussacia frondosa* Forest
Mesic coastal plain oak forest	*Quercus falcate, Q. phellos/Ilex opaca* Forest
Coastal loblolly pine	*Pinus taeda, Morella cerifera, Vitis rotundifolia* Forest
Mesic coastal plain rich forest	*Liriodendron tulipifera, Quercus rubra, Fraxinus Americana/, Uvularia perfoliata* Forest
Mesic coastal plain mixed hardwood forest	*Fagus grandifolia, Quercus (alba,rubra), Liriodendron tulipifera /Polystichum acrostichoides* Forest
Successional sweetgum forest	*Liquidambar styraciflua* Forest
Pond pine woodland*	*Pinus serotina, Magnolia virginiana, Vaccinium corymbosum, Carex atlantica* Woodland
Red maple/seaside alder swamp*	*Acer rubrum, Alnus maritima* Woodland
Coastal plain depression swamp	*Liquidambar styraciflua, Acer rubrum, Quercus phellos/Leucothoe racemosa* Forest
Coastal loblolly pine wetland forest	*Pinus taeda, Morella cerifera, Osmunda regalis* var. *spectabilis* Forest
Atlantic white-cedar swamp	*Chamaecyparis thyoides, Alnus maritima* Woodland
Cottonwood swamp	*Populus heterophylla, Acer rubrum, Quercus palustris, Liquidambar styraciflua* Forest
Atlantic Coast wild rice marsh	*Zizania aquatica* Herbaceous vegetation
Cattail brackish marsh	*Typha angustifolia, Hibiscus moscheutos* Herbaceous vegetation
Brackish meadow	*Panicum virgatum, Spartina patens* Herbaceous vegetation

Habitat Type Common Name	NVCS Association
Pickerelweed marsh	*Peltandra virginica, Pontedaria cordata* Herbaceous vegetation
Pond lily marsh	*Nuphar lutea ssp. advena* Herbaceous vegetation
Cattail marsh	*Typha anustifolia, latifolia, Schoenoplectus spp.* Sparse vegetaion
Coastal bay shore/succulent beach*	*Sesuvium maritimum, Atriplex spp., Suaeda spp.* Sparse vegetation
River seedbox marsh	*Ludwigia leptocarpa* Semipermanently flooded herbaceous vegetation
Twig rush peat mat community*	*Cladium mariscoides, Eriocaulon decangulare, Eriophorum virginicum* Herbaceous vegetation
Water willow shrub swamp	*Decodon verticillatus* Semipermanently flooded shrubland
Buttonbush coastal plain pond	*Cephalanthus occidentalis, Polygonum hydropiperoides, Panicum verrucosum* Shrubland
Brackish tidal creek shrubland	*Morella cerifera, Baccharis halimifolia, Eleocharis fallax* Shrubland
Spartina high salt marsh	*Spartina patens, Distichlis spicata (Juncus gerardii)* Herbaceous vegetation
Spartina low salt marsh	*Spartina alterniflora/ (Ascophyllum modosum)* Herbaceous vegetation
Salt panne	*Salicornia (virginica, bigelovii, maritima), Spartina alterniflora* Herbaceous vegetation

We have listed the NVCS community associations and habitat descriptions that apply to each of the four refuge management units. These vegetation inventories and resulting maps represent the best available information regarding vegetation cover on the refuge. As stated above, we recognize that the information is already outdated for portions of our managed wetland impoundments that have been affected by recent coastline changes. Detailed NVCS maps for each refuge unit are found in the HMP (appendix B).

Vegetation in Refuge Management Units

NVCS Vegetation Communities in Management Unit I

Unit I totals 1,624.9 acres (table 3-5). Of the total acres, 1,504.7 acres are natural communities and 120.2 acres are anthropogenic communities. Unit I receives tidal, brackish water inputs from Slaughter Creek, which results in the development of *Spartina* low salt marsh, which is 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 1,500 acres.

Table 3-5. Natural and Anthropogenic Communities in Management Unit I

Natural Community	Unit I acreage (hectares)
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)

Natural Community	Unit I acreage (hectares)
Spartina high salt marsh	75.2 (30.4)
Spartina low salt marsh	982.0 (397.4)
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)**

NVCS Vegetation Communities in Management Unit II
Unit II is just south of Unit I and is an impounded, nontidal freshwater system that is manipulated by water control structures. Freshwater input is from Slaughter Creek, which flows from the west. Total acreage of Unit II is 1,997.5 acres, of which 1,681.8 acres are natural communities and 315.7 acres are anthropogenic communities (table 3-6). The generic marsh cover type is the largest vegetation community and the smallest is the maritime red cedar woodland. As of 2006, this unit is being overrun (approximately 100 acres) by river seedbox *(Ludwigia leptocarpa)*, a native plant of the south, but is considered nonnative in Delaware; it has invasive characteristics at the refuge. Furthermore, storms in 2008 and 2009 created overwashes along the coast of Unit II, which have formed inlets. The resulting flow of saltwater into Unit II killed much of the freshwater vegetation that was present when the NVCS mapping was done. This list represents a baseline inventory of cover types in Unit II as of 2005 when the mapping work was conducted.

During late February and early March 2010, an algal bloom started in the most southern areas of Unit II, adjacent to Prime Hook Beach Road. By the end of May, the algal bloom had continued to expand, covering about 700 acres in Unit II and 300 acres in Unit III. This algae has been identified as *Cladophora*, a genus of reticulated filamentous Ulvophyceace (green algae) found naturally along coastline habitats within the littoral zone (open water areas near shorelines). A common component of freshwater ecosystems, *Cladophora* can provide food and shelter for invertebrates and small fish. Problems arise when environmental conditions of light, substrate, and nutrients (especially phosphorus) suddenly change and become favorable for luxuriant growth of algal mats over extensive areas. This is the first time such a nuisance bloom has occurred on the refuge. *Cladophora* itself does not present a risk to human health but decaying *Cladophora* can promote bacterial growth and a pungent septic odor like sewage. Nuisance *Cladophora* outbreaks indicate an ecosystem under stress.

Table 3-6. Natural and Anthropogenic Communities in Management Unit II

NVCS - Natural Community	Unit II acreage (hectares)
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 wwamp	47.2 (19.1)
Maritime red cedar woodland	1.9 (0.8)
Generic marsh	918.9 (371.8)

NVCS - Natural Community	Unit II acreage (hectares)
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)
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)**

NVCS Vegetation Communities in Management Unit III

Unit III is the largest of the units and lies between Unit II and Unit IV. Like Unit II, it has been managed as a nontidal freshwater system since the mid-1980s. It is 4,431.0 acres, of which 3,822.6 acres are natural communities and 608.4 are anthropogenic communities (table 3-7). The generic marsh is the largest cover type and an overwash dune at the north end of the Unit is the smallest. Generic marsh consists of various freshwater and brackish wetland species, mostly annuals, which can vary each year based on growing conditions. Biologically and ecologically, Unit III is the most important 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 west to east roughly divides this unit into a northern half and southern half. This unit contains the largest amount of anthropogenic communities at 608.4 acres, more than the other three units combined.

Table 3-7. Natural and Anthropogenic Communities in Management Unit III

NVCS – Natural Community	Unit III acreage (hectares)
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)

NVCS – Natural Community	Unit III acreage (hectares)
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)
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)**

NVCS Vegetation Communities in Management Unit IV

Unit IV is the southernmost management unit and is the smallest of all the units with a total area of 1,176.4 acres, of which 1,111 acres are natural communities and 65.3 acres are anthropogenic communities (table 3-8). 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 generic marsh category. Unit IV at Prime Hook NWR is the only known location for this community in the State of Delaware.

Table 3-8. Natural and Anthropogenic Communities in Management Unit IV

NVCS - Natural Community	Unit IV acreage (hectares)
Atlantic coast interdune swale	30.5 (12.3)
Brackish tidal creek shrubland	17.7 (7.1)
Coastal loblolly pine forest	9.7 (3.9)

NVCS - Natural Community	Unit IV acreage (hectares)
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)**

Federal and State-Listed Plants and Communities

In addition to producing high-quality vegetation cover maps of the refuge, the Service contracted the DNHP to collect baseline data on rare, endangered, or threatened flora and fauna. During 2004 and 2005, rare plant surveys were conducted through areas that mapped rare vegetation community elements, and zoological surveys were conducted that assessed the presence and location of rare herpetafauna, odonates, lepidopterans, small mammals, and other invertebrates. A final report summarizing composite data was submitted to the Service in June 2007 (McAvoy et al. 2007).

Modern scientific resource programs using the principles of conservation biology are premised on understanding and mapping the elements of rarity across the landscape. Determining which plants and animals are thriving and which are rare or declining is crucial for targeting conservation actions toward those species and habitats of greatest conservation need. The rankings provide an estimate of extinction risk to protect species before they become listed as threatened or endangered. Status is assessed and documented at three geographic scales: global (g), national (N), and state (S). Status assessments are based on the best available information and consider a variety of factors, such as abundance, distribution, population trends, and threats.

Exemplary Natural Communities

Exemplary natural communities are those that have been minimally impacted by humans and contain an exceptional diversity of rare plant species. The most significant community found on the refuge was the twig rush peat mat. These sites (six were mapped by McAvoy and Coxe 2007) support many State rare plant species (table 3-9) 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. 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 associated with many rare plants (24 species), 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: bushy bluestem *(Andropogon glomeratus* var. *hirsutior).*

Table 3-9. State Rare plants associated with Twig Rush Peat Mat Community on Prime Hook NWR

Scientific Name	Common Name	State Rank	Habit & Duration	Wetland Indicator Status
Alnus maritime	Delmarva alder	S3	deciduous shrub	OBL
Andropogon glomeratus var. hirsutior	bushy bluestem	S1	perennial grass	FACW+
Bartonia paniculata	twining bartonia	S2	annual broadleaf herb	OBL
Bidens coronata	tickseed sunflower	S3	annual broadleaf herb	OBL
Bidens mitis	small-fruit beggar-ticks	S2	annual broadleaf herb	OBL
Cyperus diandrus	umbrella flatsedge	S1	annual sedge	FACW
Drosera rotundifolia	round-leaf sundew	S2	perennial grass	OBL
Eleocharis robbinsii	Robbins spike-rush	S3	perennial grass	OBL
Eriocaulon decangulare	ten-angle pipewort	S1	per broadleaf herb	OBL
Eriophorum virginicum	tawny cotton-grass sedge	S1	perennial sedge	OBL
Eriocaulon parkeri	Parker's pipewort	S2	perennial sedge	OBL
Fuirena pumila	hairy umbrella-sedge	S2	annual sedge	OBL
Fuirena squarrosa	dwarf umbrella sedge	S3	perennial sedge	OBL
Juncus pelocarpus	brown-fruited rush	S2	per broadleaf herb	OBL
Lycopus amplectens	sessile-leaved bugleweed	S2	perennial broadleaf herb	OBL
Pogonia ophioglossoides	rose pogonia	S2	per broadleaf herb	OBL
Rhynchospora alba	white beakrush	S2	perennial sedge	OBL
Rhynchospora scirpoides	long-beaked beakrush	S2	perennial annual	OBL
Sagittaria engelmanniana	Engelmann's arrowhead	S2	perennial aquatic herb	OBL
Sagittaria graminea	grass-leaf arrowhead	S2	per aquatic herb	OBL
Sarracenia purpurea	purple pitcher-plant	S2	per broadleaf herb	OBL
Spiranthes cernua	nodding ladies'-tresses	S3	perennial broadleaf herb	FACW
Utricularia fibrosa	fibrous bladderwort	S2	per aquatic herb	OBL
Utricularia juncea	southern bladderwort	S2	per. broadleaf herb	OBL

Other Rare Plant Communities

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. Based on current knowledge the red-maple/seaside alder woodland occurs only at Prime Hook NWR and may not occur anywhere else in Delaware or North America. Other rare and unique communities mapped on the refuge include the coastal bay/succulent beach and pond pine wetland communities.

Red Maple/Seaside Alder Community

This community is typified by the dominance of red maple in the overstory and seaside alder on the edges and in the understory within a swamp environment of standing water. The substrate is peat and muck characterized by hummock-and-hollow microtopography. The shrub layer consists of water willow, sweet pepperbush, southern bayberry, and occasionally buttonbush and fetterbush. The herbaceous layer forms on hummocks and hollows and is dominated by royal fern, northern marsh St. John's wort, cardinal flower, weak stellate sedge, three-way sedge, and mild water-pepper.

Rare plant species that occur in this community include seaside alder, Mitchell's sedge, green-fringe orchis, and gibbous grass. Seaside alder occurs on hummocks along the edges of open water, green-fringe orchis is found at base of trees within the understory and blooms in mid-summer, and Mitchell's sedge is found within the interior of this community growing on hummocks in the shade of the understory. The gibbous grass grows in sun and shallow water on the edges of this community and at times forms dense, pure stands. For a complete description of all NVCS vegetation alliances and associations mapped on the refuge see the NatureServe 2006 report in McAvoy et al. 2007.

Coastal Bay Shore/Succulent Bush
This community is dominated by sea purslane with patches of spearscale, panic beachgrass, barnyard grass, brackish sprangletop, small spike-rush, and salt marsh fleabane. Although this community is located within a 200-acre impoundment in Unit IV, it is surrounded by salt marsh habitats and is often irregularly flooded by storm tides from the Broadkill River and Delaware Bay waters. As to its current Statewide distribution, this community is not known to occur anywhere else in Delaware.

Other rare plants found on the refuge are included in table 3-10. Within the coastal plain depression swamp community type about 25 individuals of the State-rare cattail-sedge *(Carex typhina*, S3) in Unit III and 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 (McAvoy and 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, *(Alnus maritima*, 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 orchid's *(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), 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.

Table 3-10. Other Rare Plants found on Prime Hook NWR

Scientific Name	Common Name	State Rank	Habit & Duration	Wetland Indicator Status
Asclepias lanceolata	lance-leaf orange milkweed	S1	perennial broadleaf herb	OBL
Bartonia paniculata	twining bartonia	S2	annual broadleaf herb	OBL
Carex exilis	coast sedge	S1	perennial sedge	OBL
Carex typhina	cattail sedge	S3	perennial sedge	FACW+
Conoclinium coelestimun	blue boneset	S3	perennial broadleaf herb	FAC
Eriocaulon compressum	flattened pipewort	S2	perennial broadleaf herb	OBL
Helianthus angustifolius	swamp flower	S3	perennial broadleaf herb	FACW
Helianthus giganteus	tall sunflower	S3	perennial broadleaf herb	FACW
Hudsonia ericoides	golden heather	S1	evergreen shrub	UPL
Iris prismatica	slender blue-flag	S2	perennial broadleaf herb	OBL
Juncus militaris	bayonet rush	S2	perennial aquatic rush	OBL

Scientific Name	Common Name	State Rank	Habit & Duration	Wetland Indicator Status
Listeria australis	southern twayblade	S3	perennial broadleaf herb	FACW
Passiflora lutea	passionflower	S3	herbaceous vine	UPL
Platanthera lacera	green-fringe orchis	S3	perennial broadleaf herb	FACW
Polygonum ramosissimum	bushy knotweed	S3	annual broadleaf herb	FAC
Pyrrhopappus carolinianus	Carolina false-dandelion	S3	annual broadleaf herb	UPL
Smilax walteri	Walter's greenbriar	S3	woody vine	OBL
Utricularia radiate	small swollen bladderwort	S3	perennial aquatic herb	OBL

Moist-Soil Management and Production

Moist-soil management provides plant and animal foods that are a critical part of the diet of wintering and migrating waterfowl and shorebirds, and has been a significant part of wetland management of the project area of Prime Hook NWR for the last 20 years. Native moist-soil wetland plants provide seeds and other plant parts (leaves, roots, and tubers) that generally have low deterioration rates after flooding and provide substantial energy and essential nutrients to wintering waterfowl, unlike common agricultural grains (corn, mile, soybeans) and nonnative cover crops (Strader and Stinson 2005).

Moist-soil management also supports diverse and abundant populations of invertebrates, which are an important protein source for waterfowl, shorebirds, and other waterbirds. For the moist-soil impounded habitats on the refuge, the annual seed yield production and foraging values greatly vary in each of the sampled areas from year to year depending on weather, rainfall patterns, and snow goose herbivory, which all affect moist-soil plant production, annual seed yields, and food availability for target bird species.

Water level manipulations make food resources available to waterfowl, shorebirds, and other wetland-dependent birds at critical times of the year. The plants and invertebrates available year-round in moist-soil impoundments provide food resources necessary for wintering and migrating birds to complete critical aspects of their annual cycles such as molt and reproduction.

During the past decade, the primary wetland habitat management focus of the refuge has been to increase the foraging carrying capacity of its impoundment complex for waterfowl and shorebirds using impoundment-specific strategies for water level manipulations (Fredrickson 1994). An integrated management approach using moist-soil management techniques has consistently generated annual seed production of moist-soil plants that provide a range from 689 to 2,630 pounds of native wetland plant seeds per acre within 4,000 acres of impounded marsh.

A seed estimator sampling technique was used to quantify annual moist-soil seed production as discussed in *Waterfowl Management Handbook,* chapter 13.4.5 entitled, "A Technique for Estimating Seed Production of Common Moist-soil Plants." For 7 consecutive years, annual moist-soil seed production was monitored on the refuge within several impoundment subunits (PMH2A, PMH2C, PMH3A, PMH3B, PMH3D, and PMH4A), documenting the successful annual production of native plant food resources available to waterfowl and other wetland dependent bird species (table 3-11, figure 3-1).

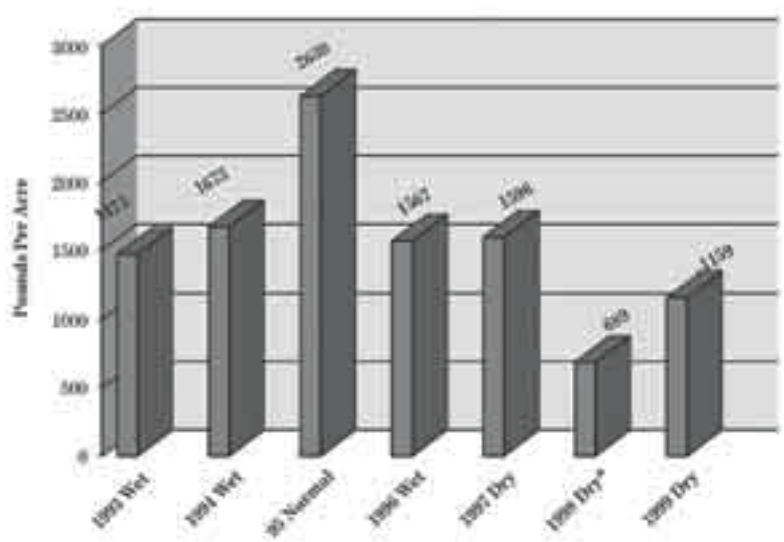
Table 3-11. Moist-Soil Production Data (Impoundments)

Comparison of Seed-Yields (lbs/acre) during Adverse Weather Conditions							
Year	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**
PMH2A	1,442	3,020	2,229	2,290	1,574	1,567	962
PMH2C	5,443	2,572	5,147	2,524	2,778	0	484
PMH3A	0	1,671	2,891	872	1,740	458	1,159
PMH3B	1,306	1,670	2,470	2,001	1,548	158	667
PMH3D	0	0	799	648	949	948	596
PMH4A	648	1,107	2,246	1,069	985	0	0
Weather	WET	WET	NORM	WET	DRY	DRY**	DRY
Total Avg. Production	2,209	2,008	2,630	1,567	1,596	522	645

** *Extreme flood conditions in early winter followed by 6 months of extreme drought.*
{Mean for wet years: X_{wet} = 1,928 lbs/acre} {Mean for dry years: X_{dry} = 921 lbs/acre}
{Grand Mean for all years = 1,425 lbs/acre}

Quantified seed yields were estimated by measuring a few dominant moist-soil plants: *Echinochloa walteri* (Walter's millet), *Cyperus esculentus* (nutsedge), *Leptochloa fasicularis* (Sprangletop), *Panicum dichloromiflorum* (Fall panicum), *Polygonum* sp. (smartweeds), and *Setaria* sp. (foxtail) (Laubhan and Fredrickson 1992). Therefore, seed production estimates were very conservative as calculated, using the data contained in Prime Hook NWR's Annual Marsh and Water Management Program Reports from 1993 through 2000.

Figure 3-1. Average Seed Yields Sampled in Prime Hook NWR Impoundment Subunits



**Note: 1998 depressed seed yields were attributed to extreme drought conditions experienced during 6 months of the growing season preceded by a severe Nor'easter season.*

Invasive Plants

The presences of invasive plants can have a major adverse impact on the biological integrity, diversity, and environmental health of refuge lands and other natural areas.

Of the 426 plant taxa listed in refuge plant inventories, 45 are nonnative, of which 10 are considered to be invasive and negatively impacting native habitats. These include spotted knapweed, Canada thistle, kudzu, mile-a-minute, Japanese honeysuckle, river seedbox, Japanese stilt-grass, reed canary grass, alien common reed, usually referred to in this document as *Phragmites*, and multi-flora rose.

Spotted knapweed, Canada thistle, mile-a-minute, Johnson grass, and kudzu 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 in mostly wooded habitats. Japanese stilt grass (about 50 acres) is mostly found on Oak Island, where it dominates the herbaceous layer.

River seedbox, a new addition to the flora of Delaware first discovered on the refuge in 2005, is an adventive plant species that has at times dominated portions of impounded marsh Unit III. River seedbox is native further south in the eastern U.S. but is not considered native in Delaware.

By fall 2006, this species had spread to about 500 acres in Units II and III impounded wetlands parallel to Prime Hook Beach Road. River seedbox is similar to alien common reed *(Phragmites australis)* in its aggressiveness. It is surmised that river seedbox became established on the refuge by waterfowl, who are attracted to this plant's large seeds. A single plant can produce thousands of seeds. One positive outcome of the May 11, 2008 nor'easter storm is that saltwater intrusion into river seedbox colonies has eliminated existing stands. As with all aggressive invasive plants, we must remain vigilant to their presence and spread and continue our active programs to control them.

Reed canary grass, which is another adventive 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, grows. The lance-leaf orange milkweed is abundant here and is the largest known population in the State (100+ individuals). Current annual mowing late in the growing season appears to be favoring this milkweed species by suppressing woody vegetation. Encroachment by reed canary grass should be monitored and hand-treated. Multi-flora rose is widespread throughout the refuge, growing in scattered areas within hedgerows, thickets, early successional fields

Phragmites control

Since the era of no management early in the refuge's history, *Phragmites* control has been a major concern and activity on Prime Hook NWR. From the late 1960s to 1982, *Phragmites* cover expanded by 34 percent and 3,000 acres of the refuge were covered in dense stands of *Phragmites* (figure 3-2). In 1983, the refuge prepared an environmental assessment to deal with this problem. The assessment described a rehabilitation program to reclaim the 3,000 acres of *Phragmites*. The project's primary objectives were to chemically treat 2,000 acres in Unit II and 1,000 acres in Unit III and reduce the severe fire hazard near private property.

Figure 3-2. Condition of refuge marsh near Fowler Beach in 1978, showing dense stand of *Phragmites*

Prior to this rehabilitation project, the refuge conducted several years of research to find effective and economical methods to control *Phragmites* on Prime Hook NWR. Refuge staff began consulting and coordinating a refuge-specific *Phragmites* control program in June 1978 with representatives of Delaware, New Jersey, North Carolina, and Rhode Island fish and game departments.

During the initial coordination sessions, Prime Hook NWR was selected as a test area to be sprayed with the then-new chemical glyphosate (N-phosphonomethyl glycine). A pilot spraying program was granted and experimental use permit (24-EUP-29) issued by the EPA in 1978. From 1976 to 1982, the before-mentioned State agencies, Monsanto researchers, and refuge personnel consulted and coordinated research activities by experimenting and assessing the effectiveness of herbicide treatments to control *Phragmites*.

Biologists with the Delaware Division of Fish and Wildlife provided technical and physical assistance in conducting trial applications of glyphosate to assess its efficacy in several wetland plots on the refuge. Prior to these field tests, Monsanto had also conducted extensive field studies on the effects of glyphosate on fish, wildlife, and vegetation. Short-term and long-term toxicity tests had been conducted on a wide variety of aquatic, avian, and mammalian wildlife species. The aquatic test organisms included fresh and saltwater species, as well as vertebrates and invertebrates. Waterfowl, upland game, fish, shrimp, and shellfish are some examples of the wildlife guilds included in these tests (USFWS 1983).

Acute (short-term) testing conducted on avian species, honey bees and fish showed that glyphosate was essentially non-toxic to these organisms. Chronic (long-term) toxicity tests also showed that glyphosate does not cause cancer, tumors, or reproductive problems in mammals (USFWS 1983). Further ecotoxicity studies of non-target impacts of glyphosate on birds, fish and aquatic life, mammals, and terrestrial invertebrates have demonstrated the same trends of minimal non-target effects (Sullivan et al. 1997). The most recent data for reregistration eligibility decision data for glyphosate maintain these past results of the nontoxicity of glyphosate on fish and wildlife species (NPIC 2011).

The timeframe for reclaiming Prime Hook NWR's marshes from *Phragmites* in the early 1980s was 3 years. From 1984 to 1986, approximately 3,000 acres were treated with consecutive double spray treatments between years and some prescribed fire used to reduce hazardous dead cane fuels. The program was a success.

Twenty years later, a second large-scale *Phragmites* control project was undertaken by the refuge to reduce or eliminate expanded stands located on refuge lands and private lands adjacent to the refuge. In close cooperation with the Delaware State Forestry Division and other partners, the refuge was funded for a 3-year, million dollar wildland urban interface project, which was executed

from 2002 to 2004. During that project, approximately 3,000 acres were treated on refuge lands and 1,000 acres were treated on private properties immediately adjacent to the refuge, resulting from the refuge partnering with 255 landowners in the Prime Hook, Broadkill, and Slaughter Beach communities.

Influence of Climate Change on Physical Environment and Refuge Management

Current Climate, and Local Coastal Storm Activity

Delaware's climate is generally mild, continental weather moderated by the effects of the Atlantic Ocean, causing brief periods of sustained hot or cold temperatures. Extreme temperatures are moderated by the Delaware Bay, the Atlantic Ocean and the Chesapeake Bay. On Prime Hook NWR, weather conditions are mild year-round with temperatures ranging from 32 °F to 80 °F. Normally, summer ocean breezes keep the refuge cooler than inland areas and most winter days are mildly attenuated by the same breezes.

Annual 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 miles per hour, 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 U.S. Department of Agriculture (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 refuge's coastal environments such as beaches, barrier islands, wetlands and estuarine ecosystems are closely linked to the local climate conditions created by coastal storms. Stronger and more frequent coastal storms are posing immediate threats and challenges to impounded wetland management schemes used on the refuge in the last three decades.

Hurricanes are usually more powerful than coastal storms along the Atlantic Coast, but coastal storms are more frequent in Delaware, last longer, and impact larger areas. While hurricane season runs from June 1 to November 30, coastal storms called nor'easters are a year-round threat to coastal Delaware. Prolonged flooding and extensive property damage are serious hazards more associated with nor'easters than hurricanes along the Delaware coast.

In Delaware, tidal flooding, or storm surge, associated with a nor'easter can actually exceed the levels associated with hurricanes. Storm surge is the result of water being dragged onto the shoreline by the storm's strong winds coupled with very low atmospheric pressure at the storm's center. Storm surge heights of 3 to 10 feet above normal are especially damaging when they bracket several high tide full and new moon cycles. The torrential rainfall from nor'easters can also cause extensive flooding in both coastal and inland areas and increase coastal erosion of sandy beach ecosystems (Carey and Dalrymple 2003).

It has been documented in the past that normal daily tide cycles and coastal storm processes actively change the configuration of the coastline. Normal low-energy processes move small volumes of sand and are both erosional and

depositional in nature. High-energy coastal storm processes involve large volumes of sediment movement (Kraft et al. 1976).

Delaware's most damaging coastal storm on record occurred over a 3-day period and five extreme full moon, high tide cycles March 6 to 8, 1962. Winds reached speeds of 70 miles per hour. Offshore waves were recorded at higher than 40 feet, while waves in the surf zone were 20 to 30 feet high. The storm surge associated with the storm was 9.5 feet, the highest tide ever recorded in Breakwater Harbor (Lewes Tide Gauge) at the mouth of the Delaware Bay (Carey and Dalrymple 2003).

Coastal storms with sustained winds can lead to prolonged flooding of refuge impoundments and roads and increase the erosion of refuge dunes. The surge of storm water landward results in heavy saltwater intrusion of freshwater wetlands and adjacent upland habitats. Long-term geologic changes from these coastal storms include beach erosion, dune erosion, and possible inlet formation from stronger flood and ebb tide surges.

Wind and saltwater intrusion, nearshore channeling, and sedimentation associated with coastal storms also cause landscape changes. In the past, this scenario and associated geological changes may have been experienced every other decade. Overwash at barrier coastlines is determined by the height and wave parameters. In 1978, Maurmeyer noted that "barriers along the southwestern shore of the bay generally require tide levels in excess of 3.0 meters (about 9 feet) above mean low water, which occur approximately once in 25 to 30 years before they overwash."

Since the 1990s, the refuge has been experiencing more frequent nor'easter activity with multiple big coastal storms making landfall during a single season, creating more rapid landscape and coastal changes. For example, the coastal storms of December 10 to 14, 1991 and January 4, 1992 had associated storm surges of up to 8.5 feet above mean high water. After these two storms, washovers and breaching of dunes occurred at scattered locations along the Delaware Bay. Geologic observations made by Delaware Geological Survey (June 1992) included the following notes relevant about the refuge (Ramsey et al. 1992):

> *The dunes were flattened between the north end of Prime Hook Beach and the south end of Slaughter Beach. Washovers were observed to extend 20 to 30 feet into the marsh throughout this area. An artificial earthen berm that originally stood approximately 8 to 10 feet high at the end of Road 199 at Fowler Beach was almost completely removed. Based on the relative position of a concrete structure at the south end of Fowler Beach (WWII tower) to the beach profile after the October 31 1991 storm and the January 4, 1992 storm, beach retreat in this area may be as much as 20 feet inland.*

Six years later, another set of back-to-back coastal storms occurred again on January 27 to 29 and February 4 to 6 in 1998. Recorded storm surges from 1999 topped the 1992 storm surges, peaking at 9.0 feet above mean higher high water. Both storms produced near-record high tides, but the January 28 storm was slightly higher than the February 5 storm; ironically, the February 5 storm was more damaging. From a comparison of Lewes Tide Gauge data, the February 5 storm was more severe because the low tides were exceptionally high before the storm developed off the coast. Of all the storms of record, even the 1962 storm, this particular phenomenon is very unusual and this makes this storm unique among those recorded to date in Delaware (Ramsey et al. 1998). Damage and erosion of artificial dunes was extensive, as the entire duneline was flattened and large overwashes developed similar to those of the 1992 storms.

Not until the category one hurricane Ernesto in 2006 did a distinctive inlet form north of Fowler Beach Road in 2006. A relatively mild storm, Ernesto made landfall with little rain. However, Ernesto blew off shore for several days, generating higher than normal tide cycles that intensified flood and ebb tide water surges even before making landfall. Since Delaware Bay is a relatively shallow body of water, waves build up more quickly than in the open Atlantic (Kraft et al. 1976). The water level continued to rise and waves attacked the shoreline for several days with increasing intensity. Finally, when landfall did occur, a new inlet broke through the refuge's sandy barrier in Unit I.

A year and half later, a severe Mother's Day coastal storm on May 11, 2008, caused considerable coastal erosion and overwashed all refuge marshes in Units I and II. One year later, two more back-to-back nor'easters occurred on October 15 to 19 and then November 12 to 15, 2009. Both nor'easters generated tide surges of 9.0 feet above mean higher high water. Sand in the form of washover fans was transported across the flattened beach dunes back into the adjacent marsh and a new tidal water flow channel was created in Unit II just south of Fowler Beach Road. Several tide cycles after the second storm hit, high tide cycles continued to pile water across the barrier, intensifying flood and ebb tide water surges that etched out two additional mini-inlets further south of the first inlet, across the Unit II duneline.

The increased frequency and severity of coastal storms over the past decade has a direct impact on the management options and capability along the refuge shoreline and in the adjacent coastal wetlands.

Climate Change, Sea Level Rise and Refuge Shoreline Dynamics

In 2007, the IPCC projected that average global sea level will likely rise between 19 and 59 centimeters (7 and 23 inches) by the end of the century (2090 to 2099), relative to the base period (1980 to 1999), excluding any rapid changes in ice melt of Greenland and Antarctica ice floes. According to the IPCC, the average rate of global sea level rise is very likely to exceed the average rate recorded over the past four decades [IPPC Fourth Assessment Report-AR4] (USCCSP 2009).

The U. S. Climate Change Science Program has generated a synthesis and assessment report in 2009 (product 4.1) determining coastal sensitivity to sea level rise and climate change scenarios with a focus on the Mid-Atlantic region. Accelerated rates of sea level rise with stronger and more frequent storms pose increasing impacts to coastal communities, infrastructure, beaches, wetlands, and natural ecosystems.

Two major processes cause global mean sea level rise: ocean temperature increases causing water to expand and increase in volume, and land reservoirs of glaciers and ice sheets melt due to rising earth temperatures.

At the same time, the land in coastal areas is subsiding. When the rates of actual sea level increase is combined with the subsidence of land areas, scientists add these two factors and refer to the total as "relative sea level rise," i.e., that the actual impact is the net of the two processes.

Global sea level rise rates rose to an average of about 1.7 mm/year over the 20th century. However, in the Mid-Atlantic region from New York to North Carolina, tide-gauge observations indicate that relative sea level rise rates ranged from 2.4 to 4.4 mm/year, or about 0.3 meters (1 foot) during the same time frame (USCCSP 2009), which is higher than the global mean. Although the body of research supporting concerns regarding global climate change and sea level rise is substantial, the Service recognizes that there is not necessarily worldwide scientific consensus regarding global or even regional sea level rise rates and predictions. Locally in Delaware, the rate of relative sea level rise has been estimated to be 3.2 ±0.28 mm/yr, (2.92 to 3.48 mm/yr, 95 percent confidence

interval), which is approximately 1.5 mm/yr higher than the average global rate of seal level rise alone (NOAA Lewes, DE, Tide Gauge: *http://tidesandcurrents.noaa.gov/sltrends/sltrends_station.shtml?stnid=8557380;* accessed August 2012).

It is this current, local rate of sea level rise which will direct many of the refuge's management decisions regarding achieving sustainable future conditions along the refuge shoreline and coastal wetlands. However, scientific projections for the 21st century are even higher, with predicted global sea level increase rates ranging from 2 to 7 mm/year (Rahmstorf 2007). Increasing sea level rise would greatly stress coastal wetlands, leading to either accelerated migration landward or wetland disintegration. Quantitative predictions of these future coastal changes remain difficult due to the complexity of coastal systems (Ashton et al. 2007). Predicting sea level rise impacts on shoreline changes or associated wetland losses with quantitative precision and certainty is not yet possible. If existing wetland habitats cannot keep pace with sea level rise through vertical accretion, the result will likely be extensive loss of coastal wetland habitats on the refuge and across the Mid-Atlantic. Also the quality, quantity, and spatial distributions of other coastal habitats will change as a result of erosion, shoreline and salinity changes, and wetland loss (USCCSP 2009).

Regardless of the future rate of sea level rise locally, it is not simply a rise in sea levels, per se, that poses the most significant threat to refuge management. Higher sea levels will also provide an elevated base for storm surges to magnify flooding effects and diminish the rate and capability at which low-lying coastal areas can drain water. This will further intensify the magnitude of flooding and erosion effects from coastal storms. Rapid sea level rise will exacerbate existing problems experienced by coastal areas from waves, storm surges, shoreline erosion, wetland loss, and saltwater intrusion.

Natural coastal ecosystems evolved under conditions of sea level rise. Barrier islands and salt marshes can sustain their features, but not necessarily their location or configuration, in the face of more frequent coastal storm events, provided they are healthy and processes such as vertical accrestion are not hindered.

Increased coastal storm-generated wind, waves, and higher astronomical tides will continually modify and change the refuge's physical shoreline and sandy beach templatesthrough breaching (inlet formation) and overwash processes with greater frequency. The refuge's undeveloped barrier island habitats may become completely reconfigured geomorphologically after each coastal storm. This reconfiguration will directly affect habitat availability and functionality and contribute to the redistribution of sediment along sandy beaches, shorelines, and refuge back barrier wetlands. This is how coastal ecosystems adjust to climate change, sea level rise, and more frequent storm surges (USGS 2010). Narrow, low-elevation barrier island communities, as found on the refuge, will become more susceptible to storm overwash development, barrier segmentation, the formation of new tidal inlets, and closing of previous inlets. These physical and geomorphic responses expedite landward migration or roll-over of shorelines as they readjust their equilibrium position in relation to rising sea levels and local storm conditions (USGS 2010).

In the past, the refuge coastal area was generally managed under the premise that sea level was relatively stable, shorelines remained static, and storms were regular and of predictable magnitude. Significant changes along the shoreline happened infrequently, and were considered to be unusual events. Within that scenario, little to no thought was given to shoreline and coastal monitoring or management. However, today it is recognized that refuge shoreline dynamics will be increasingly dominated by overwash and inlet processes as the coastline responds to the increased storm frequency and severety and relative sea level

rise associated with climate change.

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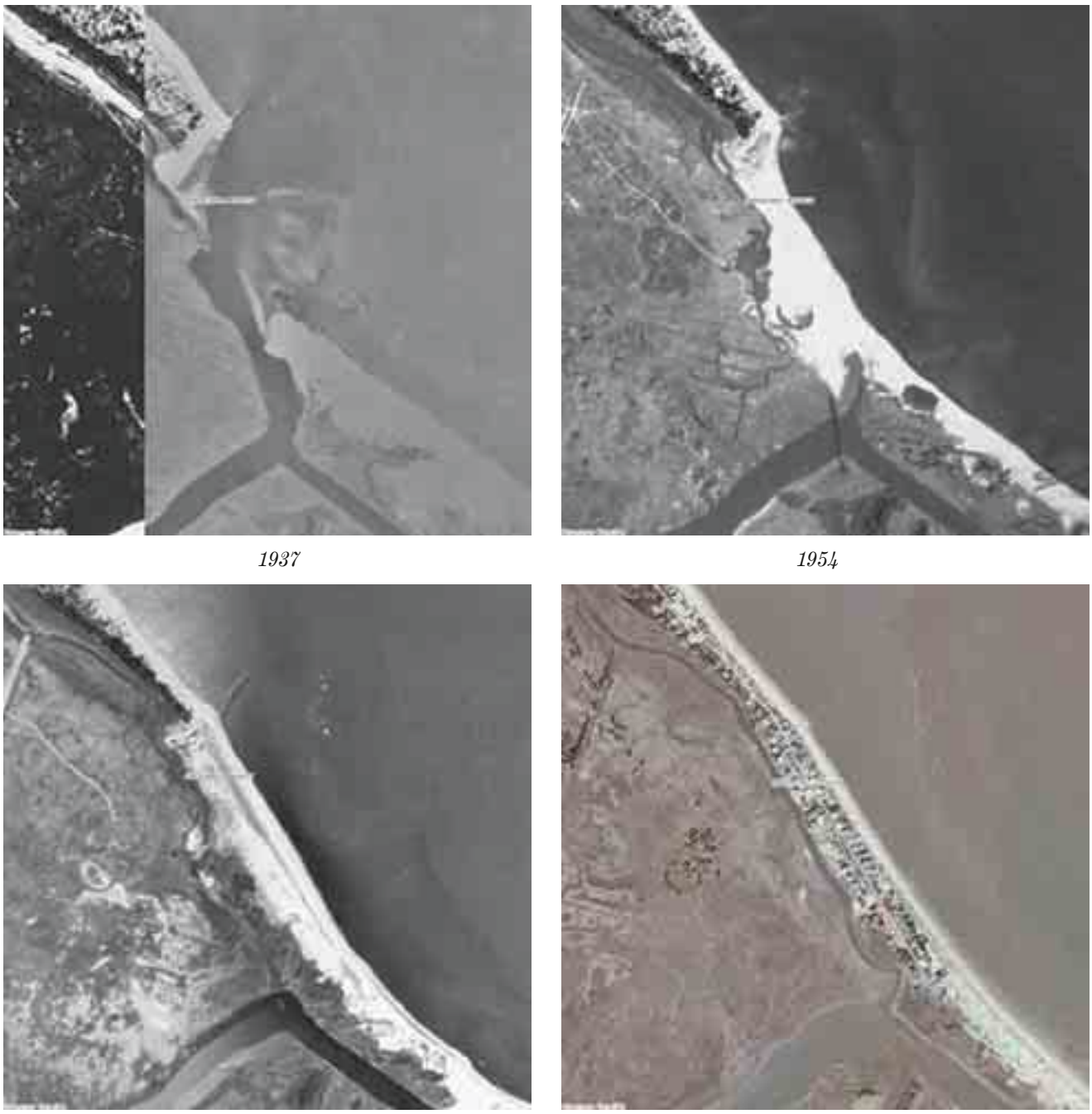
Refuge Shoreline Dynamics

Overwash and inlet processes are both integral parts of shoreline dynamics. Overwash processes deposit large sand fans across the beach and adjacent wetlands and serve to build barrier island elevation, widen beach width, and accrete sand in back barrier marshes. Storm overwash events assist in expanding barrier island width and also contribute to island roll-over or migration landward. Overwash deposition in many studied barrier island marsh systems have increased sedimentation rates that have promoted relatively stable marsh communities by enhancing vertical accretion mechanisms in the face of increased local rates of sea level rise (Ashton et al. 2007). Throughout Delaware, evidence of these coastal processes is prominent in the historic aerial imagery (appendix J). For example, portions of the Broadkill Beach community are constructed on sediments deposited naturally by the closure of an inlet that was present as recently as the 1940s (figure 3-3). The formation, recovery, and reformation of overwashes in the Fowler Beach area is illustrated in figure 1-1 in chapter 1.

Inlet formation is also vital to the short-term maintenance of barrier island ecosystems and their estuaries, and long-term barrier island evolution necessary to maintain and conserve coastal wetlands (Mallinson et al. 2008). Once an inlet is created, usually during a storm event, active flood and ebb tide deltas form in association with an inlet. As the inlet closes, the ebb-tide delta collapses, causing temporary and localized shoreline accretion while adjacent shoreline areas may erode (map 3-7).

The floodtide delta, which provides a platform for the colonization of salt marsh, is abandoned and the marsh redevelops behind the newly positioned shoreline. This increases the barrier island's width and continues the evolutionary succession of the barrier island, while facilitating the vertical accretion of back barrier wetlands (Mallinson et al. 2008).

Figure 3-3. 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*

The most important impacts on the physical environment resulting from overwash and inlet formations are the natural transport and deposition of sand to back barrier wetlands. Overwash fans and inlets that develop across wetlands and adjacent beaches are in equilibrium with the coastal dynamics of rising sea levels, more frequent storm surges, and local geomorphic conditions. If a barrier island is not allowed to roll back or migrate landward and provide back barrier marsh environments with the only potential to accrete sand, the barrier island shoreline will eventually collapse and back barrier marshes will not be able to keep up with sea level rise.

Map 3-7. Development of Overwash and Breaches near Fowler Beach

Where shoreline regression landward is not allowed, sea level rise can expedite coastal fringe marshes reverting to open water habitats sooner and quicker. Where wetlands are degraded, the reversion to open water can be even more rapid. As described in more detail in the next section, this disruption of natural coastal processes and resulting consequences in adjacent wetlands has become evident in the impoundment complex on the refuge.

Climate Change Adaptation and Vulnerability Assessment of Refuge Wetland Impoundments

Climate change and associated impacts such as sea level rise and increased storm frequency and severity are proving to be the defining wetland management issue for the refuge, increasing our challenges to managing the refuge's impounded wetland complex. Future climate change adaptation strategies used by the refuge must anticipate an increasingly different physical environment than the one in which we managed our impounded marshes from 1988 to the present. Numerous factors associated with climate change and coastal processes are interacting to affect the refuge's ability to conduct wetland management as it has been for recent decades, particularly in Unit II.

During the last phase of establishing the refuge impoundment in Unit II in 1988, DNREC required that the Service build up the duneline from the last house in Slaughter Beach (Unit I) to the first house on Prime Hook Beach in Unit II, which incorporated about 3 miles of shoreline. Although the Service felt it was not necessary, the State of Delaware reconfigured the natural barrier island berm in 1988 in anticipation of the potentially erosive effects of natural barrier beach movement. Artificial dunes were again rebuilt in 1992, 1998, 2006, and 2008 by the State, in coordination with the refuge. In 2006, a breach (mini-inlet) developed across the Unit I duneline, and in 2009 several breaches (1 large and 2 smaller inlets) of the duneline across Unit II occurred (map 3-7). Efforts to restore the dune line one more time while management and restoration plans could be developed were made by DNREC, in coordination with the refuge, in September 2011. However, Hurricane Irene (August 2011) had further depleted the affected shoreline of sand and the dune restoration failed shortly after completion, during a period of high tides and strong winds. As of the completion of the final CCP/EIS, the Unit II shoreline contains several persistent breaches, permitting saltwater to continue entering Unit II. Much of Unit II has converted to open water as a result.

Numerous factors are influencing our management capability and the response of the managed wetland ecosystem. We have been striving to better understand the various components of this comprehensive system, which includes natural elements and processes as well as human-controlled infrastructure. Information about the state of the ecosystem, the physical processes at work, and the management investments that would be necessary to maintain the Unit II impounded marsh are outlined below. Although these management challenges most imminently affect Unit II, it is clear that the future of management in Unit III will be affected by these same factors.

Washover and Beach Migration:
Starting in 2006 with tropical storm Ernesto, the natural beach barrier has been breached or overwashed numerous times. The physical forces that shape, move, and maintain barrier beach systems have been recognized by many government agencies and studied by coastal geographers for decades. Lewis et al. (2005), described the nature of fetch limited barrier islands, or those barrier islands typical of estuaries, in contrast to the ocean front. Of particular note is the relatively thin veneer of sand laid over a salt marsh base and the lack of significant wave energy outside of storm events necessary to maintain a relatively consistent beach profile. Large, continuous dunes, such as found along the Atlantic Ocean coast, are rare in estuarine environments.

Fetch limited barrier islands are backed by salt marshes and maintained in part by the overwash of beach and marine sediments. The direction of beach

movement as periodic storms occur is landward. These events are natural and outside the control of refuge management. However, they impact refuge coastlines through creation of overwashes and landward migration of the shoreline. It is well established that these processes are natural and beneficial to salt marsh communities (Ashton et al. 2007), and are common along the Delaware Bay shoreline (appendix J).

The rate of erosion and landward migration of the refuge shoreline along Unit II, in the vicinity of Fowler Beach, from 1937 to 2012 has been quantified using a series of historic aerial images (DNREC Coastal Programs unpublished data), and more recently ground measurements and observations (Psuty et al. 2010). It has been clearly demonstrated that the rate of shoreline erosion and retreat has been increasing during that time frame. Whereas the shoreline at Fowler Beach eroded 50 feet in the 17 years between 1937 and 1954, it later eroded 50 feet in only 5 years between 2007 and 2012 (figure 3-4). The rate of erosion between 1937 and 1954 was under 3 feet/year, and increased steadily to a rate of 10 feet/year between 1997 and 2012 (figure 3-5). This non-linear increase in the erosion rate will be problematic for refuge management for many years into the future (figure 3-6).

In 2011, the refuge began tracking shoreline position seasonally following a detailed protocol developed and used widely by the National Park Service (Psuty et al. 2010). That protocol will allow more detailed observation of seasonal and annual changes in shoreline position, as well as shoreline responses to management and restoration actions in the future.

Figure 3-4. Shoreline erosion in the vicinity of Fowler Beach Road in Unit II. Shoreline position from 1937 was determined using aerial imagery. Shoreline position in 2012 was determined through ground measurements and observations (Courtesy of DNREC Delaware Coastal Programs)

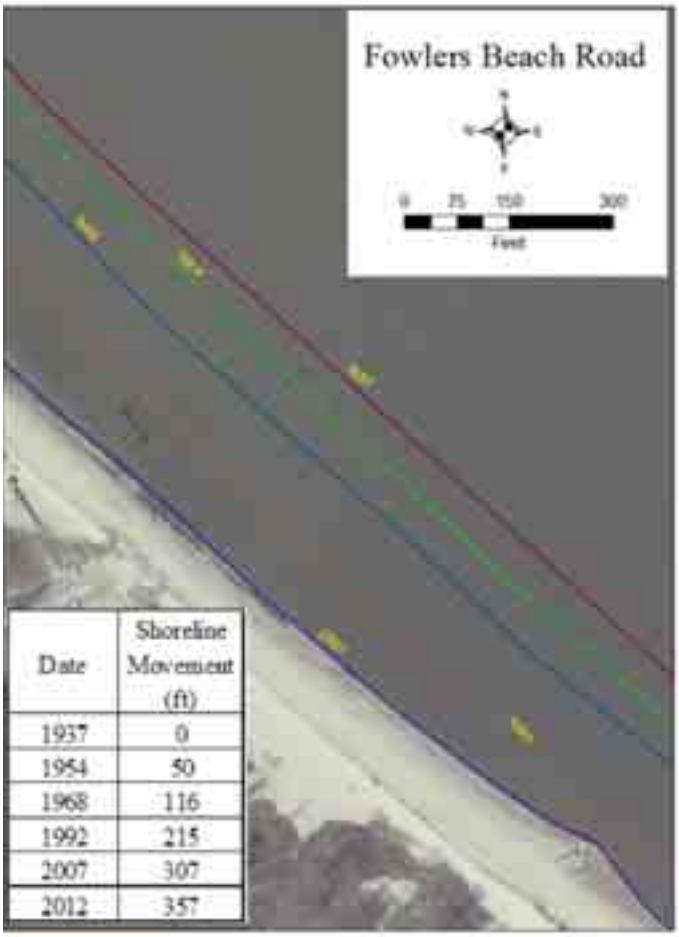


Figure 3-5. Annual shoreline erosion rates in the vicinity of Fowler Beach Road in Unit II. Shoreline position from 1937 was determined using aerial imagery. Shoreline position in 2012 was determined through ground measurements and observations (Courtesy of DNREC Coastal Programs)

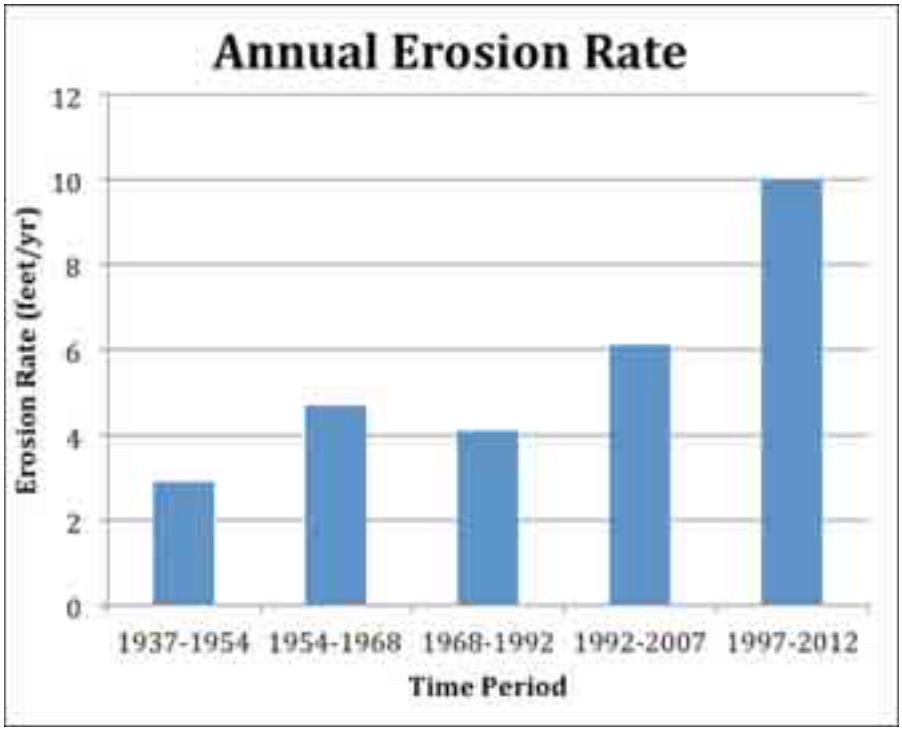
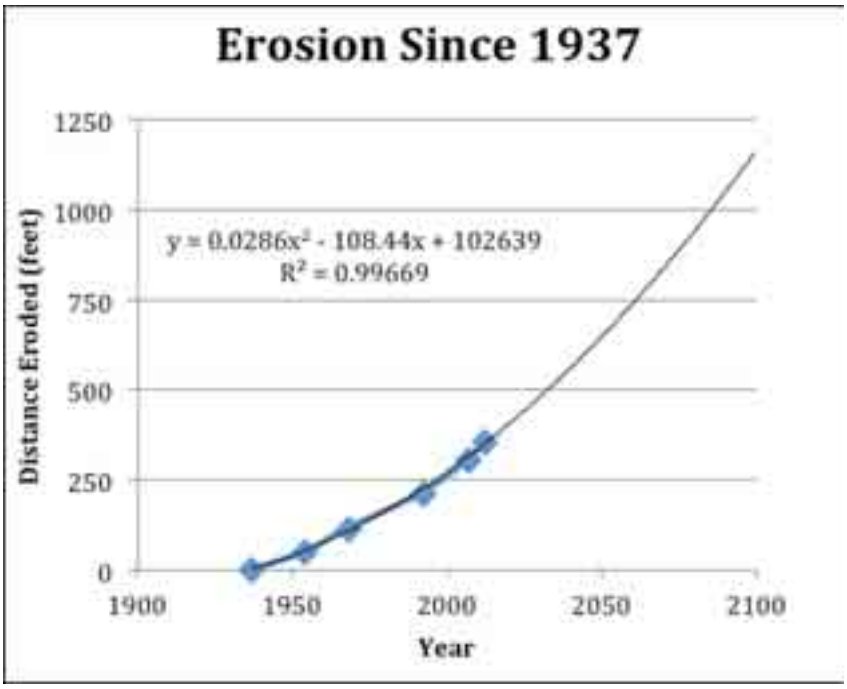
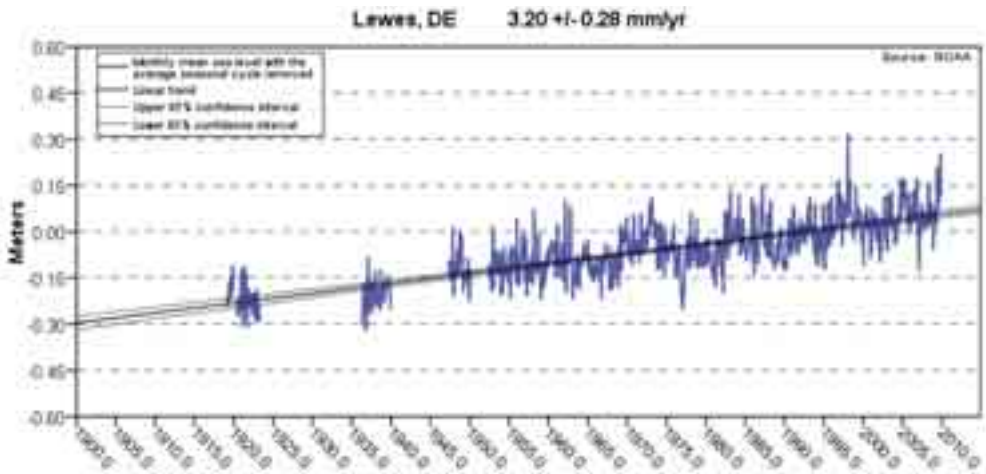


Figure 3-6. Trend of increasing annual shoreline erosion rates in the vicinity of Fowler Beach Road in Unit II. Shoreline position from 1937 was determined using aerial imagery. Shoreline position in 2012 was determined through ground measurements and observations (Courtesy of DNREC Delaware Coastal Programs, unpublished data)



Sea Level Rise:
Sea levels have been rising due to melting of major ice sheets after the last major glaciation 20,000 years ago and thermal expansion of ocean water as it warms (CCSP 2009). The Atlantic coast was located about 180 miles to the east of its present location during the immediate post-glacial period and the ocean has risen over 100 meters (330 feet) since that period. Currently, the average annual local sea level rise (figure 3-7), as measured at the NOAA tide gauge in Lewes, is 3.20 mm/yr since 1919, or 1.05 feet in 100 years *(http://tidesandcurrents.noaa.gov/sltrends/sltrends_station.shtml?stnid=8557380;* accessed January 2012).

Figure 3-7. Mean Sea Level Trend for NOAA Tide Station 8557380—Lewes, Delaware Increasing Frequency of Above Average High Tides:



No official tide data is currently being collected on or in the immediate vicinity of the refuge. Tide data for the nearby gauge at Lewes have been collected by NOAA since 1919. Although tides at the Lewes station are likely to read somewhat lower than at the refuge for high tide, the data will be adequate for analysis of long-term trends. We acquired the daily high and low tide data for Lewes for the period 1984 to 2009. We selected this period because all data were available in a format relative to a single baseline elevation, referred to as an epoch, and coincides with the history of impoundment management on the refuge. NOAA's Web-based interface *(http://tidesandcurrents.noaa.gov/;* access January 2013) outputs all high and low tides in relation to the mean higher high tide, or the average of the higher of two high tides that occur per day. We extracted all individual tidal events falling at or above mean higher high water. Figure 3-8 plots the total number of individual events by year for the period 1984 to 2009, and shows an increase over time in the frequency of higher than average tidal events. The total number of individual events above mean higher high water ranged from a low of 152 in 1988 to 323 in 2009.

Short-billed dowitchers

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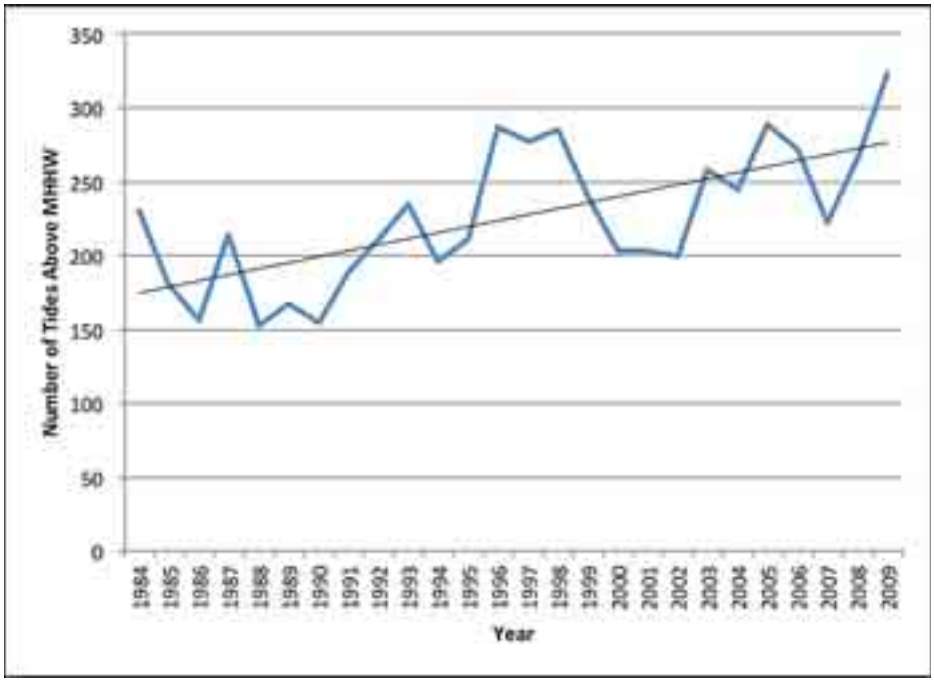
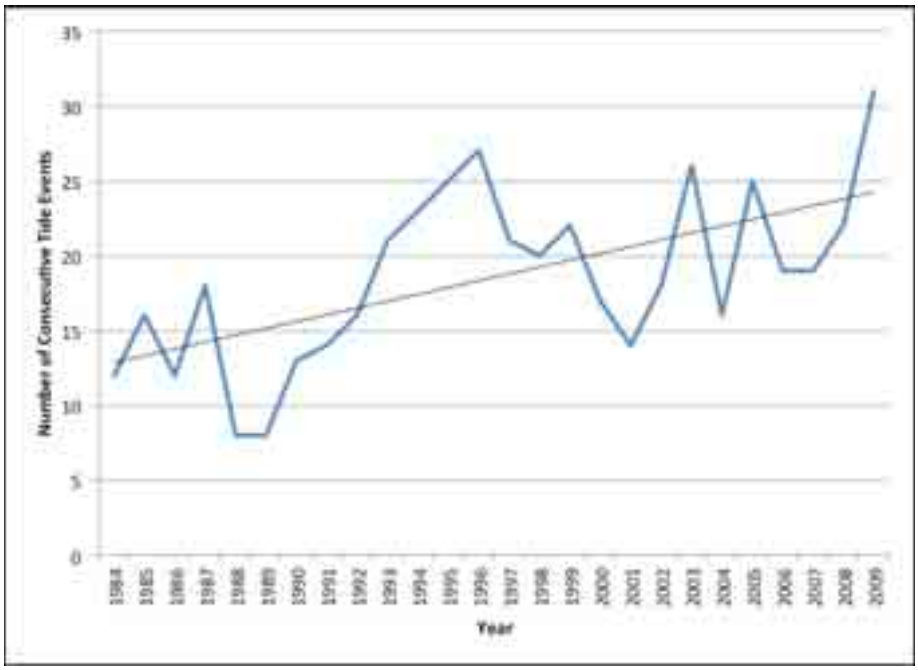
Figure 3-8. Number of Individual High Tides Per Year Above Mean Higher High Water Recorded at the Lewes, DE Tide Gauge



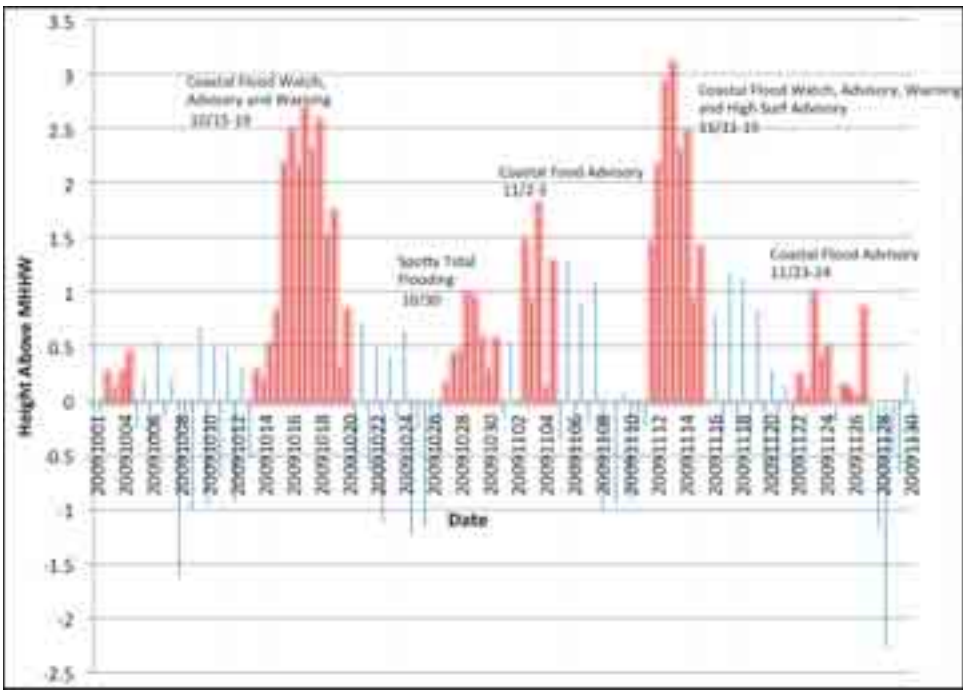
We also compiled consecutive above-normal high tide events, which are two or more consecutive high tides that were recorded at or above mean higher high water. Figure 3-9 shows an increase over time of the frequency of these events. The consecutive events ranged from 2 to 24, or the equivalent of 1 day to 12 days of consecutive high tides above mean higher high water. The total number of such events ranged from 8 in 1988 and 1989 to 31 in 2009.

Figure 3-9. Number of Consecutive High Tide Events Above Mean Higher High Water Per Year Recorded at the Lewes, DE Tide Gauge



These figures show a general trend toward a higher frequency of individual above-average high tides, but perhaps more importantly, a higher frequency of consecutive above-average tides. This has important implications for the dynamics of tidal flooding, overwash, and beach migration along the Delaware Bay shore. More frequent periods of sustained high water in combination with high wave energy associated with storms contribute to erosion and overwash of natural beaches. To illustrate one period of particularly active high tide events, we have graphed all high tides occurring during October to November 2009 (figure 3-10). The zero line on the Y axis represents mean higher high water. All highlighted red lines above mean higher high water represent periods of consecutive above average tides. The periods range from 4 to 14 consecutive tides, or the equivalent of 2 to 7 days. As noted, five of the seven highlighted periods were accompanied by NOAA coastal flood watches, advisories, warnings, and in one case during the period November 11 to 15, a high surf advisory. Much of the undeveloped region along the Delaware Bay shore sustained significant breaching and overwash during these events. As a result of a breach, much of refuge Unit II was opened to daily tidal flow.

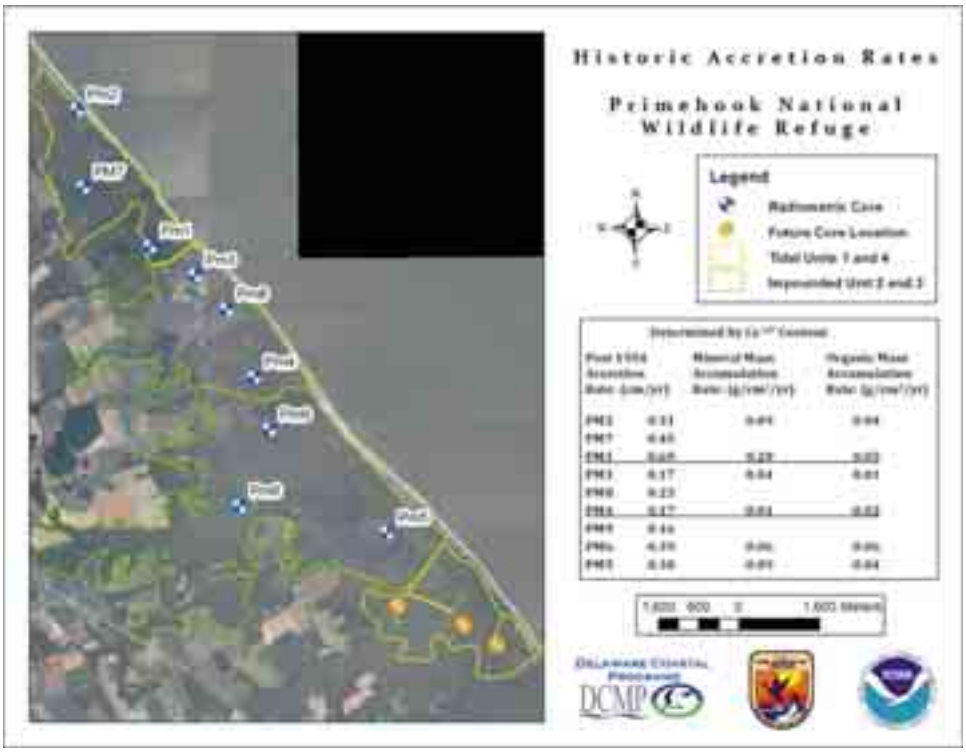
Figure 3-10. Consecutive High Tide Events Above MHHW During October to November 2009



Wetland Elevation:
Under natural conditions, salt marshes build elevation by trapping sediment during flood events, building up below ground biomass (e.g., roots and rhizomes), and accumulating organic matter (Cahoon et al. 2009). The accretion of marsh elevation must be maintained in relation to sea level or the marsh will drown, deteriorating and leaving open water in its place. Analysis of sediment cores for the presence of radioisotope fallout (^{137}Cs and ^{210}Pb) deposited at a known time in the past can provide a measure of marsh accretion over recent decades. Preliminary data from radiometric coring conducted by DNREC's Coastal Program, in partnership with the University of Delaware, indicate that the salt marshes in refuge Units I have been accreting over approximately the last 50 years at a rate nearly equal to or greater than the current local sea level rise of approximately 3.2 mm/yr (figure 3-11). However, the average rate of accretion for the same period in the Unit II is 1.7 mm/year, nearly half of the sea level

rise rate. While the average accretion rate for the southern half of Unit III was determined to be 3.85 mm/year, a core in the northern half of Unit III suggests accretion in that portion is only 1.6 mm/year – the lowest recorded anywhere in the State of Delaware during the DNREC/University of Delaware study (figure 3-11). It should be noted that these estimated accretion rates are an average for about the past 50 years, and the current management regime has only been in place for a portion of that time.

Figure 3-11. Historic accretion rates within refuge wetlands and impoundments as determined by analysis of radiometeric core (137Cs content) (Courtesy of DNREC Delaware Coastal Programs and University of Delaware, unpublished data).



In addition to radioisotopic cores, the Delaware Coastal Program conducted elevation surveys of the various wetland units utilizing real-time kinematic GPS survey techniques. The surveys documented the difference in elevation between the wetland vegetation and open water areas. In some areas, less than an inch of elevation stands between the existing vegetation and open water/mud flat (appendix K). Marshes with such a small amount of elevation capital are the most vulnerable to increases in sea level (Cahoon and Guntenspergen 2010). As of the preparation of the final CCP/EIS, elevation/bathymetric data throughout the wetland complex was being updated again using new sonar technology ideal for collecting such data in shallow water environments. Because the elevation of the impoundments is barely above sea level, they are susceptible to saltwater inundation in the short term during coastal storm events, unless and until additional sediment is present to increase the elevation. New and proposed marsh elevation monitoring (surface elevation tables and marker horizons) on the refuge will add additional critical data to our understanding of short-term accretion within the impoundments under current management regimes, as we evaluate refuge wetland management options, and as we monitor the impacts of future management actions.

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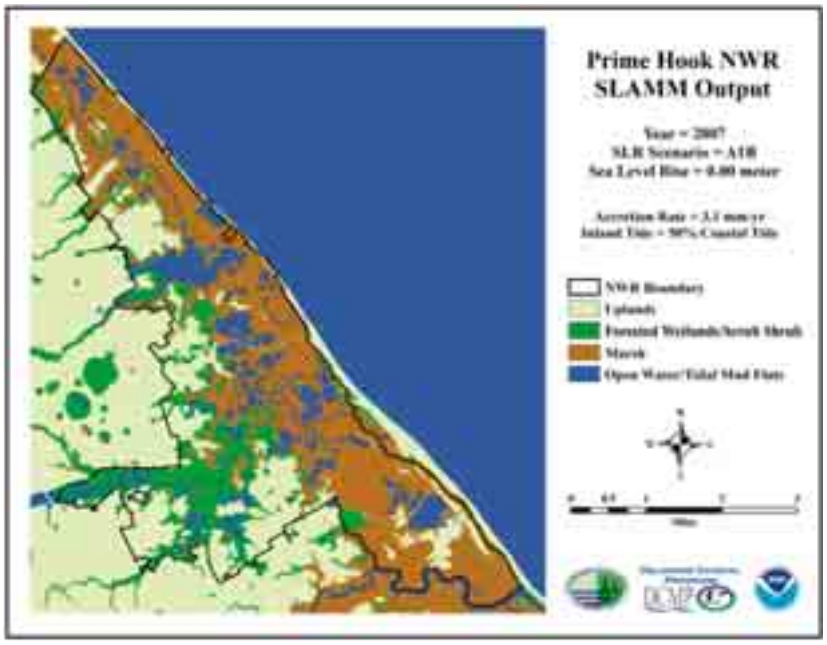
Diamondback terrapin

The potential effects of sea level rise on refuge land cover have been modeled through the SLAMM effort described in chapter 2. The model was applied utilizing inputs representing a range of possible future scenarios. It is anticipated that the reality could fall anywhere within these predicted outcomes. As an example, if sea level rises as predicted by the A1B greenhouse gas emission scenario in the Special Report on Emissions Scenarios (IPCC 2000), the total sea level increase on the refuge would be 0.50 meters in 100 years. If the model assumes that salt marsh accretion keeps pace with current sea level rise rates and that there is full tidal influence along the coast, then the refuge is predicted to lose more than half of its marsh and the amount of open water and tidal mudflat (combined) will more than quadruple (figure 3-12). If the model assumes that salt marsh accretion will increase to 5.0 mm/yr, keeping pace with sea level rise as salt marshes often can, then the loss of marsh is small and conversion to open water and tidal mud flat are not as pronounced (figure 3-12). In both cases, more than half of the upland is predicted to be lost. The primary difference is whether or not the remaining areas are maintained in some form of wetland cover or are converted to open water, which may depend on marsh accretion processes. Under each sea level rise and marsh accretion scenario, if the model assumes that coastal dunes will instead be maintained, these predictions do not change appreciably. Results for additional scenarios, such as an increased rate of sea level rise, can be found in Scarborough (2009).

An updated version of SLAMM (6.0.1) is now available, but was not available at the time the analysis was completed for the refuge. Although modeling data should be considered with caution, as high levels of uncertainty and unforeseeable factors can significantly alter model output projections and habitat predictions for the future, the results of this modeling effort can give us a general sense of how climate change and sea level rise will likely affect refuge habitats in the future. The potential land cover changes predicted by the SLAMM modeling were considered in the development of the management objectives and strategies (chapter 4). However, these modeling results are certainly not the primary factor driving evaluatoins of shoreline and wetland management regimes on the refuge, as the refuge increasingly has current locally collected data to rely upon.

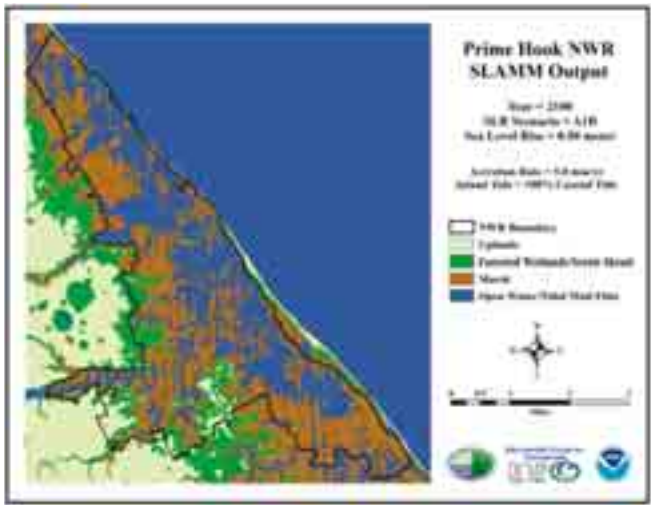
Figure 3-12. Selected SLAMM Output Maps from Scarborough 2009. (A) = Current (2007) land cover; (B) = 2100 Predicted land cover assuming 0.5 meters of sea level rise, marsh accretion keeping pace with current sea level rise (3.1 mm/yr), and full tidal influence.

(A)



(B)

(C)



The Cost of Infrastructure Rehab/Replacement:
To maintain Unit II as a freshwater system, it is anticipated that significant infrastructure rehabilitation or replacement would be necessary. A cost analysis included three factors: dune construction, water control structure redesign and replacement, and elevating two State roads, Fowler Beach Road and Prime Hook Road.

Dune Construction
No formal beach management plan has been developed for Prime Hook NWR beaches. However, we can use the data provided in the management plan for Delaware beaches completed in March 2010 to make some rough estimates. Table

3-12 provides estimates for design, permitting, construction, and monitoring of existing sand dunes within the neighboring communities of Slaughter Beach and Prime Hook Beach. Design scenarios and their associated costs are estimated based on the projected average return interval of storm events that result in a particular degree of severity and resulting storm damage. The State's analysis considered the dune design that would be required to withstand a 5 or a 10-year storm. For example, a 5-year storm is a severe storm that is expected to hit our area 1 year in 5. Another way of stating it is that there is a 20 percent chance that we will experience a 5-year storm in any given year. Similarly, one can expect a 10-year storm on average once every 10 years, or a 10 percent chance of having the storm in any 1 year. The actual number of years between storms of any given severity varies because of the naturally changing climate. It is possible to have more than one 5-year storm in a year. Therefore, beaches that endure damage from successive 5-year storms would require reconstruction on a more frequent basis. In addition to the 5 and 10-year scenario, the State has projected costs for strategic fill, i.e., fill placed along the specific locations of greatest need.

American oystercatcher

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Table 3-12. Cost Estimates from DNREC Beach Management Plan Associated with Dunes within Slaughter Beach and Prime Hook Beach communities

	Prime Hook Beach					Slaughter Beach				
Strategic Fill Placement	**Budget Estimate**									
Project Element	**FY10/11**	**FY11/12**	**FY12/13**	**FY13/14**	**Total**	**FY10/11**	**FY11/12**	**FY12/13**	**FY13/14**	**Total**
*Geotechnical Investigation	$45,193.00				$45,193.00	$139,802.00				$139,802.00
*Design/Permitting	$22,596.00				$22,596.00	$69,901.00				$69,901.00
Construction				$416,835.00	$416,835.00				$499,975.00	$499,975.00
Env. Permit Monitoring				$17,500.00	$17,500.00				$17,500.00	$17,500.00
Beach Survey	$8,000.00	$8,000.00	$8,000.00	$8,000.00	$36,000.00	$16,000.00	$16,000.00	$16,000.00	$16,000.00	$64,000.00
Total	$75,789.00	$8,000.00	$8,000.00	$442,335.00	$534,124.00	$225,703.00	$16,000.00	$16,000.00	$533,475.00	$791,178.00
5 Year Scenario										
Project Element	**FY10/11**	**FY11/12**	**FY12/13**	**FY13/14**	**Total**	**FY10/11**	**FY11/12**	**FY12/13**	**FY13/14**	**Total**
*Geotechnical Investigation	$45,193.00				$45,193.00	$139,802.00				$139,802.00
*Design/Permitting	$22,596.00				$22,596.00	$69,901.00				$69,901.00
Construction				$787,800.00	$787,800.00				$2,112,800.00	$2,112,800.00
Env. Permit Monitoring				$35,000.00	$35,000.00				$70,000.00	$70,000.00
Beach Survey	$8,000.00	$8,000.00	$8,000.00	$8,000.00	$36,000.00	$16,000.00	$16,000.00	$16,000.00	$16,000.00	$64,000.00
Total	$75,789.00	$8,000.00	$8,000.00	$830,800.00	$922,589.00	$225,703.00	$16,000.00	$16,000.00	$2,198,800.00	$2,456,503.00
10 Year Scenario										
Project Element	**FY10/11**	**FY11/12**	**FY12/13**	**FY13/14**	**Total**	**FY10/11**	**FY11/12**	**FY12/13**	**FY13/14**	**Total**
*Geotechnical Investigation	$45,193.00				$45,193.00	$139,802.00				$139,802.00
*Design/Permitting	$22,596.00				$22,596.00	$69,901.00				$69,901.00
Construction				$1,522,800.00	$1,522,800.00				$3,680,800.00	$3,680,800.00
Env. Permit Monitoring				$35,000.00	$35,000.00				$70,000.00	$70,000.00
Beach Survey	$8,000.00	$8,000.00	$8,000.00	$8,000.00	$36,000.00	$16,000.00	$16,000.00	$16,000.00	$16,000.00	$64,000.00
Total	$75,789.00	$8,000.00	$8,000.00	$1,565,800.00	$1,657,589.00	$225,703.00	$16,000.00	$16,000.00	$3,766,800.00	$4,024,503.00

*Notes: The costs for these items are proportional to total volume placed for all of the seven communities included in this management plan

Renourishment costs based on restoring 60 percent of initial volume to restore historic losses; costs are based on work being performed on a regional basis; costs shown are in July 2009 prices.

The costs range from $534,124 to $1,657,589 for the three scenarios at Prime Hook beach, and from $791,178 to $4,024,503 at Slaughter Beach. We have no cost estimates at this time for dune construction along the overwashed portion of Unit II barrier beach. The combined linear footage of privately and refuge owned beach along Unit II, of which only 60 percent is refuge owned, is approximately 1.5 miles. The 5 and 10-year scenarios at Prime Hook Beach are to be conducted along nearly 1.5 miles of beach, as well. It would therefore be reasonable to expect that the costs of constructing a dune along Unit II would be comparable with the costs of dune construction at Prime Hook Beach.

There are, however, some very important differences between the Prime Hook and Unit II beaches. First, active beach management has been occurring at Prime Hook beach to some degree throughout the years. Prime Hook beach has an intact dune system that is currently elevated several feet above mean high water. Conversely, the Unit II barrier has largely succumbed to natural overwash events, leaving small isolated dunes. The berm typically overwashes over much of its length during storm events. Additionally, there are two active inlets, currently on private land, that receive at least some tidal flow during most high tide events. Therefore, we conclude that the cost of strategic placement of sand as listed for Prime Hook Beach is not a useful figure for comparison because strategic placement assumes supplementing an intact dune system. Since the existing berm along Unit II is barely above mean high water, a considerably larger quantity of sand, and a much higher cost, would be required to achieve the 5 or 10-year specifications considered adequate for Prime Hook Beach. The costs of dune construction on Unit II may approach the cost of construction for 2.7 miles of Slaughter Beach, or as high as $4,000,000.

Table 3-13 summarizes the length of beach, quantity of sand required for initial fill, quantity of sand required in subsequent years, the return maintenance interval and cost of construction alone, without permitting, design, and monitoring costs. The maintenance intervals are 4, 5, and 10 years, respectively for strategic, 5-year and 10-year scenarios. Maintenance would be required more often if storm severity or frequency becomes more intense in the years after initial treatment.

Table 3-13. Summary of Material Requirements and Costs for Construction of Dunes According to DNREC Beach Management Plan

	Berm Length	Berm Width	Berm Elev. (NAVD 88)	Initial Fill	Maintenance Placement (Interval)	Initial Constr. Cost Only
Prime Hook Beach						
Strategic	2,800′	20′	7.2′	24,000 cy	14,400 cy (4 years)	$416,835.00
5 Year	7,500′	20′	7.2′	71,000 cy	36,600 cy (5 years)	$787,800.00
10 Year	7,500′	55′	7.2′	176,000 cy	105,600 cy (10 years)	$1,522,800.00
Slaughter Beach						
Strategic	2,500′	15′	7.5′	36,500 cy	21,900 cy (4 years)	$499,975.00
5 Year	14,500′	15′	7.5′	252,500 cy	151,500 cy (5 years)	$2,112,800.00
10 Year	14,500′	55′	7.5′	476,500 cy	285,900 (10 years)	$3,680,800.00

Importantly, if the purpose of dune reconstruction is to provide an intact barrier to artificially maintain freshwater marshes, then constructing a berm with the assumption that it will be intact only in the face of a 5 or 10-year storm will not sustain a freshwater marsh system. Since freshwater marshes are very

vulnerable to rapid increases in salinity, a barrier system should be designed to withstand, at least, a 30-year storm, otherwise the marsh vegetation and obligate freshwater biota can be expected to die frequently. A berm of this magnitude, with accompanying periodic replenishment, will increase costs, not by a factor of three above the 10-year costs, but more geometrically, because the commensurate increase in sediment requires substantially more sand to be placed over a far broader footprint, as well as formed into a higher berm.

Water Control Structures
In addition to the dunes, the three water control structures are maintained to manage water levels within the impoundment. The replacement costs of the three water control structures and associated levees are listed in table 3-14.

Table 3-14. Replacement Costs of Refuge Water Control Structures

Water Control Structure/Levees	Estimated Cost
Prime Hook Creek WCS	$436,000.00
Petersfield WCS	$852,040.00
Petersfield West Dike	$463,610.00
Petersfield East Dike	$208,311.00
Fowler Beach WCS	$1,033,725.00

Although the Prime Hook and Petersfield structures play a role in the Unit II water management, only the Fowler Beach water control structure is used for this analysis. The replacement of the structure would cost approximately $1,033,725, but could cost more. Even if the structure is replaced, the refuge can only manage water levels to 2.8 feet mean sea level (msl), according to deed restrictions. But, mean sea level in 1981 is different from mean sea level today. The deed is recorded in Deed Book 1097, page 249. Currently, larger storm events have overtopped the existing structure, allowing water in excess of 2.8 feet msl to enter the impoundment. Rising sea levels, subsidence, and other factors make it unlikely that the refuge will be able to manage water levels in the future. Saltwater intrusion is inevitable at the water control structures as we lose control to the rising seas.

Further complicating our water management challenges is the fact that the water control structures are sitting at an elevation different from the original planned construction elevation. Although we do not know the exact post-construction elevations of the water control structures, we assume they were very close to the planned elevations. In 2010, the Delaware Coastal Program resurveyed our water control structures to determine their current elevation. Subsidence of both upland and the marshes in the Delaware region is extensive, but varies based on local conditions. The results (table 3-15) show that the water control structures are lower than their planned construction elevations by approximately 5.8 to 11.25 inches. This data further supports our assumption that we will lose water management capabilities in the near future. See appendix K for further details.

Table 3-15. Estimated Subsidence of Refuge Water Control Structures

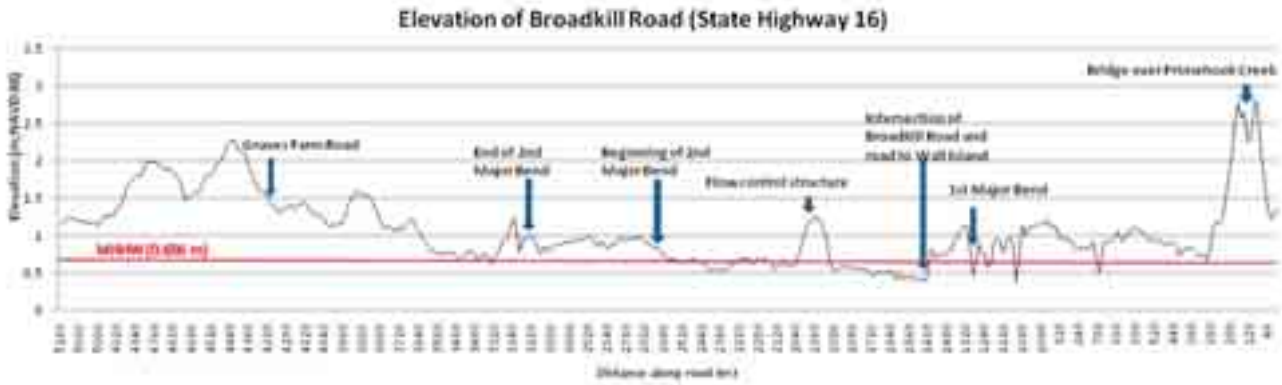
Water Control Structure	Suspected subsidence (inches)
Prime Hook Creek WCS	11.25″
Petersfield WCS	10.07″
Fowler Beach WCS	5.83″

Integrity of Road Infrastructure:
There are three roads crossing the marsh to the barrier island, forming the dikes on the northern and southern borders of Units II and III. These roadways, built in the 1950s and 1960s at relatively low elevation, have sustained numerous tidal overwashes in recent years. In 2009, the State conducted elevation surveys of the roads for analysis. Figure 3-13, figure 3-14, and figure 3-15 illustrate the results of those surveys for Fowler Beach, Prime Hook, and Broadkill Roads, respectively. Road elevation has been plotted in relation to the local mean higher high water elevation (red line). For each road, significant portions of the road (blue line) lie below mean higher high water, suggesting that the roads may have subsided. These roads routinely flood during forecast NOAA coastal flood events. As sea levels and high tide events continue to increase, the ability of these roads to serve as dikes will be reduced.

Figure 3-13. Elevations along Fowler Beach Road in relation to MHHW along the segment depicted in red on the map

Figure 3-14. Elevations along Prime Hook Road in relation to MHHW along the segment depicted in red on the map

Figure 3-15. Elevations along Broadkill Beach Road in relation to MHHW along the segment depicted in red on the map



Delaware Department of Transportation (DelDOT) currently owns a 50-foot right-of-way easement on Prime Hook and Fowler Beach Roads. Additionally, it owns a 60-foot right-of-way along U.S. 16, also known as Broadkill Road. DelDOT is the responsible agency for the construction and maintenance of these roads.

There are a number of different options to consider for each roadway area that could be affected by restored tidal flows. These include raising the roadway elevation in its current location, tolerating a certain degree or frequency of flooding, and/or abandoning a specific road or portion of road, subject to DelDOT approval and procedures. Hydraulic analysis would be necessary before raising any road crossing the marsh. Some of these roadways are well-traveled and provide access for residents. Prime Hook and Fowler Beach Roads are not adjacent to higher ground, but may need widening. In order to raise these roadways and avoid costly retaining wall construction, the toe of each roadway embankment would need to extend horizontally into adjacent wetland resource areas.

Some low-lying roadways along the coast have historically been subjected to varying degrees of flooding during coastal storms. When such flooding is infrequent, such as during storm events, the effect on the public may be minimal and can be accommodated. Issues to consider include public health and safety relative to access. This would require further assessment as more detailed hydrologic analyses are conducted. At Fowler Beach Road, abandonment may be an option. Any decision on such roadway abandonment would be subject to public hearings in nearby towns.

Planning for reconstruction of these roads must also include an assessment of impacts to fire department and emergency medical vehicle access routes and alternative access options. The refuge has long-standing mutual aid agreements with Milton Fire Department, Inc. and the Memorial Volunteer Fire Department of Slaughter Beach. These agreements need to be updated to better describe the authority and responsibility and to include other emergency situations on refuge lands or adjacent to the refuge.

To maintain a freshwater system, these roads need to be elevated 2 to 4 feet with the sides sloped at a ratio of 3:1. Costs will easily exceed $1 million per road. Some estimates put the costs closer to $2 million per road (Service's cost-estimating guide). It should be noted that if Fowler Beach Road is abandoned, costs may be considerably less. Instead of a road, a levee or other type of barricade could serve the same purpose at a fraction of the cost. In either

scenario, costs for road elevation and/or levee construction would range from over $1 million to $4 million.

Management Implications:
Significant environmental, physical, structural, monetary, and regulatory hurdles need to be addressed to maintain freshwater impoundments on Prime Hook NWR. The SLAMM model 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 or impoundments may have already reached a tipping point. It is important to note that the time frame of impoundment management has been relatively short on the refuge, in relation to the time frame of natural coastline processes. Relatively speaking, freshwater impoundment management is not a long-standing management regime on the refuge but was conceived to meet valid wildlife management objectives. It was established, in part, using existing roads, which had not been formally engineered for long-term water level management as dike infrastructure.

Preliminary data indicate portions of our managed impoundments may be losing ground to sea level rise. Unit II, for example, 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 under current freshwater impoundment management strategies. Freshwater marshes dominated by annual vegetation differ from salt marshes in that predominantly annual wetland plants contribute to high above-ground biomass, whereas the persistent below-ground organic matter of perennial vegetation, such as that found in tidal salt marshes, makes greater contributions to vertical accretion (Cahoon et al. 2009). This means that the vegetation in salt marshes build up the elevation of the marsh and that freshwater marsh plants do not, so that salt marsh can be sustained in light of rising sea levels but freshwater plants not only die if flooded by saltwaters, they also leave the marsh substrate at a depressed elevation compared to salt marsh species.

Biological Resources of Delaware Bay Estuary

The Delaware Bay Estuary is an important ecosystem recognized nationally, internationally, and globally as a resting and feeding area for millions of migrating birds each spring and fall. It supports rare and endangered species, supports commercial fisheries, and acts as a major horseshoe crab spawning ground on the East Coast. It is an ecosystem where many biogeographic provinces come together, resulting in overlapping habitat types and high biodiversity. The increase in economic pressures on these habitats of the Delaware Estuary dictates that remaining natural uplands and wetlands conserved for wildlife will require extra protection and conservation efforts in the future (Webster 1996).

There are three major ecological zones of the Delaware Estuary, which are distinguished by differences in salinity, turbidity, and biological productivity. The upper zone is tidal freshwater and extends from Trenton to Marcus Hook. The transition zone, which extends from Marcus Hook to Artificial Island, has a wide salinity range (0 to 15 ppt) and is characterized by high turbidity and low biological productivity. The lower zone, where Prime Hook NWR is located, is open bay and extends to the ocean. It has higher salinity distributions fluctuating from polyhaline to euhaline waters (18 to 30 ppt), broad areas of fairly shallow water (less than 9 meters), and over 90 percent of the primary biological productivity of the three zones (Partnership for the Delaware Estuary 1996).

Land use is a term that refers to the way land is developed or conserved. Demographic predictions provide compelling evidence for planning growth and protecting natural resources. Nine of the ten most densely populated U.S. counties are in the Northeast. Because of our love of the water, almost half of the U.S. population now lives in coastal areas, including along the shores of estuaries.

This population trend is accelerating and coastal counties are growing three times faster than anywhere else in the Nation.

Escalating population growth and the demand for new housing, shopping centers and places of employment are projected to rapidly continue throughout the Delaware River basin region between now and 2020 with an overall increase of 14 percent. The States of Delaware and New Jersey are expected to see population increases of 24.3 percent and 21.5 percent respectively, by that date. By 2020, projected development increases of 14 percent will affect over 50 percent of the total land area within the region, leaving less than 50 percent of the land cover in agricultural, wooded, open space, or water (Seymour 1994). Major problems and future threats for living resources of the Delaware Estuary are identified in the 1996 comprehensive conservation management plan.

The Delaware Estuary is one of the most heavily used estuary systems in the Nation. The estuary supports one of the world's greatest concentrations of heavy industry, and the second largest oil refining and petrochemical centers in the U.S. About 70 percent of transported oil (over one billion barrels of crude and refined oil products) reaches the east coast of the U.S. through the Delaware Estuary by way of the ports of Philadelphia, Camden, Gloucester City, Salem, and Wilmington. The estuary also receives wastewater discharges from 162 industries and municipalities and approximately 300 combined sewer overflows. The Delaware River basin supplies 10 percent of the U.S. population (20 million people) with water for drinking and industrial uses. Much of this water is transferred out of the basin through runoff into the Delaware Estuary (Partnership for the Delaware Estuary 1996).

Additional information about the biological resources of the Delaware Bay Estuary, includeing phytoplankton, benthic organisms, and horseshoe crabs, can be found in the Prime Hook NWR Final CCP/EIS, Volume 1, chapter 3 *(http://www.fws.gov/northeast/planning/Prime%20Hook/finalccp.html).*

Dragonflies. More than 100 species of Odonata occur in the Delaware Estuary. Damselflies and dragonflies (Odonata) have received increased attention as indicators of the health of wetland habitats. Activities that adversely affect water quality or alter specific habitats can eliminate odonate species or alter the composition of an area. The alteration of aquatic environments through channelization, siltation, draining, or chemical spraying has resulted in notable recent declines in many odonates throughout their ranges (Carle 1991). Because odonates are widespread and inhabit all wetlands, their absence could be an early indication of environmental degradation from a variety of sources. Odonates are beneficial to man by consuming large numbers of mosquitoes (Barber 1995).

Fish. More than 200 fish species, both residents and migrants, use the Delaware Estuary. The residents include fresh and saltwater species like the white perch which has a broad range of salinity tolerances. Resident species conduct all aspects of their life history within the estuary. Migrant species are highly dependent on the estuary for spawning habitats and nursery and feeding grounds. Ocean migrants include both warm and cool water species. A large number of migrants, such as the herrings and shad, are anadromous, living in ocean water but migrating to freshwater to breed. One species, the American eel, is catadromous, living in fresh or brackish waters and migrating downstream toward the ocean to reproduce. In the Delaware Estuary, the American eel is a very important resource from both a biodiversity and human use perspective. In all its life stages, eel serves as a prey species for many species of fish, aquatic mammals, and fisheating birds. Eel continue to support valuable commercial, recreational, and subsistence fisheries in the bay.

Major fish species in the Delaware Estuary include various sharks, skates and rays, shortnose and Atlantic sturgeon, American eel, blueback herring, alewife, American shad, Atlantic menhaden, common carp, various catfish, white perch, striped bass, bluefish, weakfish, spot, Atlantic croaker, black drum, and various flounder species. In the Delaware Estuary, changes in abundance of anadromous species have been historically linked to a decline of available spawning habitat due to obstructions in watercourses (dams, pollution blocks) that prevent access to spawning beds, overall water quality, and overfishing. Destruction and alteration of wetland habitats have decreased available nursery areas for juvenile fish development, and recreational fishing pressure has consistently increased. There are at least 31 species that are commercially harvested from the estuary valued at about $1.4 million in 1996 (Delaware Estuary-CCMP).

Birds. Four major estuaries in North America are critical shorebird stopover areas, and each supports more than one million shorebirds during migration. These are the Bay of Fundy and the Delaware Bay on the East Coast, and Alaska's Copper River Delta and Washington's Grays Harbor on the West Coast. At these stopover areas, shorebirds feed on amphipods, chironomids, and horseshoe crab eggs and nearly double their weight before moving on. These areas are unique in their mix of natural resources and consistently support high percentages of the entire world's populations of certain bird species.

Historical survey data has recorded that up to 200,000 red knots (80 percent of the Western Hemisphere population), 10,000 short-billed dowitchers, and half the ruddy turnstones in North America visit the Delaware Bay to feed on horseshoe crab eggs. Red knots fly 19,000 miles round-trip between wintering and breeding grounds and rely on one or two staging areas. After leaving its wintering grounds in southern Argentina, the red knot makes only one stop on the coast of Brazil (Lagoa do Peixe), and then flies nonstop to Delaware Bay, which is a distance of 5,000 miles (Chipley 2003).

Total birds counted in aerial surveys in Delaware Bay over the 6-week migration period from May to mid-June range from 250,000 to more than 1,000,000 birds. Birds observed in tidal marsh habitats are estimated at 700,000. Red knots, sanderlings, ruddy turnstones, and semipalmated sandpipers make up 97 percent of the individuals of 30 species of shorebirds utilizing Delaware Estuary habitats. Many migratory raptors, waders, and waterfowl also use the estuary, including brant and up to 400,000 snow geese (State-DE/NJ aerial survey data).

Delaware Estuary Program Priority Species List. In spring 1993 a habitat task force brought experts from across the region to develop a list of priority species for management purposes. Of the thousands of plant and animal species in the estuary, participants extracted the indicator and keystone species and assemblages of species that are critical to maintain and monitor the BIDEH and functioning of the Delaware Estuary. Scientists have deemed that this ecosystem would lack wholeness and integrity without them.

A final list of approximately 100 species and assemblages were identified that are critical in maintaining the Delaware Bay's BIDEH. A supplemental publication to the Delaware Estuary comprehensive conservation management plan describes the habitat requirements and species profile histories of these keystone and indicator species of ecosystem health. The document is entitled "*Living Resources of the Delaware Estuary*" (Dove and Nyman 1995). This information was stepped down to the refuge level when we developed and fine tuned our refuge-specific focal species list and identified the refuge's top priority resources of concern. This process is described in more detail in chapter 2 of this CCP, which describes the planning process.

The Delaware Estuary is impacted by toxic substances, mainly human-created chemicals that have been introduced into the waters. Elevated levels of many

toxic substances have been detected in the sediments, the water column, and in the tissues of organisms dependent on the estuary. Primary toxic substances include heavy metals, mercury, and organic contaminants such as polychlorinated biphenyls and Dieldrin. High concentrations of these contaminants of concern have prompted DNREC to post fish consumption advisories from the C & D Canal down to the mouth of the Delaware Bay for following finfish species: striped bass, channel and white catfish, American eel, white perch, and bluefish (DNREC 2010).

Refuge Biological Resources

As in our discussion of rarity patterns of plant species, we also refer to DNHP rankings in describing refuge biological resources such as birds, invertebrates, reptiles, and amphibian species.

The only resident federally endangered species on the refuge is Federal and State-listed Endangered or Threatened Species the Delmarva fox squirrel *(Sciurus niger cinereus).* The current population is very small but represents the core population for expanding Delmarva fox squirrel habitats on the refuge in coming years. In recent years, due to State-managed areas protecting and increasing piping plover productivity each summer, coupled with expanding overwash habitats and new beach acquisitions on Prime Hook NWR, greater numbers of piping plovers are using refuge sandy beach areas as foraging habitats during spring and fall migration periods. Piping plover breeding has not been observed occurring on the refuge to date.

State endangered resident species on the refuge include two pair of bald eagles. State endangered species that breed on the refuge include pied-billed grebe, northern harrier, Cooper's hawk, black rail, and Forster's tern. In most recent years State endangered species that have attempted breeding on the refuge include American oystercatcher, least tern, and common tern. Uncommon occurrences of other State endangered species using the refuge in the spring, fall, or winter include brown creeper, black-crowned night heron, yellow-crowned night heron, least tern, hooded warbler, red-headed woodpecker, and sedge wren.

Birds

The bird assemblage in the project area is as diverse as its natural vegetation communities. The project area's geographic location on the southwestern shore of the lower mouth of the Delaware Bay situates the refuge at the heart of key staging areas for migrating, breeding, and wintering habitats for waterfowl, shorebirds, waterbirds, and land birds along the Atlantic Flyway and in the Western Hemisphere. The refuge is located in the Northeast BCR 30 and PIF Physiographic Region 44 of the Mid-Atlantic.

The project area has also been designated a significant site for shorebirds within the Western Hemispheric Shorebird Reserve Network (WHSRN 1986), a Ramsar Wetland Site of International Importance (1992) and an Important Bird Area of the Delaware Bay in 2000.

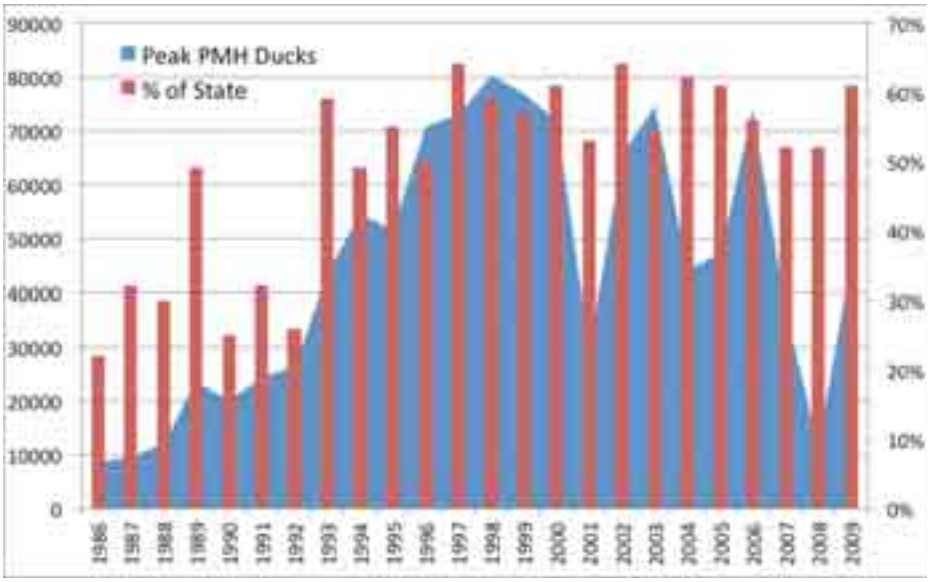
Waterfowl

Waterfowl have been a target species group for refuge management since the refuge was first established. In the past, the refuge farming program was focused on providing 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, for which croplands in grass or clover stages of rotations were designed to provide nesting habitats for ducks. In addition, waterfowl have utilized the refuge's wetland habitats, throughout several different phases of wetland management.

Waterfowl management on the refuge greatly improved habitat conditions for migrating and wintering birds when water level management capability was established in the mid-1980s. Excellent freshwater wetland habitat conditions providing abundant food resources are reflected by subsequent increased bird use of the refuge after 1986. For example, in October 2005, the refuge hosted 52

percent of waterfowl surveyed in Delaware, 71 percent of the State's snow geese, 82 percent of Northern pintails (22,800 birds), 54 percent of American green-wing teal (20,360), and 40 percent (1,889) of the State's American black ducks wintering in Delaware (DNREC, personal communication). Peak duck numbers of 47,116 ducks wintering on the refuge's marsh-complex represented 61 percent of the State's peak number of ducks (figure 3-16).

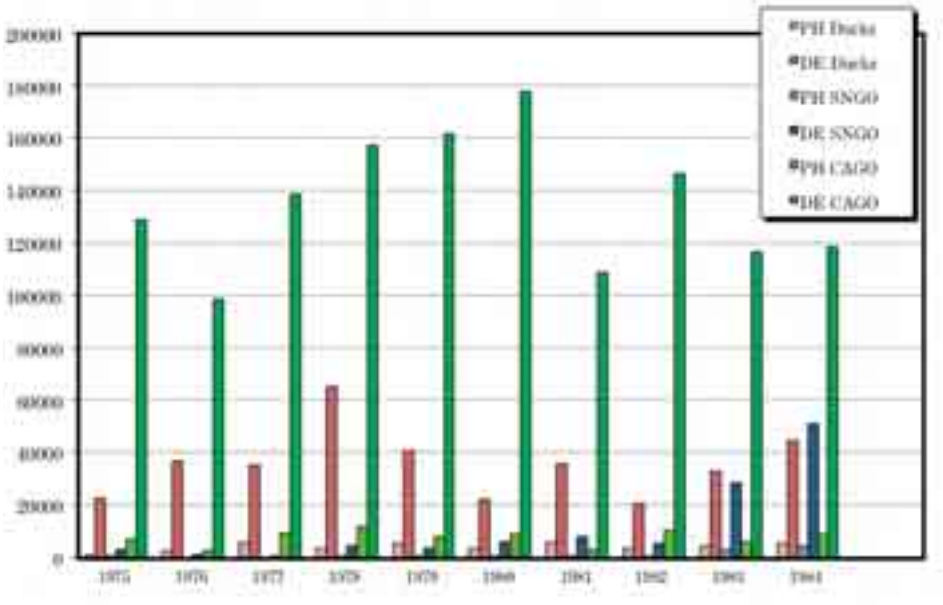
Figure 3-16. Peak Duck Populations Counted on Prime Hook NWR Marshes as a Percent of Delaware's Statewide Peak Duck Numbers



Historically, the Delaware Division of Fish and Wildlife has conducted aerial waterfowl surveys each year to measure long-term trends in duck and goose populations in the State. These surveys were flown in a small plane by the same waterfowl biologist for 30 years, using the same routes and techniques each time. The survey biologist staff changed after 2005, but DNREC waterfowl biologists have continued to provide waterfowl survey data directly to the refuge. These surveys cover the primary waterfowl habitats found in Delaware. The surveys give fairly accurate information about geese and most duck species with the exception of wood ducks and sea ducks, which are almost impossible to count from a fixed-wing aircraft. The important feature of these counts is that they provide long-term trends that are useful to measure changes in waterfowl management strategies and the environment. In most cases, no single count is especially important in itself but the collection of counts over the years has shown significant changes. These surveys detected the decline in the migrant Canada geese in the Atlantic Flyway, the loss of duck use in Christiana marshes after the construction of I-95, and recent increases in ducks using Prime Hook NWR. An analysis of this 30-year data set shows how marsh restoration and rehabilitation projects, after an early period of no management, improved habitat conditions for waterfowl.

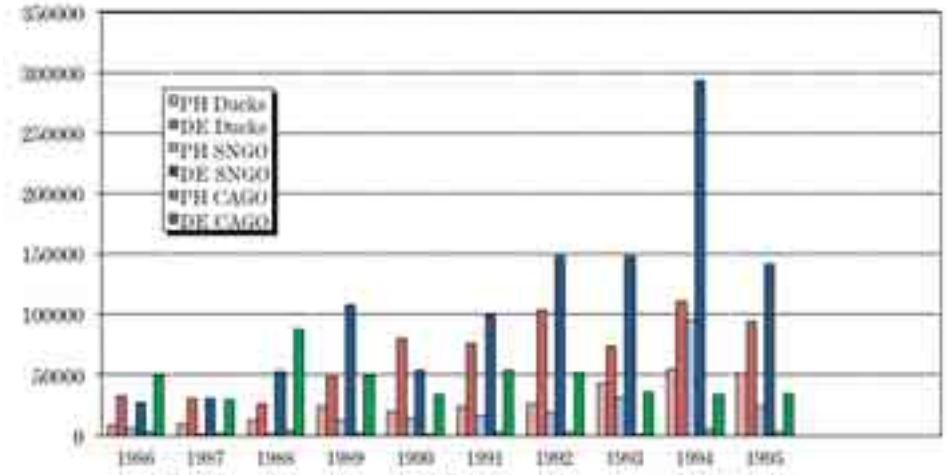
During a decade of the no wetland management era, proliferation and invasion of *Phragmites* throughout the refuge's wetland areas reduced the quality of habitat conditions for ducks. During this time, average duck use of refuge marshes was 3,905 birds (peak 5,795 to low of 2,254), which accounted for less than 10 percent of the State's total duck numbers. Average snow goose numbers were 748 birds, ranging from 0 to 4,310 birds. State average totals for snow geese were 11,000 and ranged from 678 to 50,726 birds. State migratory Canada goose numbers were at an all time high of 177,811 birds in 1980 and refuge peak numbers of Canada geese during this decade were 11,942 birds in 1978 (DNREC personal communication). For waterfowl population distributions and use of refuge marshes compared to Statewide numbers (figure 3-17).

Figure 3-17. Average Waterfowl Use during the No Wetland Management Era



During the next decade of marsh rehabilitation of Prime Hook NWR's wetlands consisted of the large-scale control of *Phragmites* and establishment of impoundment infrastructure, waterfowl use increased. These habitat improvements and increased waterfowl use on the refuge are reflected in the State of Delaware's waterfowl aerial survey data. Statewide, ducks numbers doubled from the 1986 to 1995 period compared to the 1975 to 1984 period, while duck use and numbers on the refuge increased sevenfold, ranging from a low of 8,582 ducks in 1986 to a peak of 54,606 in 1994. Pintails (28,920) and green-winged teal (39,611) were the duck species contributing the highest total numbers to duck counts during this period. Snow geese also showed increases on the refuge and throughout the State. Peak snow goose numbers recorded in 1995 for the refuge were 95,300 birds and 293,651 birds for the State. In contrast, Canada geese numbers dropped sharply with average numbers during the 10-years of no management of 7,486 dropping to 2,573 birds during the marsh rehabilitation era. Likewise, Statewide numbers of Canada geese dropped from an average of 135,213 birds down to 45,678 birds in the second decade of trend monitoring data (figure 3-18) (DNREC, personal communication).

Figure 3-18. Average Waterfowl Use during Marsh Rehabilitation Era



Continuing this 30-year trend analysis, during the intensive wetland management strategies of integrative moist-soil management, waterfowl use of Prime Hook NWR's marshes continued to increase. Teasing out the duck numbers from the waterfowl data, the State experienced a general 37 percent increase in duck numbers during this decade (1996 to 2005), while Prime Hook NWR recorded a 72 percent increase from prior decades in duck use. At Prime Hook NWR, duck use ranged from a low of 29,638 ducks in 2001 to a high of 80,261 ducks in 1998.

Increases in snow goose numbers were recorded both Statewide and refugewide. Peak snow geese numbers on the refuge were 143,432 birds occurring in 1999 and a low of 13,775 snow geese in 2005, compared to a Statewide high of 371,715 birds in 1997 and low of 91,654 also in 2005. Canada goose numbers using the refuge doubled from the prior decade but Statewide Canada goose numbers continued to spiral downward.

Thirty-two waterfowl species have been recorded using refuge habitats. The two duck species contributing the most in the 30-year trend data analysis were green-winged teal and northern pintail. Green-winged teal numbers were 41,047 in 1996; 46,795 in 1997; 53,260 in 1998; and 65,727 in 1999; and peak northern pintail numbers include 28,920 in 1993; 21,061 in 1998; 21,835 in 2000; and 35,497 in 2003. Other duck species contributing to duck totals included American black duck, mallard, gadwall, American wigeon, northern shoveler, wood duck, scaup, ring-necked duck, ruddy duck, and hooded merganser.

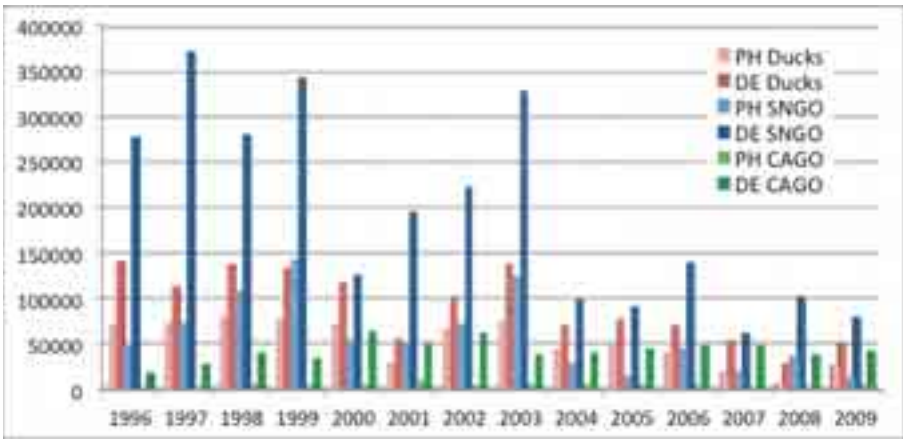
By means of marsh rehabilitation and integrative moist-soil management techniques through water level manipulation strategies, Prime Hook NWR has demonstrated considerable success in increasing both waterfowl and shorebird use of the refuge's wetland habitats simultaneously. Fredrickson and Laubhan (1994) described how intensive wetland management strategies are the keys to enhancing biodiversity in the face of continuing wetland degradation and loss throughout all landscape scales.

The basic premise of intensive wetland management is producing a diverse array of plant and animal food resources that can feed a greater abundance of target species of waterfowl and shorebirds on smaller patches of marshland. Intensive wetland management has demonstrated improvement in wetland productivity and biodiversity when the correct combination of water level manipulations and other habitat management techniques are applied at the appropriate times for an array of target wetland species (Fredrickson and Laubhan 1994).

The general strategy of intensive wetland management is predicated on knowing the life history requirements of target waterfowl and shorebird species, annually creating abundant native plant and animal food resources consistently, and making these annually produced food resources available to target species at the right time of the year.

Annually from 1995 to 2005, Prime Hook NWR attempted to match the chronology of particular biological events such as molting, migration, and reproduction requirements of target waterfowl and shorebird species with specific water level drawdown and reflood regimes conducted asynchronously between the refuge's three impoundment units. Concurrent waterfowl and shorebird habitat management can be accomplished each year by producing abundant invertebrate food resources and then linking drawdowns to local migration phenology. Management success is reflected in the bird use data (figure 3-19).

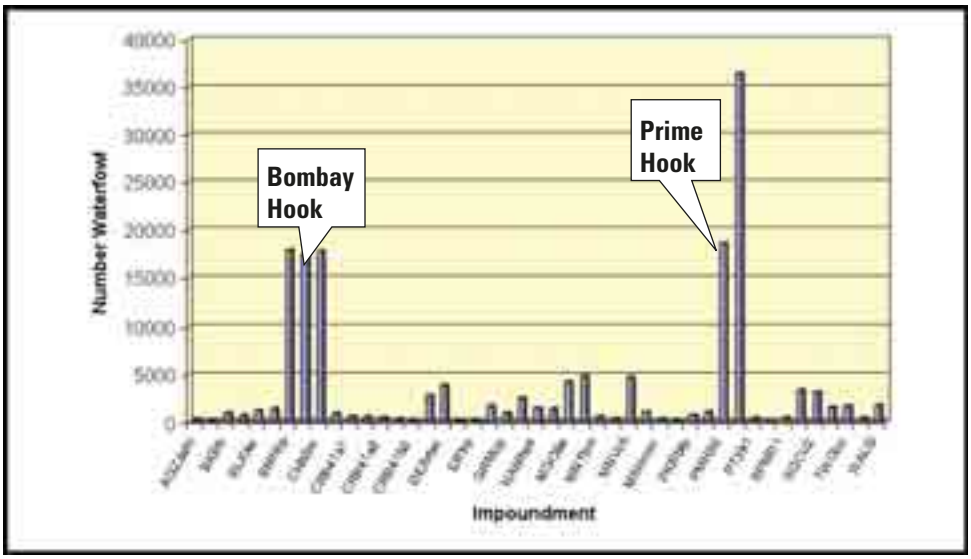
Figure 3-19. Average Waterfowl Use during the Integrative Wetland Management Era



Managed wetlands provide a broad spectrum of resources to migratory birds throughout the annual cycle. Successful conservation and management of waterfowl, shorebirds, and waterbirds depend on integrated approaches. Few managed wetlands have the capability to provide habitat during both spring and fall migration. Whether management actions are designed to benefit spring or fall migrant shorebirds, hydrologic regimes will also impact waterfowl and other waterbirds, primarily through changes to invertebrate and plant communities. With this in mind, the refuge participated in a 3-year, multi-regional wetland management study from 2005 to 2007 to understand the differential impacts of spring versus summer/fall drawdowns on the vegetation structure, invertebrate communities, and use of impoundments by waterfowl, shorebirds, and other waterbirds (USGS 2005). The refuge used study areas in Unit III (PMH3D) and Unit IV (PMH4A).

Preliminary analysis of study results (Green et al 2007) after two seasons of field data (2005 and 2006) indicated that early spring drawdowns conducted in PMH3D to prepare habitat conditions for spring migrating shorebirds, also yielded excellent waterfowl use in mid-November in the same wetland, with more than 20,000 ducks and geese recorded using the area. During the same timeframe PMH4A experienced a late summer drawdown targeting fall migrant shorebirds which also generated excellent waterfowl use with a peak of 15,000 birds using the same wetland by the first week of November. Of the 22 national wildlife refuges from regions 3 and 5 participating in this study, most refuges recorded waterfowl use in the tens and hundreds range while Prime Hook and Bombay Hook NWRs recorded waterfowl numbers in the thousands of birds range, indicating the importance of the Coastal Delaware NWR Complex to waterfowl resources (figure 3-20). A final analysis and study report will soon be released by USGS.

Figure 3-20. Relative Abundance of Waterfowl Using Refuge Impoundments Enrolled in Multi-Regional Impoundment Study. Note importance of Delaware refuge impoundments.



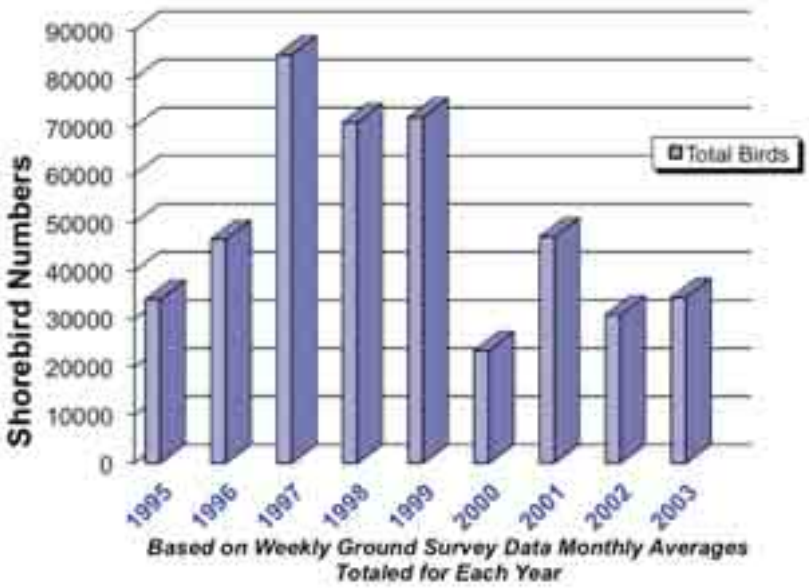
Shorebirds, Gulls, Terns, and Allied Species

The refuge provides diverse fresh and saltwater marsh and impoundment habitats that support 54 species of shorebirds, gulls, terns, and allied species. Most species are migrants, but 13 of these species breed on the refuge (black rail, clapper rail, king rail, Virginia rail, sora, common moorhen, American coot, killdeer, black-necked stilt, willet, spotted sandpiper, American woodcock, and Forster's tern), while 12 species winter in marsh habitats (sanderling, killdeer, American woodcock, willet, greater and lesser yellowlegs, western sandpiper, dunlin, common snipe, ring-billed, herring, and lesser black-backed gulls). Common terns, least terns, and black skimmers seasonally utilize refuge habitats; these three bird species are on the State's endangered species list.

Refuge saltwater marsh, sandy beach, and impoundment habitats support a shorebird migration that has worldwide ecological significance. Abundance of invertebrate foods is recognized as an important determinant of habitat quality for migrant shorebirds. High densities of chironomid larvae are common in the diets of breeding, migrating, and wintering shorebirds (Batzer et al. 1993). As previously mentioned, intensive management of Prime Hook NWR's seasonally flooded impoundments for migrant shorebirds has been a part of the refuge's habitat management strategies by incorporating methods to increase annual invertebrate biomass production. It is possible to successfully manage for such macroinvertebrates as chironomids and other short-cycle invertebrates, purposefully for shorebird consumption, using water level manipulations to produce invertebrate densities of at least 100 individuals per square meter (Baldassarre and Fisher 1984, Helmers 1992). The essence of successful shorebird management within impounded wetland habitats is based on the seasonal production of high densities of macroinvertebrates and their availability at critical times of the year for spring and fall shorebird migrants (Rundle and Fredrickson 1981, Elridge 1992).

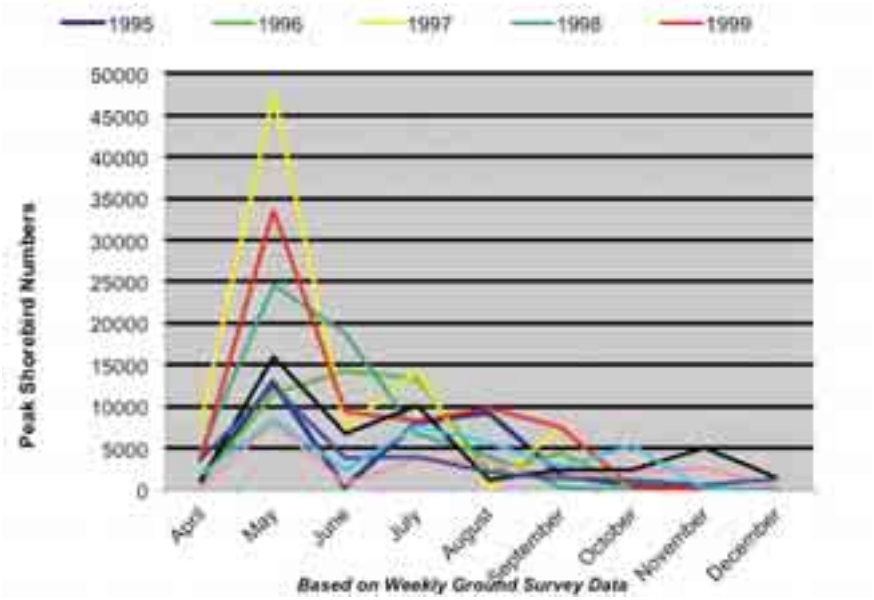
Manipulating water levels at the appropriate times to create areas with a mosaic of open mudflats with shallow water levels (between 1.0 and 10.0 cm deep) and invertebrate densities of at least 100 individuals/M2 have yielded excellent results on the refuge. A decade of shorebird ground surveys were conducted weekly from April to December on Prime Hook NWR's impounded marsh units (figure 3-21).

Figure 3-21. Refugewide Shorebird Use of Prime Hook NWR's Impoundments



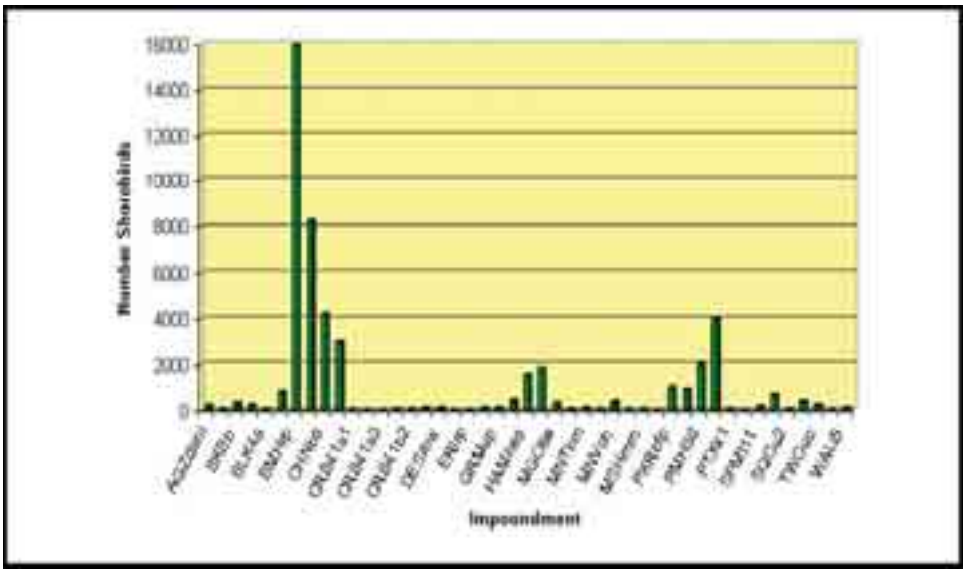
Dominant shorebird species contributing to shorebird numbers on Prime Hook NWR from weekly ground surveys included the following spring migrants: semipalmated sandpipers, short-billed dowitchers, dunlin, sanderlings, and red knots; and fall migrants: short-billed dowitchers, semipalmated plovers and sandpipers, dunlin, least sandpipers, and yellow-legs. Chronology of use information for the years of 1997, 1998, 2000, 2001, 2002, and 2003 shows that spring migrants start arriving by mid-April and peak during the last 2 weeks of May, while fall migrants start arriving by the last week of June and peak during the first 2 weeks of July. Local spring migrants arrived 2½ weeks later in 1996 and peak fall migrant numbers were 3 weeks later in 1995 and 1999 (figure 3-22).

Figure 3-22. Chronology of Shorebird Use at Prime Hook NWR



As previously mentioned in the waterfowl section, the refuge participated in a multi-region refuge cooperative research impoundment study, whose primary objective was to monitor management actions that created shallow water and mudflat habitat for shorebirds either for the northward or southward migration. While management actions targeted shorebird habitat creation within the impoundments, we also simultaneously monitored the responses of waterfowl and wading birds in addition to shorebirds. The preliminary shorebird monitoring results (Green et al. 2007) suggest that both early spring drawdowns and late summer drawdowns generated greater numbers of fall migrants (peak about 4,000 birds) using Units III and IV impounded study sites, compared to spring migrants (peak about 1,500 birds). Chronology of use plots suggest that the first week of September was when the greatest shorebird use occurred (about 3,000 birds) in Unit III during 2005 and 2006; fall migrant shorebird use in Unit IV occurred in mid-August, and again September 1st and mid-September (about 4,000 birds for all 3 plot peaks) during the same timeframe as Unit III. Preliminary results suggest that refuge impoundments are more important for the southward migration. Overall, impoundments at Prime Hook NWR, as well as Bombay Hook NWR also in Delaware, are clearly important to migratory shorebirds, relative to other impoundments evaluated in the study (figure 3-23). A final study report is pending that will analyze and compare study results of 22 national wildlife refuges representing regions 3 and 5.

Figure 3-23. Relative Abundance of Shorebirds Using Refuge Impoundments Enrolled in Multi-Regional Impoundment Study. Note importance of Delaware refuge impoundments.



Marsh and Water Birds

Freshwater impoundments, brackish marsh, and salt marsh wetland areas provide excellent feeding and resting areas for 30 species of marsh and water birds. Pied-billed grebe, least bittern, and green herons all nest on the refuge. Pied-billed grebes are on the State endangered species list and American bitterns and little blue herons use refuge habitats for portions of the year. These three species are ranked as (S1) species of special conservation concern in the Delaware Wildlife Action Management Plan (2005).

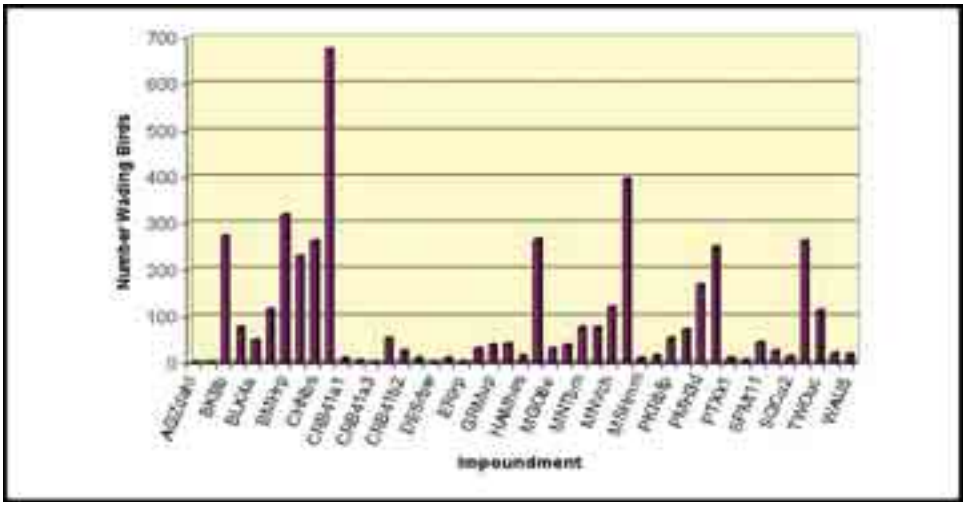
The most important heron and egret rookery in Delaware is located in the middle of Delaware Bay Estuary on a 310-acre island named Pea Patch Island. Located about 54 miles north of the refuge, it is the largest heronry on the East Coast north of Florida. It is a resource of both regional and national significance. Ten species of herons, egrets, and ibises nest on this isolated island, which supports

3,000 nesting pairs of wading birds. Many of these birds spend the months of August and September feeding on diverse and plentiful fish resources found in refuge habitats. Of particular note are the black-crowned and yellow-crowned night herons found on the refuge during this timeframe which are listed as State endangered bird species of Delaware.

The Mid-Atlantic/New England/Maritime Waterbird Conservation Plan (2006) has identified the highest priority species in need of immediate conservation action. Highest priority species that breed or migrate through the refuge include pied-billed grebe, American bittern, least bittern, snowy egret, little blue heron, tricolored heron, black-crowned night heron, glossy ibis, black rail, least tern, gull-billed tern, common tern, black skimmer, yellow rail, sora, black tern, and Forster's tern.

An integrated wetland management approach to create optimal shorebird habitats at appropriate times for spring and fall shorebird migrants can also provide a broad spectrum of resources for marsh and water birds. This group of birds was also targeted for monitoring during the Refuge Cooperative Research Program Region 3/5 Impoundment Study previously mentioned in the waterfowl and shorebird sections of this chapter. The objective of conducting management actions to create shallow water and mudflat habitats for shorebirds and monitor the subsequent responses of invertebrate populations and plant communities also included monitoring water bird use of the various seasonal habitat conditions that were generated during the study in PMH3D and PMH4A. Preliminary data analysis (Green et al. 2007) indicated that marsh and water birds utilized impounded wetland study sites throughout the year, with peak use occurring during mid-August and September during the 2005 and 2006 field seasons. Peak water bird use in PMH4A occurred in late August (approximately 350 birds) and peak use in PMH3D (approximately 250 birds) occurred during the first week in September (figure 3-24).

Figure 3-24. Relative Abundance of Wading Birds Using Refuge Impoundments Enrolled in Multi-Regional Impoundment Study.



Landbirds

The conservation of birds is a primary purpose of the Refuge System, and refuges provide important breeding and migrating habitats for a variety of landbirds, many of which are of state, regional and national management concern (USFWS 2008a, DWAP 2005, BCR 30 and PIF 44 plans). The term landbirds generally refers to the smaller birds (exclusive of raptors and upland game birds) not usually associated with aquatic habitats. This group refers to songbirds (Family Passeriformes) also known as passerines. These include resident songbirds that breed on refuge lands, such as corvids, chickadees, and

nuthatches, and short and long-distance neotropical migrants such as flycatchers, swallows, wrens, thrushes, vireos, and warblers.

Many landbird species require large forest areas to breed successfully and maintain viable populations. This diverse group includes songbirds (tanagers, warblers, and vireos), which breed in North America and winter in Central and South America, and residents and short-distance migrants, such as woodpeckers, owls, hawks, and eagles. According to breeding bird survey data since 1966, there has been a 60 percent decline in occurrence of individual birds of landbird migrant species in Maryland and an 83 percent decline in Delaware from 1980 to 2007 (Sauer et al. 2008).

Baseline information about Prime Hook NWR's landbird community during the breeding season is necessary for planning management activities that will contribute to the conservation of targeted resources of concern. A standardized point count survey route for breeding landbirds was established on Prime Hook NWR in 1998 using 40 points all located in fragmented upland forested habitats throughout the refuge.

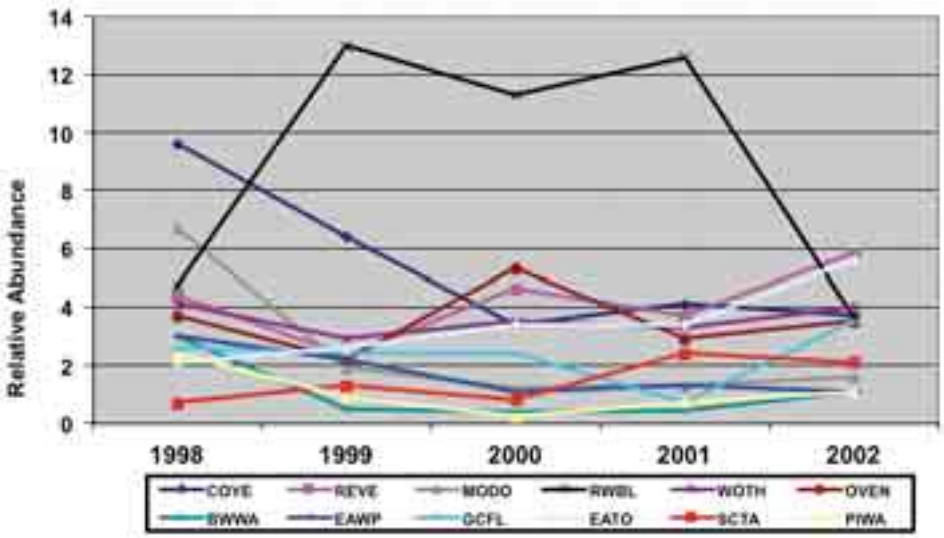
Information gathered from landbird breeding surveys conducted from 1998 to 2005 on Prime Hook NWR showed a wide variety of landbird species utilizing refuge habitats. Monitoring data was archived in the wildlife inventory census database and analyzed. Of the 40 points surveyed on the refuge landbird monitoring route, 70 species were recorded in 1998, 53 in 1999, 64 in 2000, 47 species in 2001, and 49 species in 2002. Monitoring data reflected only 36 points surveyed in 2001 and 32 points in 2002.

Data analyses were conducted separately for each individual species detected during each annual breeding landbird survey. The parameters used for each landbird species during the breeding season were species occurrence (presence/absence), frequency of occurrence, and relative abundance. The frequency of occurrence was calculated using species occurrence values at each point and was represented by the percentage of sampled points of the whole survey route in which the species was detected. The top 12 most abundant species with the greatest distribution across the refuge monitored from 1998 to 2002 are listed below:

Breeding Landbird Species	Frequency of Survey Points
COYE (Common Yellowthroat)	(31 – 71%)
REVE (Red-Eyed Vireo)	(28 – 68%)
MODO (Mourning Dove)	(16 – 27%)
RWBL (Red-wing Black Bird)	(28 – 48%)
WOTH (Wood Thrush)	(31 – 48%)
OVEN (Ovenbird)	(25 – 48%)
BWWA (Black and White Warbler)	(8 – 37%)
EAWP (Eastern Wood Pee-wee)	(9 – 37%)
GCFL (Great-Crested Flycatcher)	(11 – 38%)
PIWA (Pine Warbler)	(2 – 32%)
EATO (Eastern Towhee)	(30 – 53%)
SCTA (Scarlet Tanager)	(10 – 33%)

The relative abundance was calculated as the mean number of individual species detected per point on the refuge during a sample year. This variable provided an index for comparing the abundance of different species and for quantifying the rate of population change of a single landbird species across years on the refuge (figure 3-25).

Figure 3-25. Prime Hook NWR Breeding Landbird Survey Data



Based on relative abundance data, it seems that red-winged blackbirds had good and poor breeding years but the numbers on the refuge do not indicate a significant negative trend. However, compared to National Breeding Bird Survey data sets from 1966 to 2004 for both region 5 and BCR 30, significant declining trends are indicated in both R5 (P = -2.2734) and BCR-30 (P = -0.2767) when (P less than 0.1) for this wetland breeding species.

Scrub breeders like common yellowthroat and pine warbler are showing significant negative trends on the refuge along with region 5 and BCR 30 data sets. Woodland breeders on Prime Hook NWR, like the eastern wood peewee, black and white warbler, and ovenbirds showed declines in breeding numbers, while red-eyed vireos and wood thrush numbers were stable on the refuge for the past five years. However, these five landbird species have demonstrated significant negative trends in the breeding bird survey data trend sets (Sauer et al. 2005).

Cavity nesters such as great-crested flycatcher and woodland nesters such as scarlet tanager showed no significant trend declines on the refuge, but trend data from regional data sets revealed slight declines for these two species. Although not present in high numbers (five occurrences or less), records of short-distance and long-distance neotropical migrants breeding on the refuge and captured in these landbird surveys included American redstart, northern parula, Acadian flycatcher, blackpoll warbler, black-throated green warbler, summer tanager, chestnut-sided warbler, prairie warbler, hooded warbler, prothonary warbler, yellow warbler, blue-wing warbler, yellow-rumped warbler, eastern phoebe, cerulean warbler, worm-eating warbler, yellow-breasted chat, and yellow-billed cuckoo.

Between May 2001 and October 2003, the Service, in partnership with USGS, conducted a study of grassland-breeding bird abundance and diversity in some of the largest grassland fields existing on 13 refuges in region 5, including Prime Hook NWR (Runge et al. 2004) Each refuge evaluated at least two fallow fields (e.g., abandoned agricultural fields or old pastures maintained by mowing or burning) at least 12 to 16 hectares (ha) in size, in a surrounding non-wooded landscape of 25 ha. Grassland bird density differed substantially among refuges ranging from a low of 0.04 obligate birds/ha at Eastern Neck NWR (Maryland)

to 4.77 obligate birds/ha at Missisquoi NWR (Vermont). The density of obligate grassland birds detected at Prime Hook NWR was 0.19 birds/ha. While many of the refuges showed the potential to sustain densities of obligate grassland birds that were at least comparable to midwestern habitats, Prime Hook NWR showed some of the lowest densities, much less than midwestern habitats or other refuges in the region. For all of the refuges, fields planted with warm-season grass did not support much higher densities of obligate grassland birds than their cool-season or fallow counterparts.

The abundance of grassland birds supported on the fields enrolled in the study shows a similar pattern to the density. These results are affected by the area of the fields, and thus demonstrate a better measure of the relative contributions each refuge could make. The refuges along the Delaware Bay (Supawna Meadows NWR, Bombay Hook NWR, and Prime Hook NWR), and upper Eastern Shore of Maryland (Eastern Neck NWR), have the lowest abundance of grassland birds and the lowest relative contributions of obligate grassland birds in fallow fields among refuges in the Northeast. In terms of species composition, the refuges on the Mid-Atlantic Coastal Plain also show a distinctive community composition, dominated primarily, and almost exclusively, by grasshopper sparrows. The species detected at Prime Hook NWR, albeit in very low numbers, were mostly grasshopper sparrows and horned larks, as well as eastern meadowlarks and sedge wren.

Very few terrestrial species are resident or reproduce in vegetated portions of the harsher environments of salt marshes (Greenberg et al. 2006). However, obligate salt marsh passerines, such as seaside sparrows, thrive on the refuge salt marsh areas. These salt marsh obligate species can serve as indicators of healthy salt marsh habitats because of their strong relationship with ecosystem structure and function, and because they are easier to sample compared to other environmental health parameters (DeLuca et al. 2004). The refuge monitors their presence and, as staff and resources permit, their breeding productivity.

©Chuck Fullmer

Black and white warbler

The refuge also serves as critical stopover habitat for migrating landbirds. Researchers have been reporting for decades on the particular importance of wooded habitats along the Atlantic coast to migrating songbirds for cover and food sources at this vulnerable stage in their life cycles. Preliminary analysis of National Weather Service Doppler radar data (Dawson and Buler 2010), has underscored the importance of forested wetland cover on Prime Hook NWR to migrating songbirds (figure 3-26). Forested wetlands on the refuge are consistently used by songbirds in very high densities during migration periods, as are a number of large, forested patches outside the refuges. Birds were detected as they left daytime stopover sites at dusk to resume nocturnal migratory flight.

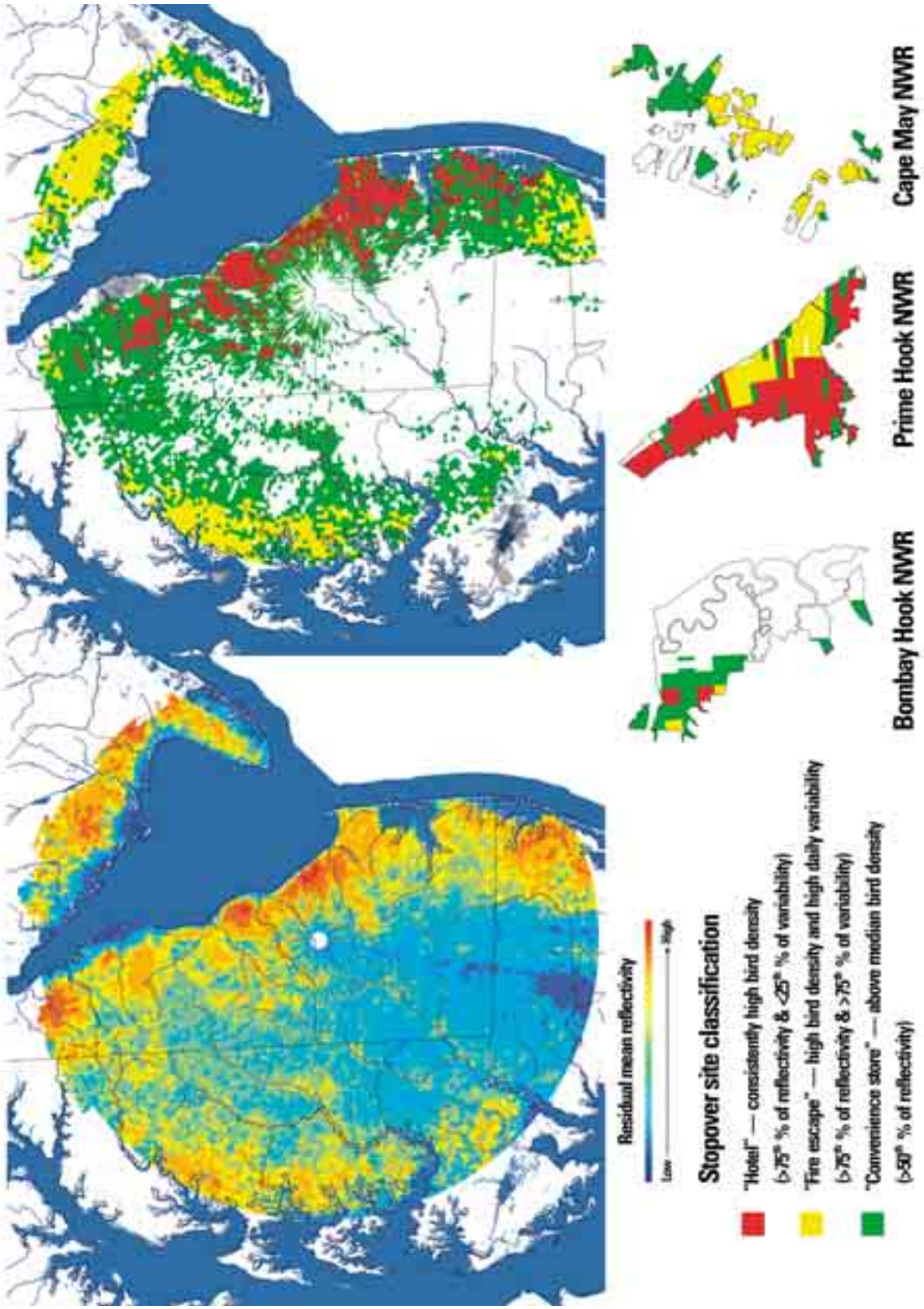
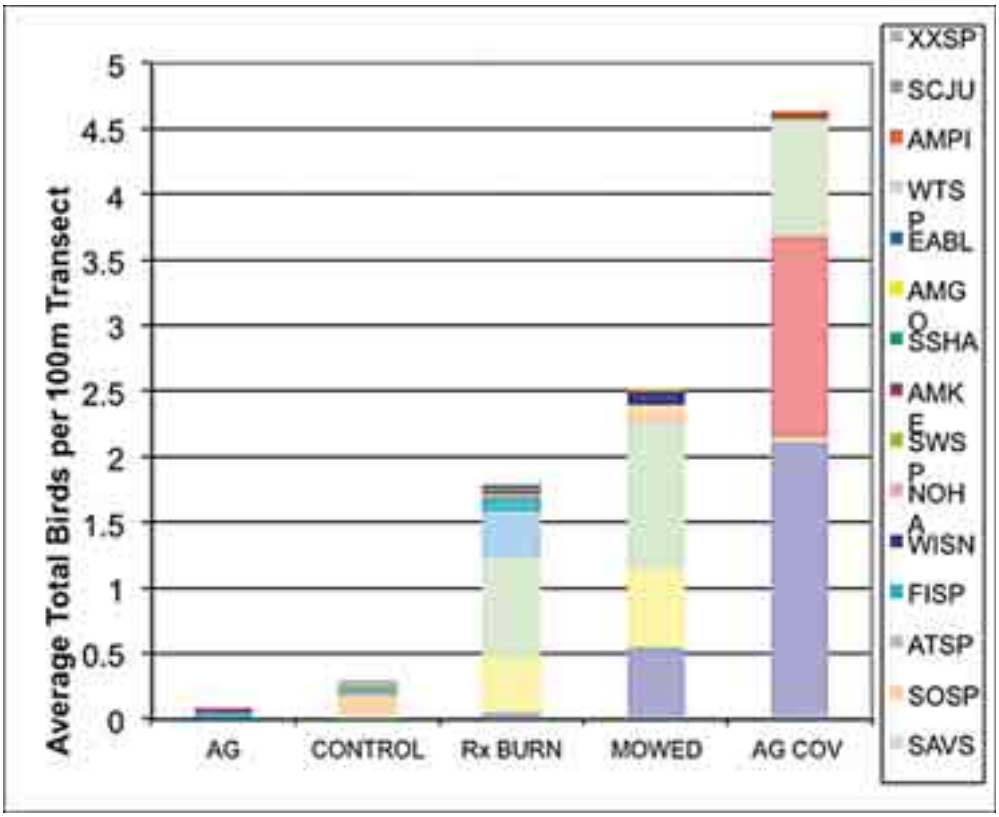


Figure 3-26. Residual mean radar reflectivity (i.e., relative bird stopover density) and stopover site classification during fall 2008 and 2009 in the area sampled by radar station KDOX, located roughly 35 km S of Dover, DE. Figure taken Dawson and Buler (2010).

The refuge may also be providing valuable overwintering habitat for landbird species of conservation interest, such as grassland specialists. In 2003 to 2004, the refuge participated in a pilot wintering grassland bird survey. The primary objective of the survey was to evaluate survey techniques, timing, and duration. Wintering grassland birds are difficult to survey because they are less abundant, less vocal and active and often patchily distributed and spatially and temporally unpredictable (e.g., found in flocks that move throughout suitable habitat). The pilot surveys provided baseline data regarding the abundance and species composition of grassland birds using some of the managed open fields on the refuge.

The pilot study involved a series of survey transects in each sampled field, across 2 to 4 days, once per month (December 2003, January 2004, and February 2004). Five fields with varying cover types or recent management history were surveyed during the pilot study: Field 202A (mowed), Field 321 (burned), Field 332 (control - unmanaged fallow), Field 318 (agricultural), and Field 202B (agricultural with winter wheat cover crop). Seventeen species were detected in the fields over the course of three separate survey bouts. Because the total length of transects surveyed varied with field size and transect configuration, survey results were calculated as the average number of birds detected per day, per 100 meters of transect sampled. In general, Field 202B had the highest average number of birds, which was driven primarily by a large number of horned larks and red-winged blackbirds using that field, especially during the February survey bout. The greatest species diversity was found in Field 332, the unmanaged fallow field (control), and Field 321, the burned grassland field. Savannah sparrows and eastern meadowlarks preferred Fields 202A and 321, the two managed grassland fields (figure 3-27).

Figure 3-27. Average number of birds detected per 100 meters of transect surveyed in five fields at Prime Hook NWR during winter 2003 to 2004.



Finfish and Shellfish
Refuge fishery resources are extensive and very diverse. The broad goals of refuge fishery management have been to maintain and improve the quality of aquatic habitats for a well-balanced community of fish and other aquatic species, provide fish passage for anadromous fish species, and offer quality recreational fishing opportunities compatible with the refuge's purposes. Current refuge aquatic environments support 52 species of fishes, 4 species of shellfish, and nursery habitats for elvers, striped bass, river herring and other anadromous fish species, and blue crabs.

Early surveys of refuge fishery resources (1969) indicated that 23 species of fishes utilized refuge waters and that largemouth bass, chain pickerel, black crappie, pumpkinseed sunfish, and bluegill were the predominant game fishes of freshwater habitats. Rough fishes such as common carp, creek chubsucker, and gizzard shad were also abundant. Updated surveys conducted in the late 1990s and salt marsh research studies conducted from 2000 to 2004 have supplemented refuge fishery inventory data. See appendix D for a list of the fishery resources found on the refuge.

In its State Wildlife Action Plan (2005), Delaware has identified species of greatest conservation need and placed them in a two-tier system based on endangered and threatened status, significant/sensitive Delaware populations, State and global rankings, highest BCR 30 rankings, and American Fish Society vulnerability rankings. Tier 1 species found on the refuge include blue crab, mud sunfish, and yellow bullhead. Tier 2 species include comely shiner, banded sunfish, fourspine stickleback, and hickory shad.

Additional information about finfish and shellfish resources of the refuge can be found in the Prime Hook NWR Final CCP/EIS, Volume 1, chapter 3 *(http://www.fws.gov/northeast/planning/Prime%20Hook/finalccp.html).*

Mammals
During the settlement of North America and heavy exploitation of the land, nearly all the native mammal species of what is now the eastern U.S. suffered radical declines in numbers. Several species are threatened and endangered. Of notable exception is the white-tailed deer, which has done well in recent years due to extirpation of larger predators coupled with unnatural subsidies of rich food resources in the form of agricultural crops. The white-tailed deer is the most important big game animal in Delaware and the eastern U.S. In Delaware over 15,000 deer are reported in annual harvests and the refuge kills about 130 deer per year.

Prime Hook provides habitats for 37 species of mammals. Thirty-four are native to Delaware and four are exotic. Four of the native mammalian species are ranked as rare and uncommon in the State and include the Delmarva fox squirrel, (both Federal and State-listed as an endangered species), American beaver (S-3), marsh rice rat (S-3), and American mink (S-3). Three species ranked as (S-4) are secure in present habitat conditions are woodland vole, northern river otter, and star-nose mole. Four species are ranked as (SU), their status is uncertain but they are usually uncommon species believed to be of conservation concern, but data are inadequate to determine the degree of rarity. These SU species include the silver-haired bat, eastern red bat, and hoary bat. The remaining species are ranked as (S-5) common species and defined as secure in the State under present conditions.

Of the four exotic species found on the refuge, nutria causes the most concern. The only member of the family Myocastoridae, they are native to Brazil and Chile and were introduced in California in 1899 and during the 1930s in the Southeast. Nutria are denizens of freshwater or brackish marshes and compete for habitat

with muskrats. In the 1960s the annual take of nutria pelts (used mostly in trim and lining) and the meat (for pet food) was more than $1 million.

Harvest and values of pelts declined drastically in the mid-1980s to early 1990s. The decreasing harvest resulted in concomitant increase in nutria damage to marsh habitats, levees, and agricultural crops. The first appearance of nutria on Prime Hook NWR marshes occurred in 1991. At the manager's request, a refuge trapper harvested any nutria encountered during the 1991 muskrat trapping season. A nutria was preserved as a museum sample for educational purposes at the refuge.

Adult nutria weigh about 26 kg (12 lbs) and eat about a quarter of their own weight in food per night. They are entirely vegetarian and generally prefer more common aquatic plants found in the habitats where they live. Nutria will also opportunistically feed on corn or other crops if adjacent to their marsh homes. Like muskrats, marsh plants are their favorite foods especially rushes, spikerush, pickerelweed, cattail, arrowhead, and smartweeds.

The presence of nutria on the refuge today is confirmed by anecdotal observations of animals seen along the peripheral edges of Units II and III marshes. However, nutria populations have not exploded or even significantly expanded on Prime Hook NWR since 1991. A nutria meeting was held at the refuge in February 2004 to assess the current status of Prime Hook NWR's nutria population, by Dan Murphy of the Maryland Nutria Project from the Chesapeake Bay Field Office and in attendance were Stephen Kendrot, the Nutria Project Field Supervisor, his staff, including trained nutria dogs, and several State DNREC employees.

In the past, refuge areas of confirmed nutria sightings were visited in an attempt to capture some animals. No nutria were found after 4 hours in the field. It was concluded that the present refuge wetland habitat management techniques (water level manipulations) have created insufficient habitat to support large numbers of nutria. Based on data from Blackwater NWR and other Delmarva areas with large populations, nutria are associated with large contiguous stands of *Scirpus*, which does not exist on Prime Hook NWR. In addition, the very shallow freshwater wetland systems readily freeze-up every winter, further stressing nutria and hampering proliferation.

In 2011, USDA Animal and Plant Health Inspection Service (APHIS) Wildlife Services conducted delimiting surveys to establish the distribution of nutria throughout the Delmarva Peninsula, focusing first on watersheds that have historically been occupied, even if only sporadically. Wildlife Services identified habitats and divided them into four zones. Prime Hook NWR was mapped in zone 3, identified as an area where nutria exist in small isolated populations; Wildlife Services habitat assessments prioritized zone 3 areas for more intensive ground searches. Twelve Wildlife Services personnel conducted nutria population delimiting surveys on the refuge from several boats in navigable waters along the shoreline edges. They also conducted ground surveys by foot in wetland and woodland habitats. Delimiting surveys were conducted from September 21 to 27, 2011 throughout the entire refuge; and no nutria were detected.

Refuge Endangered Species Management: Delmarva Fox Squirrel Population

The Delmarva Peninsula fox squirrel *(Sciurus niger cinerus*), generally called the Delmarva fox squirrel, was listed as federally endangered in 1967 because of concerns about a reduction in distribution to only 10 percent of its historic range.

The original recovery plan for the squirrel was approved in 1979 with a first revision in 1983. These plans emphasized two action objectives: identify optimum habitat conditions for the squirrel and translocate squirrels into suitable habitat outside currently occupied areas into new locations within their historical range.

The Delmarva fox squirrel was extirpated in Delaware in the 1800s. The recovery team decided to reintroduce fox squirrels throughout the Delmarva area and beyond. Sixteen translocations of Delmarva fox squirrels occurred from 1979 to 2000, including 11 in Maryland, 2 in Virginia, 2 in Delaware, and 1 in Pennsylvania. Delaware's sites were restricted to Sussex County; the first was a State wildlife management area (Assawoman) and the second site was on the refuge.

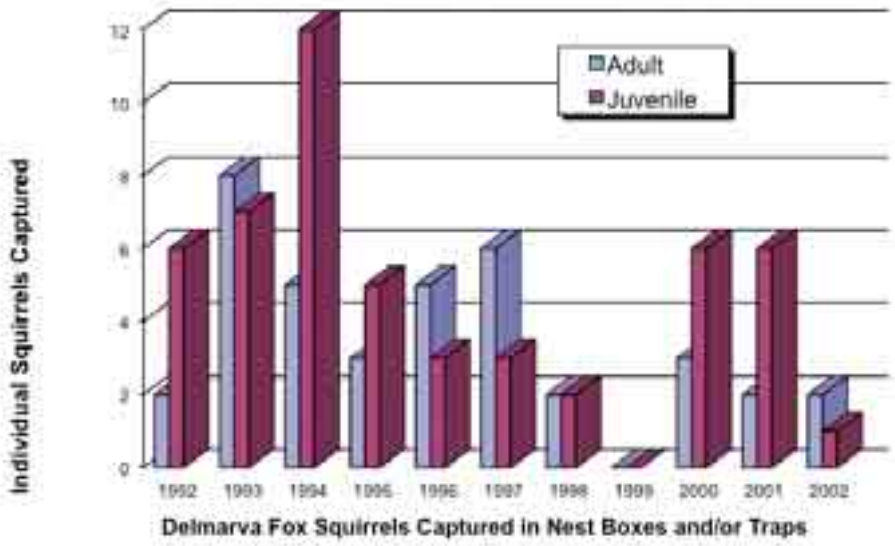
Prime Hook's translocations occurred in 1986 and 1987. A founder Delmarva fox squirrel population of 17 individuals, 4 from Dorchester County, Maryland, and the remainder from Blackwater NWR, was introduced onto the refuge. Two radio-collared squirrels were lost to predation during their first week on the refuge. The remaining squirrels settled into suitable forested habitats, mostly within Unit III.

By 1993, the Prime Hook translocations were deemed successful as per the 1993 second recovery plan, which defined success when a new reproductive population established on or near the original release site had persisted for at least 5 years and increased beyond the original group size (USFWS 1993). However, after 20 years the refuge population remains very small eliciting concerns of founder effects and genetic drift issues, and doubts about long-term viability of the refuge's population. Recent changes in land use surrounding the refuge (i.e., development), the small scale of available habitats on Prime Hook NWR and climate change and sea level rise modeling data, all suggest poor prospects for long-term viability and persistence for the refuge Delmarva fox squirrel population.

Moncrief and Dueser (2001) had recommended that a minimum of 30 squirrels would provide a sufficient number of founder individuals for reintroduced populations at specific sites to reflect enough variation present from a source population. More conservatively, Soule (1987) recommended a minimum of 50 individuals to avoid founder effects or decreased genetic diversity. The founding Prime Hook population may have been established at a disadvantage due to its small size (n = 15) from the beginning, which may warrant considering additional translocations of fox squirrels to augment the refuge population in the future.

Population monitoring and censusing is also more difficult on very small-sized populations. Annual nest box checks and live trapping efforts have provided some refuge trend data. Thirty nest boxes were established by the State of Delaware on Prime Hook NWR in the late 1980s for monitoring purposes. In 1992, the refuge added 45 more nest boxes for a total of 75 boxes, which samples an effective area of about 250 acres in 4 different locations. Calculating refuge fox squirrel population estimates based on traditional mark-recapture techniques for population size (Lincoln-Petersen Index) is imprecise due to small {n} numbers and few recaptures. However, refuge monitoring data does provide evidence of annual recruitment for 10 of the 11 years monitored (figure 3-28).

Figure 3-28. Delmarva Fox Squirrel Nest Box Monitoring on Prime Hook NWR (1992 to 2002)



Refuge Delmarva fox squirrel population occurrence information from 2003 to present is based on sightings, trapping data, nest box checks and documentation from photo-monitors. In 2004, photomonitoring cameras were placed at 10 trap sites throughout the refuge in suitable squirrel habitat. During a 3-week sampling period, Delmarva fox squirrel visited five traps, four of which failed to capture squirrels. On May 26 and 30, 2004 two adult females were caught in traps and ear-tagged (H. Neiderriter, unpublished data). In 2005 and 2007, nest box checks resulted in zero squirrels captured and in 2008, photomonitoring efforts resulted in no observed or trapped fox squirrels. The long-term viability of the refuge's population is presently unknown (H. Neiderriter, personal communication).

Reptiles and Amphibians

A diversity of refuge natural communities provides for a variety of herpetofauna (38 species) on Prime Hook NWR. Common and scientific names for genus, species, and subspecies descriptions listed in this section are based on Crother et al. 2000. From 1999 to 2002, anuran (frog and toad) call surveys were conducted on selected tracts of Prime Hook NWR to assess overall quality and health of anuran habitats through time and to monitor the distribution of this sensitive group throughout Prime Hook. Twelve species were recorded from these surveys, of which one species is State listed – carpenter frog (S1).

Refuge Anuran Call Count Survey – Species Detected

American toad	*Bufo a. Americana*
Fowler's toad	*Bufo fowleri*
Eastern cricket frog	*Acris c. crepitanus*
Green treefrog	*Hyla gratiosa*
Northern spring peeper	*Pseudacris c. crucifer*
Pickerel frog	*Rana palustris*
Northern gray treefrog	*Hyla versicolor*
Southern leopard frog	*Rana sphenocephala utricularia*
Carpenter frog	*Rana virgatipes (S1)*
Wood frog	*Rana sylvatica*
New Jersey chorus frog	*Pseudacris feriarum kalmi*
American bullfrog	*Rana cateseiana*

The carpenter frog is 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 population is only one of two in the State (Heckscher 2003).

Two local herpetologists have significantly contributed to the surveying, inventorying, and understanding of the refuge's herpetofauna. Joseph "Mick" McLaughlin began surveying anurans of the refuge from 1999 to 2002 by conducting anuran call surveys with the refuge biologist. He has been studying and monitoring the distribution of reptiles and amphibians in Delaware since the mid-1960s and continues critical work with the federally threatened/State endangered bog turtle, contributing much to the State's survey information. James F. White, Jr., herpetologist with the Delaware Nature Society, has conducted occupancy surveys and published several articles about Delaware's amphibians and reptiles. He conducted surveys on the refuge during the 2004 and 2005 field seasons, contracted by the Delaware Natural Heritage Program, as part of the refuge's CCP preplanning inventorying efforts.

State-identified reptile and amphibian species of greatest conservation need in Delaware (DWAP 2005) found on the refuge as a result of survey efforts include the following:

Tier 1
Carpenter frog
Cope's gray treefrog
Spotted turtle
Northern diamondback terrapin
Corn snake
Milk snake

Tier 2
Eastern spadefoot
Rough green snake
Eastern ribbon snake

Amphibians, which are a unique group of vertebrates with more than 6,000 known species, are threatened worldwide. A global amphibian assessment group (Stuart et al. 2004) has found that nearly one-third (32 percent) of the world's amphibian species, representing 1,856 species, are threatened. Amphibians have existed on earth for about 300 million years, but just in the past two decades nearly 168 species have gone extinct and at least 2,469 (43 percent) are declining in numbers as environmental threats continue to escalate.

Due to the especially high incidences of frog abnormalities reported in Minnesota and Vermont, the Service began assessments in region 5 (Northeast) and region 3 (Midwest) in 1997 to document the extent of abnormal frogs on refuges. Scientific literature suggests that abnormalities in amphibians occur normally at low frequencies (0 to 2 percent) in wild populations; therefore the Service set greater than or equal to 3 percent abnormality level as the trigger point for greater study effort (USFWS 2003a).

A malformed frog survey was conducted on Prime Hook NWR during the 1998 field season. The goal was to sample 50 to 100 frogs of the most abundant species. Two sites were sampled: Turkle Pond and Black Farm Pond. Turkle Pond proved to harbor too many amphibian predators which precluded catching a significant sample size (n=9). Black Farm Pond was ideal. One hundred twelve frogs were captured and examined, including 48 percent southern leopard frogs, 44 percent Eastern cricket frogs, 7 percent Fowler's toads, and 1 percent northern spring peeper (Williams 1998).

A low number (less than 2 percent) of cricket frogs were found missing eyes, which placed abnormality levels below the trigger point. Deformed tadpoles and frogs were also noted in the lead shot cleanup site, and remediation and future monitoring is addressing this frog issue on the refuge.

Invertebrate

Invertebrates are the most diverse and abundant animals in natural ecosystems, but their importance in sustaining those systems is not commonly understood or appreciated. Invertebrate conservation and management depends on sound knowledge of the distribution, biology, and food web dynamics of individual species and ecosystem interrelations which all have far-reaching implications for migratory bird management. E.O. Wilson (1987) elegantly referred to them as "the little things that run the world." Both terrestrial and aquatic invertebrate communities are very important components within the Delmarva Coastal Plain ecosystem and more than outweigh all the taxa combined in species richness, abundance, and biomass.

Invertebrates serve vital functions as pollinators and detritivores (facilitating decomposition of matter and returning nutrients to the soil), and are critical food resources for birds, insectivorous mammals, fish, reptiles, and amphibians. They play predominant roles in all ecosystem processes and are necessary links in all food webs in refuge biological communities. Invertebrates represent critical elements of BIDEH and are essential to the maintenance of ecosystem services.

Invertebrate surveys for State-rare insects were conducted in 2004 and 2005. Insect surveys included numerous nights of blacklighting and baiting for nocturnal Lepidoptera (moths). In addition to noctural moths, fireflies, tiger beetles, and Odonata (damselflies and dragonflies) were also surveyed on Prime Hook NWR based on the high probability that the refuge harbors several uncommon species directly linked to a high diversity of habitat types. Diurnal Lepidotera (butterflies and skippers) were also surveyed in 2005.

Of the animal inventories of refuge biological resources, insect surveys focused on species of conservation concern for which adequate information regarding conservation status (local, regional, global) are available. The objective of these invertebrate surveys was to complete an inventory of the refuge to reveal rare and uncommon species.

Thirty-one species of State conservation concern (S1, S2, SU, State records, county records, and new to science) were found during this sampling period, including 18 S1 species, 8 S2 species, 3 State records, 1 county record, and 2 new species unknown to science. All invertebrate species listed in the final report (McAvoy et al. 2007) are represented by voucher specimens that have been placed in the University of Delaware and/or DNHP insect collections.

The great purple hairstreak is an insect species of very high concern in Delaware (DWAP 2005). This butterfly's host plant is mistletoe *(Phoradendron flavescens)*; 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 and Heckscher 2007).

Hydrangea sphinx was found in several locations throughout the refuge's freshwater shrub and swamp communities; it is very rare across the Delaware landscape. The last confirmed State record prior to the refuge discovery in 2004 and 2005, was in 1886 (Heckscher 2003, Jones 1928). Host plants for this species are buttonbush *(Cephalanthus occidentalis)* and water willow *(Decodon verticillatus)*.

Praeclara underwing 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 Delaware Natural Heritage Program 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 and 2005 surveys on the refuge, if it is found in future years, its discovery would warrant consideration as an extremely high conservation target, as only a few secure populations are known worldwide (Heckscher 2003).

The rare marbled underwing was found in the swamp cottonwood coastal plain pond community, and considered highly notable by 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 is the rarest animal species recorded by DNHP with the possible exception of State record firefly species *(Photuris pyralomimus)* and *Delphacid* species new to science, a plant hopper secured from the refuge's peat bog community currently being studied for taxonomic classification.

Mosquito Management on Refuge Wetlands

In the early 1900s, people became aware of the mosquito's role in disease transmission and recognized that controlling the mosquito would check diseases such as malaria. East coast tidal marshes were targeted for ditching as a means to drain marshes to control mosquitoes. From 1905 to the mid-1930s a general pattern of ditching known as parallel ditching was established. Ditches (greater than 36 inches) were run in a grid system, about 100 to 150 feet apart, across the surface of the marsh. This activity was carried out whether or not various marsh sites were heavy mosquito-breeding areas. Such drainage patterns resulted in the rapid removal of water from the marsh surface. Progress was evaluated in miles of ditches dug each year (Daiber 1986).

Parallel grid-ditching reached its peak during the depression years of the 1930s, when Federal and State agencies hired people to dig ditches by hand. Prior to Federal ownership, most of the refuge's marshes were parallel grid-ditched by Civilian Conservation Corps (CCC). CCC workers also widened the Prime Hook Creek that drained into the Broadkill Sound in 1933, near the current location of the second water control structure in Unit III (map 3-1).

Parallel grid-ditching was concerned only with the elimination of mosquito breeding with little to no consideration to other consequences. People with wildlife interests began to express concern about plants and animals associated with these drained marshes. This drainage technique significantly lowered the ground water table and replaced species of the low marsh zone *(Spartina alterniflora)* with less desirable species from the high marsh zone like salt marsh fleabane (*Pluchea odorata*) and salt marsh aster *(Aster subulatus)* followed by brushy vegetation particularly *Iva frutescens* and *Baccharis halimifolia* that invade dredged material piles. Lowered water table levels and shifts in vegetation become less desirable for waterfowl and other marsh birds due to the reduction in invertebrate populations as a food resource (Daiber 1986).

The Delaware Mosquito Control Section (DMCS), under Service permits, has controlled mosquitoes on the refuge since its establishment in 1963. The refuge has worked with the section 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. Prime Hook NWR is adjacent to residential beach communities where mosquito nuisance issues are amplified.

The control of mosquitoes is a State priority and a reality of management of salt marshes in the State of Delaware, and therefore, on the refuge as well. There are three techniques currently 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 biological control facilitated by open marsh water management.

Adulticides
Adulticides are inherently non-specific, i.e., they kill non-target species, as well as mosquitoes. The adulticides used on the refuge most recently include naled products such as 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 2005a). Based on acute toxicity data, the EPA considers the active ingredient naled, 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 a fast-acting organophosphate adulticide licensed for the purpose of controlling aphids, mites, flies, and mosquitoes. Naled is a cholinesterase inhibitor; cholinesterase is an enzyme important for proper nervous system functioning in animals, including mammals, birds, fish, and other insects.

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).

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 will not emerge as adults.

Due to the potential adverse effects of methoprene on non-target insects, Bti is 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 to 10 days) have been 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 have been applied using handheld, backpack, and aerial dispersal methods. DMCS conducts surveillance and carry out methods, including dip samples, light/carbon dioxide traps, and landing rates. *Bacillus*

thurigiensis and methoprene are applied following limitations included in the product EPA label, an annual Service pesticide use proposal, and an annual refuge special use permit.

Areas Currently Permitted for Larvicide Treatments
In accordance with an annual larvicide special use permit, up to 8 larvicide applications per year (byground or air) can be made to any given marsh site, involving the following areas:

Unit I—no larviciding is allowed, but none was requested by the DMCS. Open Marsh Water Management (OMWM) work, was undertaken in Unit I in the 1990s with additional treatments in the early 2000s. Reduced saltmarsh mosquito production in this unit is low enough that the DMCS has had no need to request any larviciding in this unit for a decade or so.

Unit I—up to 1,637 acres within what use to be, until about 2009, a heavily-vegetated freshwater wetland impoundment (prior to recent bayfront breaching) can be larvicided. However, relatively little larviciding actually occurred in this unit during the past decade, due to its former freshwater impoundment habitat conditions having reduced saltmarsh mosquito production. The impounding of this unit did not eliminate all saltmarsh mosquito production, but it occurred in a more diffuse manner over widespread areas within the unit, that in aggregate can occasionally produce large numbers of adult mosquitoes.

Unit III—up to 2117 acres within what use to be until about 2009 a heavily-vegetated freshwater wetland impoundment (prior to recent bayfront breaching) can be larvicided. But for reasons similar to Unit II above, relatively little larviciding actually occurred within this unit for the past decade.

Unit IV—this unit received extensive OMWM treatment in the late 1980s and early 1990s, which greatly reduced saltmarsh mosquito production. DMCS is currently permitted to treat up to 371 acres that were missed by the original OMWM work, or which weren't mosquito production areas at the time of treatment, but have since naturally become such. Approximately 90 acres of formerly OMWM-treated areas are currently dysfunctional requiring maintenance, for a total of 461 acres that are currently permitted for larvicide treatments.

Areas Currently Permitted for Adulticide Treatments
In accordance with an annual adulticide special use permit, DMCS is currently permitted to aerially adulticide over a 600 ft wide strip of refuge lands immediately behind or landward of the 3 bayfront communities of Slaughter Beach, Prime Hook Beach, and Broadkill Beach, up to 6 times per year for any given site. The northern portion of this strip in Unit I, located behind the south end of Slaughter Beach, totals 58 acres; the southern portion of this strip in Units II, III and IV, located behind Prime Hook Beach and Broadkill Beach, totals an additional 169 acres, for a total of 227 acres.

Larvicide use on-refuge
From 2007 to 2011, aerial larvicide applications on-refuge (by fixed-wing aircraft or helicopter) averaged 1.2 applications per year (range = 0 to 3 applications), and involved an average total of 188 acres per year (range = 0 to 880 acres. Ground larvicide applications on-refuge (by hand or backpack sprayer) averaged 4.6 applications per year (range from 2 to 8 applications), and involved an average total of 11 acres per year (range = 5 to 19 acres).

Adulticide use on-refuge
Aerial adulticide applications on-refuge (by fixed-wing aircraft or helicopter) consistently averaged 1 application event per year over the 5-year period

examined (from 2007-2011), involving an average of 227 acres per application event (range = 55 to 227 acres).

Open Marsh Water Management
By the 1960s, a different form of water management for mosquito control advocated the use of biological control rather than mechanical drainage. This concept, which became known as quality ditching was fostered to replace parallel grid-ditching. Quality ditching has since been transformed into OMWM and is based on the following assumptions (Daiber 1986):

- Not all parts of a tidal marsh breed mosquitoes.
- Mosquitoes are greatly reduced or absent from portions of the marsh where tidal action circulates water over the surface and removes excess water.
- Biological control in the form of predation by marsh fishes will reduce mosquito populations.
- Permanent pools of water on the marsh surface serve as reservoirs for mosquito-eating fish, which can forage on the surface of the marsh among *Spartina alterniflora* stems during high tide cycles.

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. This method is intended to mimic natural wetland features, such as pools and channels, more closely than the dense parallel grid-ditching techniques used in the 1930s. OMWM biological controls are effective in reducing mosquito production by 95 percent in treated areas (DNREC 2008).

In 1980 special use permits were issued to DNREC to start a refuge OMWM study that included a 6-acre control site and 6-acre treatment site in tidal salt marsh habitats in Unit IV. From 1982 to 1986 study data was collected and analyzed on the effectiveness of OMWM on the refuge to control mosquitoes. Four years later, a 90 to 99 percent reduction in mosquito production was recorded by the State in the treatment site and was deemed as a good technique to use to reduce the use of insecticides to control mosquitoes on the refuge, an environmental assessment was completed in 1987 to treat about 960 acres in Unit I and 430 acres in Unit IV salt marsh areas. In subsequent years other areas in Units II and III were identified as breeding areas where OMWM systems should be used. From 1989 through 1995, approximately 1,290 acres were treated with the construction of OMWM systems (closed ponds with sumps, radial ditches, plugs, and sills connecting existing parallel grid ditches), essentially removing about 1,800 acres from the spray program. In 2001, an additional 10.2 acres (3.2 acres of ponds and 7.0 acres of radial ditches) were treated with OMWM construction, removing an additional 362 acres from the spray program.

Socioeconomic Environment

Demographic data ranks Delaware's human population (830,364) as 45th in the Nation. State land area covers 1,982 square miles compared to 3,537,438 (U.S.), with a population density of 401 persons per square mile compared to 80 Nationwide. Delaware is 96 miles long and varies from 9 to 35 miles in width. Its chief products are manufacturing, mining, fish industry, and agriculture. Agriculture is one of Delaware's major industries, with 470,000 acres currently in croplands. Delaware ranks 5th in the Nation in percentage of land under cultivation, with a total of 39 percent of the total land cover in croplands.

Half of Delaware's 25 miles of seashore beach habitats are State parks. Prime Hook NWR is located in Sussex County 22 miles southeast of Dover. Refuge

headquarters are located 12 miles southeast of the town of Milford and 10 miles northwest of the town of Lewes, both of which are also located in Sussex County.

Population and Demographic Characteristics

Sussex County is somewhat less ethnically diverse than the State or Nation, with nearly 68 percent of its residents being white persons not of Hispanic origin (U.S. Census Bureau). The poverty rate in Sussex County in 2007 was 9.7 percent, lower than the rates for both the State and Nation. Median value of owner-occupied homes in Sussex County is $220,100, which is higher than the national median home value of $181,800 (American Community Survey). More than a quarter of all housing units in Sussex County are for seasonal or recreational use (American FactFinder, Census 2000 Summary File 1).

The largest town in Sussex County is Milford (population 7,201), part of which is in Kent County. Shipbuilding was the major industry of Milford through World War I. During much of the 20th century Milford served primarily as the commercial center for much of southern Delaware's large agricultural community.

Other large towns in Sussex County include Seaford (population 6,997), Georgetown (4,643), Lewes (2,932), Millsboro (2,360), and Milton (1,657). The primary industry in the area surrounding Seaford was agriculture, particularly the cultivation of tobacco, and the style of living was plantation. In 1925, the poultry industry became important as new methods of housing and feeding were introduced. The nature of farming changed from truck crops to grains and corn for chicken feed as Sussex County became the largest chicken-producing area in the world. In 1939, the DuPont Company chose Seaford as the site of the first nylon plant in the world *(www.seafordde.com;* accessed February 2012).

Georgetown is the county seat of Sussex County and contains the county's regional airport (Georgetown Local News 2006). The town is home to a large chicken processing plant owned by Perdue Farms. The plant employs a sizeable number of immigrants from Haiti and Guatemala. In fact, in 2000, 21.6 percent of Georgetown residents were of Guatemalan heritage, representing the highest percentage of Guatemalan Americans anywhere in the country (Georgetown Local News 2006) and giving Georgetown a more international feel than one would expect from a colonial-era town.

The Town of Lewes was founded as a Dutch whaling colony in 1631, giving it the distinction of being the first town in the first State, making Sussex County the oldest county in Delaware. Lewes is named after the town of Lewes in England, which also is situated in a county named Sussex (from which Sussex County, Delaware, takes its name), and has the same seal as its English counterpart. Lewes is a vacation and resort spot popular with residents of Washington, D.C. and the surrounding suburbs. Even though the city technically sits on the lower reach of the Delaware Bay, it is nonetheless considered an ocean resort, particularly as the ocean is nearby at Cape Henlopen. Lewes is the home of the Zwaanendael Museum, which features exhibits about Delaware's history. Fisherman's Wharf is a dock that stretches along the Lewes and Rehoboth Canal. It features multiple restaurants and bait shops, and in season the dock hosts hundreds of boats. The Lightship Overfalls, moored there, is owned by the Overfalls Maritime Museum Foundation and is one of seven surviving lightships at museums in the U.S.

The great mainstays of the local economy of Millsboro since the 18th century have been agriculture and timber, though both have changed significantly. Thriving businesses that began in the early 20th century include the manufacture of holly wreaths, cultivation of strawberry, and tomato canneries. Poultry production became a dominant industry in the Millsboro area, as in most other parts of Sussex County, beginning in the early 1930s *(www.millsborochamber.com;* accessed Feburary 2012).

The Town of Milton, originally settled in 1672, is a quaint little Victorian shipbuilding village centered around the headwaters of the Broadkill River, that today it is a growing tourist attraction. For a small town, Milton has a remarkably large number of historic buildings and homes. It has a diversity of historic architecture and boasts 198 homes on the National Historic Register. Milton hosts several annual celebrations co-featuring Prime Hook NWR, most notably the Lower Sussex Bass Masters Youth Fishing Event and the Annual Horseshoe Crab and Shorebird Festival; the latter is a unique day of fun to raise awareness of horseshoe crab conservation and the critical link to healthy shorebird populations. The refuge also has a featured link on the Milton Chamber of Commerce home page.

Employment and Income

As the home to industry, agriculture, and numerous seaside resorts and small towns, Sussex County is diverse in both its natural resource assets and its lifestyles. The county is classified as a recreation and retirement destination, with an economy largely dependent on service industries. Tourism is responsible for employing more than 10,000 people in Sussex County with an estimated economic contribution exceeding $709 million annually (Delaware Economic Development Office, 2008). Sussex County has abundant beaches and inland bays, beautiful state parks, and quaint historical towns. There are 16 public and private golf courses, with 2 additional courses currently under construction.

Today, western Sussex County is the center of Delaware's agricultural industry with more acres of land under cultivation than anywhere else in the State. There are 205 agricultural preservation districts now in Sussex County. Currently, Delaware leads the Nation in the percentage of protected farmland with 5.2 percent of the total land area and 11.3 percent in farms permanently preserved through agricultural easements.

Economic Benefits of Refuge Visitation and Management to Local Communities

National wildlife refuges enrich people's lives in many ways. Some benefits are relatively easy to quantify and some are not. Ecotourism is one method to derive economic benefits from the conservation of wildlife and habitats. It is important to quantify the economic effects of ecotourism to assist in refuge planning and facilitate the interaction of refuges and local communities (Caudill and Henderson 2005).

> *"In a world where money counts, the land needs value to give it a voice." —(Frances Cairncross/Banking on Nature 2004)*

Economic impacts at the refuge have been evaluated through several analyses over the past several years. Caudill and Henderson (2005) evaluated the economic benefits of the refuge to local communities in 2004 through the Banking on Nature study discussed in this section. Sexton et al. (2007) reported visitor trip spending of non-consumptive visitors and big game hunters using 2004 to 2005 data as part of a visitor and community survey for the refuge (discussed in the "Community Attitudes and Opinions about Prime Hook NWR" section). Koontz (2010) provided regional economic impacts of current and proposed management alternatives for the refuge (appendix I).

Banking on Nature Study by Caudill and Henderson (2005)
Refuge visitors pay for recreation through entrance fees, lodging near the refuge, and purchases from local businesses for items to pursue their recreational experience. This spending generates economic activity throughout the local economy. Some of the money leaks out of the local area (leakage), and some is recycled through the local economy (multiplier). Spending by non-residents must be separated from spending by local refuge visitors. In the data below, total visitor spending is evaluated to show its significance to the local economy.

Daily visitor expenditures for both residents and non-residents were developed in four categories (food, lodging, transportation, and other expenses) for six activities: freshwater fishing, saltwater fishing, migratory bird hunting, small game hunting, big game hunting, and non-consumptive activities. Visitor days were factored in, and the total expenditures by category of spending for each activity were determined. The area economy of the local surrounding area was characterized by population growth, employment, and per capita income (Caudill and Henderson 2005).

Although Prime Hook NWR is located in Sussex County, New Castle and Kent Counties provide significant sources of numbers of refuge visitors. The area had a population of 818,200 in 2003, an increase of 15.8 percent from 1993, compared to a 12 percent increase Nationwide. Total area employment increased by 19.4 percent from 1993 to 2003 compared with an 18 percent increase in the U.S. per capita personal income increased in the area by 17.7 percent in the same timeframe. This compares with a 15.6 percent increase in the U.S (see table 3-16 for summary of these data: source from U.S. Department of Commerce 2003).

Table 3-16. Summary of Area Economy, 2003
(Population and Employment in thousands; Per Capita Income in 2004 dollars)

	Population		Employment		Per Capita Income	
County	2003	Percent change 1993-2003	2003	Percent change 1993-2003	2003	Percent change 1993-2003
New Castle	515.1	11.4%	342.1	16.4%	$39,679	17.8%
Sussex	168.4	33.5%	85.9	29.5%	$27,556	17.8%
Kent	134.6	14.1%	77.4	22.4%	$27,152	17.4%
Area Total	**818.2**	**15.8%**	**505.4**	**19.4%**	**$35,123**	**17.7%**
United States	290,789.0	11.9%	167,174.4	17.9%	$32,322	15.6%

Prime Hook NWR had a total visitation of 106,525 during 2004 (table 3-17). The majority of recreation visits (108,611) were for non-consumptive activities and 63 percent of all recreational visits were undertaken by area residents.

Table 3-17. Prime Hook NWR 2004 Recreation Visits

Activity	Residents	Non-Residents	Total
Non-Consumptive:			
Nature Trails	30,077	20,052	50,129
Observation Platforms	5,264	3,509	8,773
Other Wildlife Observation	25,916	17,277	43,193
Beach /Water Use	0	0	0
Other Recreation	3,910	2,606	6,516
Hunting:			
Big Game	345	518	863
Small Game	71	4	75
Migratory Birds	1,100	367	1,466

Activity	Residents	Non-Residents	Total
Fishing:			
Freshwater	5,357	282	5,639
Saltwater	3,572	188	3,760
Total Visitation	***75,612***	***44,802***	***120,414***
Total Visitors			***106,525***

The regional area for the refuge is defined as Sussex, New Castle, and Kent counties of Delaware. In 2004, total Prime Hook NWR visitor recreation expenditures were $1,043,600 with non-residents accounting for $795,000 or 76 percent of the total refuge visitor recreational expenditures. Dollars spent by non-consumptive users totaled $771,900, fishing expenditures accounted for $222,100 or 21 percent of the total, and hunting expenditures ($49,700) or 5 percent of total recreation expenditures (table 3-18).

Table 3-18. Prime Hook NWR: 2004 Visitor Recreation Expenditures (in thousands)

Activity	Residents	Non-Residents	Total
Non-Consumptive:	$165.2	$606.6	$771.9
Hunting:			
Big Game	$3.3	$18.9	$22.2
Small Game	$0.3	—	$0.3
Migratory Birds	$7.5	$19.7	$27.2
Total Hunting	$11.0	$38.6	$49.7
Fishing:			
Freshwater	$36.2	$100.6	$136.9
Saltwater	$36.1	$49.1	$85.2
Total Fishing	$72.3	$149.8	$222.1
Total Expenditures	**$248.6**	**$795.0**	**$1,043.6**

Table 3-19 quantifies the local economic effects associated with 2004 recreation visits. The data focuses on the final demand (see glossary), employment income, and tax revenue dollars generated by Prime Hook NWR's recreational visitors. In addition to the economic effects of refuge hunting and fishing programs to local economies, it measures the dollar impact of ecotourism, which is the recent phenomenon of large numbers of people traveling substantial distances to take part in non-consumptive uses of the natural environment, to capture the total economic impacts associated with refuge visitor spending.

This total final demand was calculated as $1,456,000. This amount reflects the total monetary value of economic activity generated in the three county area by Prime Hook NWR visitor spending. In turn, the final demand generated 13 jobs (both full-time and part-time) with a total job income of $419,400. Total tax revenue generated (county, State, and Federal) amounted to $291,000 (table 3-19).

Table 3-19. Local Economic Effects Associated with 2004 Recreation Visits

	Residents	Non-Residents	Total
Final Demand	$346,400	$1,110,200	$1,456,600
Jobs	3.0	9.8	12.8
Job Income	$99,400	$320,000	$419,400
Total Tax Revenue	$69,700	$221,300	$291,000

The total economic effects (total recreation expenditures plus net economic value) are compared with Prime Hook NWR's budget for 2004. Net economic value is defined as an individual's total willingness to pay for a particular recreation activity minus his or her actual expenditures for that activity. The figure for economic value is derived by multiplying net economic values for hunting, fishing, and non-consumptive recreation use (on a per day basis) by estimated refuge visitor days for that activity and combining that number with the estimate of total expenditures, and dividing by the refuge budget for 2004. Caudill and Henderson (2005) estimated that the total economic effect is $1.85, meaning that for every $1 of budget expenditures, $1.85 of total economic effects are associated with these budget expenditures (table 3-20). This ratio provides a basis to compare the magnitude of economic effects resulting from refuge visitation to budget expenditures.

Table 3-20. Summary of Local Economic Effects of Recreation Visits (2004)

	FY 2004 Budget	Recreation Expenditures	Net Economic Value	Total economic effects per $1 budget expenditure
Prime Hook NWR	$1,290,700	$1,043,600	$1,344,400	$1.85

Regional Economic Impacts of Current Management for the Refuge by Koontz (2010)

The USGS-Fort Collins Science Center estimated the direct and total economic impacts of refuge management activities 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 the refuge Revenue Sharing Program, and spending in the local community by refuge visitors. The economic impacts in this study were estimated using the impacts analysis for planning regional input-output modeling system. 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, refuge activities would generate total economic impacts of $3.9 million in local output, 33 jobs and $1.1 million in labor income.

More specifically, non-consumptive use directly related to refuge operations would generate an estimated $2.1 million in local output, 21.3 jobs, and $602.7 thousand in labor income in the local economy. Including direct, indirect, and induced effects, non-consumptive use would generate total economic impacts of $3.1 million in local output, 29.3 jobs and $875.6 thousand in labor income.

Fishing activities directly related to refuge operations would generate an estimated $180.4 thousand in local output, 1.8 jobs, and $50.4 thousand in labor income in the local economy. Including direct, indirect, and induced effects, fishing activities would generate total economic impacts of $252.5 thousand in local output, 2.1 jobs, and $72.1 thousand in labor income.

Overall hunting activities directly related to refuge operations would generate an estimated $73.5 thousand in local output, 0.6 jobs, and $21 thousand in labor income in the local economy. Including direct, indirect, and induced effects, overall refuge hunting activities would generate total economic impacts of $103.5 thousand in local output, 0.9 jobs and $30.1 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 $45.5 thousand in local output, 0.4 jobs, and $13 thousand in labor income. Waterfowl hunting on the refuge would generate total economic impacts of $56 thousand in local output, 0.5 jobs, and $16.6 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.

Recreation and Tourism

According to the 2009 State of Delaware Comprehensive Outdoor Recreation Plan, 91 percent of Delaware residents indicate that outdoor recreation had some importance in their lives. When asked about facility needs, survey respondents in Sussex County identified as high priorities walking and jogging paths, bike paths, beach access, fishing access, and open space/passive recreation. According to the 2003 State of Delaware Comprehensive Outdoor Recreation Plan, the majority of Delaware residents surveyed think that there is too much development and not enough forests or open spaces in the State. Nearly half think there is too little farmland in the State, while one-third think there are too few wetlands in the State.

The National Survey of Fishing, Hunting, and Wildlife Associated Recreation collects information about anglers, hunters, and wildlife watchers in the U.S. (U.S. Fish and Wildlife Service and U.S. Census Bureau, 2006). The 2006 survey found that 395,000 Delaware residents and non-residents 16 years old and older participated in wildlife-associated recreation in Delaware. While the total number of participants[1] has fallen since 2001, the number of *days* spent participating in wildlife recreation has risen (table 3-21), as has expenditures on such recreation. In 2006, State residents and nonresidents spent $299 million on wildlife recreation in Delaware, compared to $148 million in 2001.

Table 3-21. Wildlife-Related Visitors in Delaware

	Visitors (Resident and Non-Resident)		Visitor-Days (Resident and Non-Resident)		% Non-Resident Visitor-Days
Activity	**2001**	**2006**	**2001**	**2006**	**2006**
Wildlife Viewing	232,000	285,000	722,000	855,000	16%
Fishing	148,000	159,000	1.4 million	1.8 million	33%
Hunting	16,000	30,000	226,000	654,000	22%

Source: U.S. Fish and Wildlife Service and U.S. Census Bureau (2006)

Wildlife Viewing

Abundant opportunities for wildlife viewing are available throughout Delaware. Wildlife viewing includes the activities of observing, identifying, and photographing. These activities can be done for formal educational purposes or general recreational enjoyment.

In 2006, trip-related and equipment-related expenditures associated with birding nationwide generated more than $82 billion in total industry output, 671,000 jobs,

[1] The sum of anglers, hunters, and wildlife-watchers exceeds the total number of participants in wildlife-related recreation because many individuals engaged in more than one wildlife-related activity.

and $11 billion in local, state, and Federal tax revenues, impacting local, state, and national economies (USFWS 2009a).

Wildlife-watchers spent $131 million on wildlife-watching activities in Delaware in 2006 (U.S. Fish and Wildlife Service and U.S. Census Bureau, 2006). The majority ($110 million, or 84 percent) of wildlife-watching expenditures were for equipment. Trip-related expenditures, including food, lodging, transportation, and other trip expenses such as equipment rental, made up $13 million, or 10 percent of all wildlife-watching expenditures. Other items purchased by wildlife-watching participants, such as magazines, membership dues and contributions, land leasing and ownership, and plantings, made up the remainder.

Accounting for the multiplier effect of these direct expenditures, wildlife-viewing generated a total of $203 million in economic activity and supported 1,975 jobs in Delaware in 2006 (Leonard 2008), comprising 0.34 percent of the State's Gross Domestic Product (Bureau of Economic Analysis) and 0.36 percent of all jobs in the State (USA Counties).

Preliminary findings from the 2011 National Survey of Fishing, Hunting, and Wildlife Associated Recreation report no significant change in wildlife watching from 2006 to 2011 and a nine percent increase from 2001 to 2011 in overall wildlife watching participation (U.S. Fish and Wildlife Service and U.S. Census Bureau, 2012).

Hunting

Total expenditures for all hunting activities Nationwide (big game, small game, migratory birds, and others) totaled $22.9 billion in 2006 (USFWS and U.S. Dept. of Commerce 2006). A more detailed analysis conducted for waterfowl hunting Nationwide, found it generated over $2.3 billion in total industry output, 27,618 jobs, and $347 million in state and Federal tax revenues, impacting local, state, and national economies (USFWS 2008b).

Preliminary findings from the 2011 National Survey of Fishing, Hunting, and Wildlife Associated Recreation report that overall hunting participation has increased nine percent from 2006 to 2011 (U.S. Fish and Wildlife Service and U.S. Census Bureau, 2012). In 2006, hunting participation nationwide was decreasing; however, it was increasing in Delaware (U.S. Fish and Wildlife Service and U.S. Census Bureau, 2006). In 2006, the majority (57 percent) of hunting was for big game, with the remainder being for migratory birds (29 percent) and small game (14 percent) (U.S. Fish and Wildlife Service and U.S. Census Bureau, 2006). All hunting-related expenditures in Delaware totaled $41 million in 2006 (U.S. Fish and Wildlife Service and U.S. Census Bureau, 2006). Equipment made up the largest proportion of hunting expenditures ($25 million, or 60 percent). This was followed by trip-related expenses, such as food and lodging, transportation, and other trip expenses, which made up one-third of all hunting expenditures. The purchase of other items, such as magazines, membership dues, licenses, permits, and land leasing and ownership, made up the remainder of all hunting expenditures.

A more detailed analysis conducted for waterfowl hunting in Delaware, found it generated more than $3.9 million in total industry output and $679,000 in State and Federal tax revenues (USFWS 2008b).

Fishing

Total expenditures for all fishing activities nationwide totaled $42 billion in 2006 (USFWS and U.S. Dept. of Commerce 2006). Preliminary findings from the 2011 National Survey of Fishing, Hunting, and Wildlife Associated Recreation report that the number of anglers increased eleven percent from 2006 (USFWS and U.S. Census Bureau 2012). In 2006, fishing participation Nationwide was decreasing, but it was increasing in Delaware (USFWS and U.S. Census Bureau 2006).

Fishing-related expenditures in Delaware totaled $97 million in 2006 (USFWS and U.S. Census Bureau 2006). Trip-related expenditures, including food and lodging, transportation, and other trip expenses, totaled $49 million—half of all fishing expenditures. This was followed by expenditures on equipment, which totaled $39 million (41 percent of all fishing expenditures). The purchase of other items, such as magazines, membership dues, licenses, permits, stamps, and land leasing and ownership, made up the remaining 9 percent of expenditures.

Recreation in Sussex County

According to the 2007 Sussex County Visitor Profile Study (Delaware Economic Development Office, 2008), nearly 3.2 million visitors traveled to Sussex County in 2007, a 6 percent increase over 2006 and a 20 percent increase over 2005. The majority of trips to Sussex County were for leisure (78 percent), increasing nearly 2 percent over 2006. On the other hand, business travel to the County declined by 2 percent. After Delaware, most visitors came from Maryland and Pennsylvania. Personal auto travel remained the dominant form of transportation to Sussex County, accounting for 69 percent of person-trips in 2007.

The average age of visitors in to Sussex County in 2007 was 45 and the median income of households visiting Sussex County was over $75,000, significantly higher than the median household income in Sussex County ($50,132). Average total trip spending was $405, a decrease of 7 percent from 2006. The average length of trip for Sussex County visitors was approximately 1.7 nights. Approximately 41 percent of overnight visitors stayed in a home/apartment/condo, while 30 percent stayed in a hotel/motel/resort and 19 percent stayed in a private home. Dining was the most popular activity for Sussex County visitors (42 percent), followed by visiting the beach/waterfront (41 percent), shopping (32 percent), entertainment (27 percent), touring/sightseeing (22 percent), hunting/fishing (13 percent), and visiting national/State Parks (10 percent).

Agriculture

As previously stated, Sussex County is the center of Delaware's agricultural industry. In 2007, 1.4 percent of all farmland in Sussex County was enrolled in Conservation Reserve, Wetlands Reserve, Farmable Wetlands, or Conservation Reserve Enhancement Programs.

According to the census of agriculture, farmland made up 41 percent of Delaware's land area in 2007. The majority of this farmland (81 percent) was used for growing crops, while 9 percent was woodland, 1.3 percent was pastureland, and the remaining was house lots, ponds, roads, and wasteland. In line with national trends, the average farm size in Delaware has been increasing, while total farmland has been decreasing. The average farm size in Delaware in 2007 was 235 acres, compared with the national average of 418 acres. Major crops grown in Sussex County are soybeans, corn for grain, wheat, barley, and corn for silage.

Community Attitudes and Opinions about Prime Hook NWR

USGS also estimated visitor trip spending and reported visitor and community attitudes and preferences about Prime Hook NWR (Sexton et al. 2007). The full report may be viewed at: *http://pubs.er.usgs.gov/usgspubs/ofr/ofr20071239;* accessed February 2012.

This extensive public use study was commissioned by the Northeast Region of the Service in support of the comprehensive conservation planning at Prime Hook NWR. The research was conducted by the Policy Analysis and Science Assistance Branch of the USGS/Fort Collins Science Center in order to determine how current and proposed CCP planning strategies for Prime Hook NWR could affect:

- Visitor use
- Visitor experiences

- Visitor spending
- Community residents' perceptions and opinions

Data for this study were collected using a survey administered to visitors to Prime Hook NWR and individuals living in the communities surrounding the refuge. 1,859 surveys were randomly distributed to two groups—to on-refuge visitors and to residents of surrounding communities, both consumptive (participating in fishing, hunting, or crabbing) and non-consumptive users. The stratified random sample of community residents, weighted with U.S. Census Bureau data to correct for age, gender, and community proportionality, had a +/- 4.4 confidence interval and the visitor survey had a +/- 5.4 confidence interval. Most refuge visitation is from repeat visitors, with visitors coming about 12 times a year and residents about 16 times per year. The study explicitly focused on whether there were statistically significant differences between the consumptive and non-consumptive users. About 72 percent of the total refuge visitors were from the local area and about half of them engaged in consumptive activities. Eighty-nine percent of the nonlocal visitors were classified as non-consumptive users. The non-consumptive users were more likely to be older (60s), retired, and female (54 percent). The consumptive users were more likely to be in their late 40s, employed, and male (97 percent). Other demographic factors were not significant differentiators between the visitor and community residents.

Wildlife observation was listed as the primary reason for both the visitor and community residents' visits, drawing 54 percent of the respondents' visits, regardless of whether they otherwise engaged in consumptive or non-consumptive activities. The refuge visitor group engaged in hunting more frequently than the community resident group and ranked it at a higher level of importance. The community residents more frequently participated in driving for pleasure and observing wildlife from or close to, their vehicles. The community residents also participated in various festivals, the National Fishing Day event, and organized lectures or birding trips to a larger extent than the refuge visitors did. Consumptive users primarily engaged in hunting (80 percent) and fishing (30 percent) and the non-consumptive visitors identified bird watching (73 percent), nature/wildlife viewing (64 percent), hiking/nature trails (56 percent), and special events, environmental education, and guided interpretive tours (collectively 68 percent) as their primary activities, although both groups did engage in the other activities. Proximity to the roads was of key importance to both the consumptive and non-consumptive users, but presumably for different reasons--the consumptive users use roads to access areas for hunting and fishing; many of the non-consumptive users, being older, remain in or near their cars while viewing birds on or near the water. However, non-consumptive visitors also placed the roads as important for viewing forest birds and paddling. Both the community residents and the visitors placed being in natural, undeveloped lands, experiencing a serene environment, using hiking/nature trails, and viewing birds on or near water as the activities of highest importance to them. Overwhelmingly, both consumptive and non-consumptive users held similar views of the refuge as providing attachment or meaning to their sense of place and identity and for family tradition or heritage.

Both groups expressed strong support for the level of services and features presently being provided by the refuge. In almost all categories of refuge services or opportunities, "Leave As Is" received the highest or close to the highest view (as compared to those wanting "More" or "Less" of some attribute.) Both consumptive and non-consumptive users indicated that refuge improvements could include increased wildlife viewing opportunities, improved environmental education and interpretive exhibits, increased hiking/nature trails, a new wildlife observation tower, and additional roadside pull-offs. Both consumptive and non-consumptive users highlighted only one area of services as important and poorly served by existing refuge management; this was media coverage/information, i.e., brochures and publications.

Local consumptive-use visitors rated the hunting and fishing programs as important and satisfactory, non-consumptive, especially non-local visitors, perceived the hunting programs as relatively unimportant and as "possible overkill" (a term not related to killing, but to the degree of program emphasis provided for that activity.) One statistical difference between the consumptive and non-consumptive users is that the non-consumptive users preferred to have more areas restored to natural conditions, more hiking trails, and more interpretive exhibits. When asked to rate five potential future services, the non-consumptive users rated an observation tower overlooking the marsh, road-side pull-offs, more walking trails around refuge headquarters, and more scheduled guided interpretive walks as far more important to them than the consumptive users rated such increased services. Non-consumptive users also wanted to have less hunting or level amounts of hunting, whereas the consumptive users overwhelmingly requested increased access for hunting and areas where they could set up their own blinds or deer stands.

Attitudes about certain aspects of visitor activities and refuge management revealed some areas of strong agreement amongst the respondents and some areas of clear polarization. Most habitat management options (restoration of natural habitats, use of fire to reduce risk and improve wildlife habitat, elimination of invasives) generated agreement amongst all respondents. The "continue farming/cease farming" issue was highly polarized when the survey was conducted in 2004 to 2005, with non-consumptive visitors far more supportive of restoration of natural habitats than the consumptive users. Continued land acquisition from willing sellers was strongly supported by both groups, of both private lands currently managed as farmland or of beachfront. Mosquito control generated strongly disparate opinions, again polarizing non-consumptive users who tended to favor limited spraying, but this group still accepted spraying when mosquito numbers are excessively high or when a public health emergency was declared. Since the survey was conducted before the breach of the barrier island east of Unit II, concerns about beach and marsh management did not generate public comments.

In contrast to the farming and mosquito control issues, hunting and other consumptive uses did not generate such disparities in attitudes between the non-consumptive users and the consumptive users. About 55 percent of the non-consumptive users were content to leave hunting 'as is' or to have it be increased. But the survey also included an open-ended response option regarding views about whether some activities should not be allowed/should be allowed on the refuge and about one quarter of the respondents provided some point of view. Some community residents stated the desire to have increased areas open for off-trail non-hunting use in addition to having more trails in areas now open to hunting. About 10 percent of the respondents expressed general opposition to hunting as an allowed refuge activity, but these comments did not reflect an understanding that hunting and fishing are identified by law as a priority public recreation wildlife-dependent use.

Spending associated with refuge recreational activities such as wildlife viewing and hunting can generate considerable tourism activity in the local Sussex County economy. On average, non-consumptive visitors spent 2 to 3 days in the local area with approximately three people in their group sharing expenses. Most of the non-local deer hunters were from other counties in Delaware; about half spent the night locally while the other half drove home after hunting. The current level of non-consumptive use and big game hunting non-local visitor days accounts for more than $983,500 of spending annually in the local communities near Prime Hook NWR. Direct and secondary effects generate more than $1.21 million in local output, $447,700 in personal income, and 19.4 jobs annually in Sussex County.

Currently, there is no fee to visit Prime Hook NWR. Survey results indicate residents and visitors do not feel that they should have to nor would they be willing to pay to visit the refuge. Responses were divided among agreement, disagreement, and uncertainty regarding this issue, although visitors were more willing to pay a fee than community members. While opinions regarding fees sometimes change once implemented, more study would be needed if implementation of fees were to be considered at Prime Hook NWR in the future.

Respondents were asked about their participation in natural resource decision-making (civic engagement) and ways in which they commonly obtain information on these topics, as well as their level of trust in both the refuge and the Service. Understanding individuals' civic engagement and their trust in the managing organization aids in public communication efforts.

Visitors to Prime Hook NWR rely heavily on friends and neighbors for news and information about the refuge. Local residents rely mostly on newspapers, followed by friends and neighbors, for news and information about the refuge. There appears to be some emerging use of the Internet for refuge information by visitors and community residents. These results support the importance of targeting communication strategies and outlets to different user groups of the refuge to convey important messages.

Community residents and visitors to the refuge have been quite engaged in natural resource decision-making in the past 5 years, engaging in passive activities, such as signing a petition, and active activities, such as joining a special interest group. On average, visitors and community residents have engaged in half the activities listed in the survey. The most common activities include attending a public meeting (59 percent of visitors and half of community residents), signing a petition (59 percent of visitors and 45 percent of community residents), and joining a special interest group (about half of visitors and 41 percent of community residents).

Another factor important in public involvement in decision-making is trust in the managing agency. Visitors and community residents appear to have moderate trust in Prime Hook NWR staff and the Service. However, nearly a quarter are unsure about their level of trust in the Service and the refuge. A planning process such as development of the CCP is an opportunity to build relationships and improve trust not only with visitors and community residents with whom the refuge has established relationships, but also with those who are less familiar with the refuge or have not engaged in the process due to lack of trust in the agency or uncertainty of their role in the process.

The study has been a key tool for the Service as it developed the CCP and many of the actions and initiatives incorporated into alternative B reflect the perspectives expressed by the survey respondents, including increasing the extent of trails open both to consumptive and non-consumptive users, increasing habitat restoration efforts, and expanding environmental education and interpretation programs, informational brochures, internet information, etc. Some of the issues which were identified in 2004 to 2005 may be less confrontational now, such as increased recognition of the national policies about unacceptable farming practices (requiring use of non-genetically modified seed.) However, some issues which did not surface at the time of the survey, such as barrier island management and maintaining the fresh-water impoundments in light of climate change and sea level rise have generated controversy more recently. While many more non-local residents than local visitors did not engage in consumptive activities or felt that hunting should be reduced, slightly more than 50 percent of the non-consumptive users accepted hunting at existing levels or were supportive of an increase in this use. Only about 10 percent of the survey respondents felt that hunting should not be allowed at all, and it is possible that some of these visitors did not understand that Congress has already determined

that hunting and fishing are to be facilitated as well as wildlife observation, photography, or environmental education. Since hunting, fishing, and crabbing have been a key aspect of Delaware history and culture, the results of the random survey support the conclusion that the refuge has appropriately allocated its resources amongst all of its priority public recreation users, and that increasing opportunities for shared public access of areas which were previously closed to any public access will be perceived as beneficial by both consumptive and non-consumptive visitors.

Refuge Administration

Prime Hook NWR Staffing

Through the implementation of a regional workforce plan in 2007, Prime Hook NWR was merged with Bombay Hook NWR to form the Coastal Delaware NWR Complex. As part of the plan, some staff positions were deleted or reassigned to different positions. The approved staffing chart indicates five full-time employee equivalent positions (table 3-22).

Table 3-22. Prime Hook NWR Staffing levels (over the past 10 years)

Fiscal Year	FY 03	FY04	FY05	FY06	FY07	FY08	FY09	FY 10	FY11	FY12
Funded FTEs	9	8	8	8	7	7 (2 temps)	5 (1 temp)	5 (2 temps)	5 (2 temps)	5 (1 temp)
Approved FTEs	9	8	8	8	7	5	5	5	5	5

Facilities and Maintenance

A 3,920-square-foot headquarters building houses the refuge administrative staff. The building was constructed in 1997 and provides space for staff, a friends group sales outlet, public restrooms, and an auditorium that can accommodate 45 persons. Adjacent to the refuge office building is an office trailer that houses two employees. A larger building is needed to accommodate all staff in one building and increase auditorium seating capacity. Located in the headquarters area is a self-service boat ramp and a 12,350-square-foot parking area. The boat ramp provides access to Prime Hook Creek. There are two additional boat ramps on the refuge. In 2004, a 4,500-square-foot maintenance facility was constructed that allows for the storage and repair of refuge heavy equipment. The building has a full shop, which allows the maintenance staff to perform a wide range of tasks. A 3,200-square-foot pole style pavilion was constructed in 2006 to provide an area for festivals and educational programs to be held. In 2008, an additional pole shed was constructed to store equipment. The environmental education pavilion was replaced and relocated closer to the refuge office in 2010. Three county roads are found within the refuge. They are maintained by DelDOT.

The refuge has several informational kiosks, a photography blind, an accessible observation tower, and several hunting stands (96) and blinds (28) that are maintained for recreational uses. Walking trails cover a distance of approximately six miles. The refuge manages 4,200 acres of impounded marshes to provide feeding and resting areas for migrating birds, particularly waterfowl and shorebirds. Through a series of dikes and water control structures, the refuge controls water levels to manage for waterfowl and shorebirds. Three water control structures within the impoundments contain fish weirs. To access these areas and structures, there are paved, earthen, and graveled roads and parking areas.

Operating Budget

Table 3-23 summarizes the budget for the refuge over several recent years.

Table 3-23. Recent Refuge Budgets

	FY 04	FY 05	FY 06	FY 07	FY 08	FY 09	FY 10	FY11
Operation	370,527	609,678	216,845	301,956	318,489	697,093	320,397	295,722
Maint.	910,171	109,215	138,507	125,985	113,716	263,848	118,828	97,176
Visitor services	–	–	203,722	184,593	156,837	158,172	164,171	158,850
Planning	–	–	132,415	132,415		–		
Other	177,321	159,684	96,962	22,658	19,662	41,426	35,451	41,547

** Funds in "Other" category can be carried over from year to year; therefore, they do not necessarily represent new funds.*

Refuge Visitor Services Program

A visitor services review of the refuge was conducted in October 2004 by regional office visitor services professionals to serve as a tool for refuge staff to use as they continue to develop their visitor services program and consider new possibilities in the various alternatives of the CCP (USFWS 2004a). A great deal of background information and recommendations from this review have been used to summarize the affected environment of the visitor services program at Prime Hook NWR.

Public use objectives at Prime Hook NWR are to provide wildlife-oriented recreational opportunities compatible with habitat and wildlife objectives. Current management at Prime Hook NWR provides for all six of the priority wildlife-dependent recreational opportunities, which are wildlife observation, wildlife photography, hunting, fishing, environmental education, and environmental interpretation. Long-term focus for the refuge, recommended in the review, suggests that emphasis should be placed on hunting, wildlife observation, and photography, and encourages the staff to continue to work toward providing and developing strong, high-quality programs in these areas in particular, and balancing the emphasis placed on these three uses.

The refuge's affected audiences include hunters, anglers, birders, wildlife enthusiasts, photographers, beach tourists, and retirees. The refuge has dealt with a number of controversial issues over the years that have strained its relationship with the community. Past and current issues include land condemnation, management and protection of the endangered Delmarva fox squirrel, farming, hunting, dune overwash, lead shot contamination, and water management. However, refuge staff continues to work with diligence and patience to secure the community's trust and understanding.

Service employees, volunteers, concessionaires, and other cooperators conform to the following standards when planning, conducting, and evaluating all visitor service activities and facilities at refuges, as described in Part 605 Wildlife Dependent Recreation of the Service Manual.

Visitor Services Plan

To date, visitor planning at Prime Hook NWR includes the public use management plan, which was prepared in June 1993. Currently, no updates or revisions have been made to the 1993 plan. In addition, the refuge has also prepared a sign plan (1992), a station management plan (1987), a safety plan (1986), a fishing plan (1986), a hunt plan (1987), a crowd control plan (1971), an occupant emergency plan (1983), a fire management plan (2003), a furbearer/trapping plan (1987), and an interim land use plan (1967). A visitor services plan is scheduled to be completed following the completion of the CCP.

Welcoming and Orienting Visitors
Eastern Sussex County, Delaware, is a major summer tourist attraction and receives several million visitors per year. A portion of those tourists visit Prime Hook NWR. Visitation at the refuge is growing as more people move into the area and as visitors traveling on Route 1 and 16 observe directional signing that clearly identifies the location of refuge headquarters. Increasing public use is expected to continue well into the future, bringing large numbers of first-time visitors in need of basic refuge orientation and information. Records going back to 1968 indicate a low of about 5,900 visits per year and a high of about 106,525 visits in 2004. Since 1995, the average number of visitors is approximately 81,000.

The visits at Prime Hook NWR fall into several seasonal categories. Throughout the year, visitors use Prime Hook by hunting, fishing, birding, canoeing/kayaking, wildlife photography and observation, and participating in environmental education programs, refuge special events, and interpretive programs. Summer visits primarily include tourists, education visits occur during the spring and fall, and outreach initiatives provide refuge information to visitors during the spring, summer, and fall through display booths at dozens of offsite events.

Refuge staff have not conducted formal surveys of annual visitation as limited funding and staffing along with numerous refuge access points have proved challenging. However, for the purpose of the CCP, annual visitation has been estimated based on a variety of sources, including a traffic counter located at the refuge headquarters area, hunt permits, visitor facility counts, group counts, and general observations by refuge personnel. Offsite interpretive exhibit numbers are based on either an estimate of total event attendance or the number of people visiting the refuge's exhibit.

During fiscal year 2012, over 85,000 people were estimated to have visited Prime Hook NWR. Onsite interpretation, special events, visitation at the headquarters office/visitor facility, nature observation, and photography accounted for majority of the visits; environmental education accounted for more than 400 visits; hunting visits numbered 1,520; fishing visits numbered 8,693; and other recreation accounted for an additional 1,929 visits.

The refuge has one primary access point at the refuge headquarters/visitor contact station located on Turkle Pond Road. There are four secondary entrances located at Slaughter Beach, Fowler Beach, Prime Hook, and Broadkill Beach Roads. These are State-maintained roads that cross the refuge and provide access to refuge lands and several beach communities.

The refuge headquarters entrance is the main entrance. A refuge orientation kiosk is located at the hunter check-in station located at the entrance to welcome visitors with refuge information and literature. The entrance sign is appropriately located outside the electronic gate entrance that provides access to the road leading to the refuge headquarters. There is one refuge entrance sign on the northeast tip of the refuge on the Slaughter Beach Road adjacent to the community of Slaughter Beach. The road here aligns with the refuge boundary. The entrance sign is suitably located where it is visible to visitors traveling in either direction along Slaughter Creek Road. Fowler Beach Road bisects the refuge, terminating at Fowler Beach. A refuge entrance sign is well-placed at the west end of the road and refuge entrance signs are located at both ends of this refuge-bisecting road. The entrance sign on the east end of the road is visible to visitors entering the refuge from the Prime Hook Beach community. The entrance sign located on the west end serves travelers who continue east on Prime Hook Road or who turn north onto Cods Road.

The refuge headquarters area is the key visitor activity location. By Service standards, the use of the word "center" implies more extensive visitor services

and facilities than currently exist here, which actually align more with the Service's concept of a visitor contact station. It was recommended by the review team that this location be identified as a visitor contact station or visitor facility.

The refuge does not charge an entrance fee; however, the Prime Hook NWR does participate in the Recreation Demonstration Fee Program through collection and deposit of hunting permit fees and boat launching fees. During fiscal year 2011, the refuge collected $10,843 for hunt permits, with $8,674 returned to the refuge. Boat launch fees and the sale of interagency passports yielded the refuge an additional $656, with $524 returned to the refuge. The review team commented that there did not seem to be a clear reason for charging boat launching fees while not charging fees for use of improvements such as boardwalk trails and observation platforms and recommended that the refuge explore developing a more equitable process for determining the imposition of user fees.

Information kiosks are located throughout Prime Hook NWR—at the headquarters, adjacent to all entrance signs except on Broadkill Beach Road, and near Slaughter Canal on Fowler Beach Road. Kiosks include flyers announcing upcoming refuge events and other information. Refuge orientation maps are included at some of the kiosks and would be a good addition to those kiosks currently lacking this map. Refuge volunteers regularly inspect and update kiosk information.

Wheelchair accessibility is available on trails, an observation platform, bathrooms, the visitor contact station and refuge office, fishing pier on Fleetwood Pond, and deer and duck hunting blinds. Benches are placed in several refuge locations, including the fishing access areas at Turkle and Fleetwood Ponds and along refuge hiking trails.

Refuge lands and outdoor facilities are open for public use half an hour before sunrise until half an hour after sunset. The refuge headquarters and visitor facility are open Monday to Friday, 7:30 a.m. to 4 p.m. The visitor facility is also open on weekends from 10 a.m. to 4 p.m. during April through November, and occasionally on weekends during the off-season. Staffing of the visitor facility is provided largely by refuge volunteers. It is sometimes difficult ensuring that volunteers are available, particularly on the weekends when safety concerns heighten with the absence of refuge staff. During open hours at the headquarters and visitor facility, the telephone is answered by a live person. The after-hours message on the answering machine offers facility schedules and emergency contact information. A general email address is posted on the refuge's Web site for visitors to inquire about Prime Hook NWR.

Additional information about welcoming and orienting visitors at the refuge can be found in the Prime Hook NWR Final CCP/EIS, Volume 1, chapter 3 *(http://www.fws.gov/northeast/planning/Prime%20Hook/finalccp.html).*

Hunting Opportunities

Prime Hook NWR hosts one of the largest hunting programs of all East Coast refuges within the Refuge System. Hunting is a historic, traditional, and very popular activity in the Prime Hook area and in other parts of the Delmarva Peninsula. Prime Hook NWR is open to hunting of deer, waterfowl, and upland game. The primary objectives of the refuge hunting program are to offer high-quality opportunities for hunting white-tailed deer, waterfowl, upland game, and webless migratory birds, and to manage wildlife populations, where appropriate. The two most popular forms of hunting at Prime Hook NWR are for waterfowl and white-tailed deer. During the 2011 to 2012 hunting season, 513 deer hunters and 908 duck hunters participated in refuge hunts, harvesting 66 deer and

1,050 waterfowl. Along with State hunting regulations, Prime Hook NWR has refuge-specific regulations at 50 C.F.R. § 32.27. Not all of these regulations are presented in this overview.

Section 605 (FW 1.10 F1) of the Service Manual states: "Refuge managers should offer wildlife-dependent recreation programs consistent with staff and funding resources needed to develop, operate, and implement the program safely and with quality standards." The refuge's existing hunting program is complex and requires a considerable amount of staff resources. The review (USFWS 2004) found our hunt program to be "out of balance with other priority refuge needs and services." Another important quote from the review that confirmed the refuge staff's own evaluation of the hunt program was, "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….put an undue burden on staffing resources. Consideration should be given to eliminating this service, increasing the user fees for hunters, and either contracting this work out or hiring a temporary employee to conduct the maintenance."

Administrative burdens of the existing program have included excessive compensatory time accumulations and staff burnout. The hunt program is out of balance with staff time used on other priority refuge needs and services, and the amount of station resources going into the program seem to far exceed what is necessary to provide for a quality hunting program. Administrative changes were made to the 2006 to 2007 program in collaboration with the Delaware Division of Fish and Wildlife to ease some of these administrative burdens on staff. These changes continued to be implemented during the 2011 to 2012 hunting season and included instituting self check-in procedures and hunter-facilitated morning drawings for blind and stand vacancies on lower use hunting days, and instituting a first-come, self-serve system for deer firearms hunts after the morning standby lottery drawings are conducted (this allows hunters to arrive throughout the day until 2 p.m. to check out any available stand; a similar procedure was already in place for waterfowl hunts).

To relieve staff from conducting the standby lottery drawings on the mornings of scheduled hunts, standby hunters were charged with the task of facilitating a drawing in the absence of staff on days other than opening hunt days. This system has proven to be reliable with few minor problems or complaints; however, the success of the program is dependent upon the hunters cooperating and monitoring each other, some staff monitoring, and law enforcement compliance checks. A few of the problems encountered with this system included failure of hunters to flip over their blind/stand tags, not following proper procedures for fee collection, and not properly filling out the permit information.

All hunters must possess a permit to lawfully hunt. Permits are issued by self-service for hunters wishing to pursue upland game, webless migratory birds, and deer by archery. Hunters wishing to pursue deer using firearms or waterfowl in refuge impoundments may participate in a daily standby lottery drawing for vacant stands or blinds on days open to hunting. On opening days, it is common for 80 or more waterfowl hunting parties (maximum of three people per party) to be present at the daily drawing for 26 blinds (including one handicapped-accessible blind), and more than 100 deer hunters trying for 89 stands (including 11 accessible blinds) when all hunting areas are open. Deer hunters may also enter into a preseason lottery drawing for stands. In 2011, nearly 700 applications were submitted for the preseason lottery drawing for deer stands. No preseason drawing currently exists for waterfowl hunting.

The issuance of permits through the daily lottery requires a staff member to be at the check station as early as 2:50 a.m. to check in pre-selected deer hunters or to sign-in waterfowl hunters for the lottery drawing. The current hunter facilitated drawings have decreased the number of days required by staff members to be present. Standby lottery drawings take place two hours before legal shooting time. Refuge staff operating the morning standby drawings consisted of an administrative assistant, visitor services manager, tractor operator, refuge manager, and deputy manager. After the morning standby lottery drawings, deer hunters may obtain permits by self-service until 2 p.m. and waterfowl hunters until 12 noon. All hunters must return their permits and harvest information to the hunt check station following their hunt.

Prior to implementing the administrative changes during the 2006 to 2007 hunting season, standby lottery drawings were conducted in 2004 by staff on a total of 49 days from October 2004 through January 2005. Stated another way, 40 percent of all the days from October through January required staff to be at the refuge early in the morning, therefore allowing them to leave for the day as early as 11:30 a.m., or stay and incur compensatory time to meet other required obligations. The program caused compensatory time accumulations of 90 hours or more, staff burnout, and inefficient use of management time to run the hunt. The total of 49 days breaks down into 13 deer days, which also included a daily stand-by drawing at noon for stand vacancies, and 36 waterfowl days. After the lottery drawing, vacant blinds for waterfowl hunting were issued on a first-come, self-serve basis until noon. There were also days when both deer and waterfowl hunting occurred, which required refuge staff to conduct two separate drawings each morning.

In past years, the refuge hired temporary positions to assist in conducting the daily drawings. From October through mid-December 2005, the check station was operated by a volunteer couple who were not from the local area. The use of temporary positions involves a considerable amount of training by refuge staff while not guaranteeing that the hired individual will remain throughout the hunting season before leaving for another position. Refuge staff has experienced the scenario in which the individual was just trained and left at the start of the hunting season. The use of local volunteers is not recommended, as it has led to accusations of special privileges and affected the integrity of the program.

The annual cost of conducting the 2004 to 2005 hunting program was approximately $43,050. Hunter use fees accounted for estimated revenue of $17,535, of which $14,028 was returned to the refuge to offset the cost of the hunt. Still, the refuge recovered less than one-third the costs required to carry out its hunting program through the existing Recreation Demonstration Fee Program. After administrative changes were implemented, the cost of the 2011 to 2012 hunting season was $34,482, which is $8,568 less than during the 2004 to 2005 season. Hunter-use fees for the 2011 to 2012 hunting season accounted for an estimated revenue of $10,973, of which $8,778 was returned to the refuge. Expenses include planning, materials for stands/blinds, publications, hunt operations, law enforcement, processing applications, fuel/electricity, inquiries, and toilet rentals. All permit funds received from hunters are deposited into the fee account for use in supporting the hunting program and other visitor services related needs. Senior citizens (age 62 and older) are entitled to a 50 percent discount with an interagency senior passport. Citizens who have been medically determined to be permanently disabled are also entitled to a 50 percent discount with an interagency access passport. Refuge staff follow the guidelines of the interagency passport program. The interagency senior passport can be purchased in person for $10 and the interagency access passport is free of charge at the refuge headquarters during office hours.

Refuge managers have taken reasonable steps to facilitate hunting through user fee programs and cooperative efforts. Refuge staff are very active in seeking and nurturing cooperative relationships with the Delaware Division of Fish and Wildlife and refuge volunteers. State personnel from the Assawoman State Wildlife Area work cooperatively with refuge staff to cut and grass the waterfowl hunting blinds located on refuge, on the Prime Hook Wildlife Area, and at the Assawoman Wildlife Area. In addition to our 17 blinds, we also administer the State's 8 blinds located in the Prime Hook Wildlife Area through the daily standby lottery drawing for waterfowl hunting. Besides conducting the daily lottery drawings, refuge staff, along with considerable assistance from volunteers, construct and maintain 115 combined deer and duck blinds, expending considerable human and financial capital. A small group of volunteers in 2011 donated over 500 hours in this area alone.

Deer Hunting Stands and Waterfowl Hunting Blinds
Permanent elevated deer hunting stands have been used on the refuge since 1983, when 20 stands were donated by the Delaware Division of Fish and Wildlife. By 1989, the use of these stands became mandatory. The majority of these stands were placed along the edges of agricultural fields of corn and soybean, which are attractive to deer. Since the cooperative farming program ceased in 2006, these fields have been maintained in early succession, which limits the ability of deer hunters to see and harvest deer from these permanent stands. Since 2006, refuge staff have been criticized for a decrease in the quality of their hunt because hunters are confined to these stands that do not offer any flexibility for movement. Relocating nearly 100 stands is not feasible due to lack of space within currently open areas, and time and budget restraints. Free roam areas for deer hunting are available to hunters in Unit I of the refuge, where hunters in groups of 2 to 10 can access four zones using boats (one is accessible by foot). Demand for these areas is low and the use of boats is a limiting factor. Free roam hunting of deer was permitted in all deer hunting areas between 9 a.m. and 3 p.m. up until the 2002 to 2003 hunting season, but was prohibited due to complaints of unethical hunting behaviour such as harvesting deer from the stands of other hunters.

Permanent waterfowl hunting blinds have been used on the refuge since the hunting program was first established in the 1960s. These structures are rectangular frames enclosed with plywood and mounted on a platform over refuge marshes. Every year, these blinds are camouflaged with switch grass. The variability from year to year in the vegetation surrounding these blinds may affect the naturalness or effectiveness of the camouflage. With current changes in marsh vegetation due to sea level rise and dune overwash issues, a majority of these blinds may be isolated in open water, minimizing their effectiveness. Hunters complain about the amount of grass on the blinds and current blind location, and many offer their preferences on how to improve the construction of the blinds to better meet their needs.

Both waterfowl and deer hunters have inquired about having greater flexibility to enhance the quality of their hunt by scouting, choosing their own hunting locations, and using portable hunting stands/blinds (boat blind, pop-up blind, tree climbers, etc.). For example, waterfowl hunters would like to have the flexibility to adjust their hunting locations for changing weather conditions. Waterfowl hunters have also stated that allowing them to camouflage themselves in the location of their choice will allow birds to get closer, thereby reducing crippling loss. Skybusting, or shooting at birds flying out of range, leads to more crippled birds and has been a constant complaint from refuge hunters.

Provision of elevated deer stands, and to a lesser degree waterfowl blinds, is relatively unique to Delaware. There are many areas on the Delmarva Peninsula,

other than Prime Hook NWR, that offer public hunting opportunities in free-roam areas where the hunter is required to provide the blind or stand, if desired.

The Service conducted a Web-search for public lands within the three states making up the Delmarva Penninsula in order that we evaluate the prevalence of permanent waterfowl blinds or deer stands on public hunting lands. A wide assortment of ownership and management regimes was evident across 215 tracts managed or described by 19 different designations, e.g., State Park, National Park Service, State Forest, Chesapeake Forest Lands, Natural Resources Management Area. For waterfowl hunting, 131 of the 215 tracts examined permitted waterfowl hunting. Of the 131, only 36 provided either a pit or standup blind somewhere on the tract. The Service makes this qualifying statement because some areas, Tuckahoe State Park for example, provide four pit blinds but also allow free roaming along the Tuckahoe River. Of the 36, 28 were located in Delaware, 8 in Maryland, and none in Virginia. Twenty tracts required hunters to hunt at a stake or within some designated distance from a blind site where the hunter would provide the blind (if desired), including 9 in Delaware, 11 in Maryland, and none in Virginia. A total of 84 tracts permitted free-roam hunting where the hunter would provide the blind (if desired), 17 in Delaware, 60 in Maryland, and 7 in Virginia.

For deer hunting, of the 215 tracts examined, 181 permitted some form of deer hunting. Unfortunately, the Service did not make a distinction between the various methods, i.e., some tracts may be limited to bow hunting only. Of the 181 tracts, 95 were located in Delaware, 77 in Maryland and 9 in Virginia. A total of 51 of the 181 tracts required hunters to use stands that were provided, all of which were located in Delaware. Free-roam hunting was permitted on 165 tracts, including 80 in Delaware, 76 in Maryland, and 9 in Virginia. The Service acknowledges that some free roam areas were for bow hunting only, however, such a distinction would only apply in Delaware; all deer hunting tracts in Maryland and Virginia permitted free-roam hunting regardless of hunting method.

For the 85 tracts located in Maryland and Virginia where no stands are provided, only 2 require an elevated stand, which the hunter must provide. For areas immediately adjacent to the building complex on Blackwater NWR, the hunter must use an assigned blind site where the hunter erects a stand with a platform minimum of 8 feet above the ground. All other tracts on Blackwater NWR are free-roam where ground-hunting is permitted.

The second site where elevated deer hunting is required is on Chincoteague NWR, around the tour loop. Here the hunter must erect his/her own stand with a platform minimum of 14 feet above the ground. All other areas on Chincoteague NWR permit free-roam hunting.

The Service should also add that rifle hunting, as well as deer drives, are permitted on most public hunting lands on the lower eastern shore of Maryland and the eastern shore of Virginia.

Refuge's Disabled Hunting Program
The refuge currently provides hunting opportunities for those individuals with a permanently disability as defined by the interagency access passport guidelines. However, up until the 2005 to 2006 hunting season, the refuge offered hunting areas with accessible ground blinds only for individuals permanently confined to wheelchairs to participate in a limited number of days for archery, firearms deer hunting, and waterfowl hunting. A disabled hunter who was not permanently confined to a wheelchair and who was denied access to these accessible blinds filed a complaint to the Washington, D.C. Office. As a result, the decision was made that refuges could not segregate individuals with certain disabilities from

others wanting to use the program's accessible sites, unless there is a justifiable reason established by the agency as a policy, which there is not.

Based on this decision, the refuge opened its wheelchair-only hunt area and structures to all individuals with any permanent disability and the disabled hunt area was required to remain open for all scheduled hunts on the refuge. The number of deer observed and harvested by hunters in this area decreased sharply when the change was made. Furthermore, the guidelines of the interagency access passport require refuge staff to rely on the honesty of the applicant and do not require medical proof of the disability. The Privacy Act prevents refuge staff from asking for proof of disability.

Since this change has been made, frustrations have been running high for staff and wheelchair-bound hunters. Hunters with wheelchairs have limited opportunities on the refuge to hunt unless refuge staff provide them with accessible infrastructure such as ground blinds and vehicular access to them. These hunters are limited by the accessibility that the refuge provides them.

Additional Information on Refuge Hunting Program
The refuge prepares one-page sheets or booklets on hunting information. These publications outline general provisions, permit information, and general requirements, such as hunting areas (including maps), seasons, shooting times, use of boats, youth and disabled hunting requirements, bag limits, safety requirements, stand/blind requirements, and other special conditions of the hunt.

Hunting areas and blinds are identified by numbered markers and referenced on hunting maps. Upland game hunting areas are not signed, but areas are referenced on hunting maps. Specifically designated parking areas are clearly identified on the refuge.

Use or possession of alcoholic beverages on hunt areas is prohibited. Youth must be accompanied by a hunting or non-hunting adult who is 18 years or older. It is recommended that the adult be licensed to hunt in the State of Delaware. Deer hunters are required to display a minimum of 400 total square inches of blaze orange material on their head, chest, and back. Deer hunters may only have loaded weapons while in their assigned deer stand or when actively in pursuit of a crippled deer. Designated safety zones have been established.

Hunting is a traditional activity in this area and little opposition has been encountered by refuge staff. Occasionally, adjacent neighbors complain about shooting noise and the close proximity of hunters to their property, particularly residents in the Broadkill area. Hunters must make a reasonable effort to recover wounded game and may not shoot toward the refuge boundary or into private property.

Most hunting occurs in areas of the refuge usually closed to the general public. During the 2 days each year that the headquarters area is open to deer hunting, it is closed to all other public uses. Impact of this closure on the visiting public is minimal. Canoeists and anglers are not permitted to launch at the office boat ramp to access the easternmost 3 miles of Prime Hook Creek from October 1 to March 15 to lessen disturbance to migrating and feeding waterfowl and potential conflicts with hunters. Earlier closures have also been necessary to accommodate the hunting of teal in September on the adjacent State-owned Prime Hook Wildlife Area and ensure the safety of refuge visitors. There are no commercial hunting guides operating on the refuge.

Certification of hunter safety education is a requirement to receive a State hunting license. The refuge has partnered with the State of Delaware to provide hunter education courses on the refuge, including the young waterfowlers course.

Hunting for White-Tailed Deer
During the 2011 to 2012 deer hunting season, Prime Hook NWR was open for 53 days of deer hunting from September 1 to January 28. The refuge was open for archery, muzzleloader, and shotgun hunting. Approximately 39 percent of refuge lands (4,020 acres) are available for deer hunting. Areas open to deer hunting are Prime Hook North, Prime Hook South, Fowlers North, Fowlers South, Cods Road, Jefferson-Lofland, Slaughter Canal, Island Farm, Headquarters, and Graves Tract (map 3-8).

The 2011 to 2012 deer hunting program resulted in a total harvest of 66 deer, which includes 26 (39.4 percent) male deer and 40 (60.6 percent) female deer. Deer harvested in 2011 to 2012 were not inspected by refuge personnel for weight and age. The State has eliminated deer checking stations, opting for local vendors to check deer for them. A youth hunt was conducted on November 5 with a total of nine young people removing four deer. In addition, disabled hunters made a total of 46 visits and harvested six deer. The refuge maintains 78 elevated deer stands, which include 32 for use in the headquarters area, primarily through volunteer assistance. An additional 11 wheelchair-accessible ground blinds are available to disabled hunters.

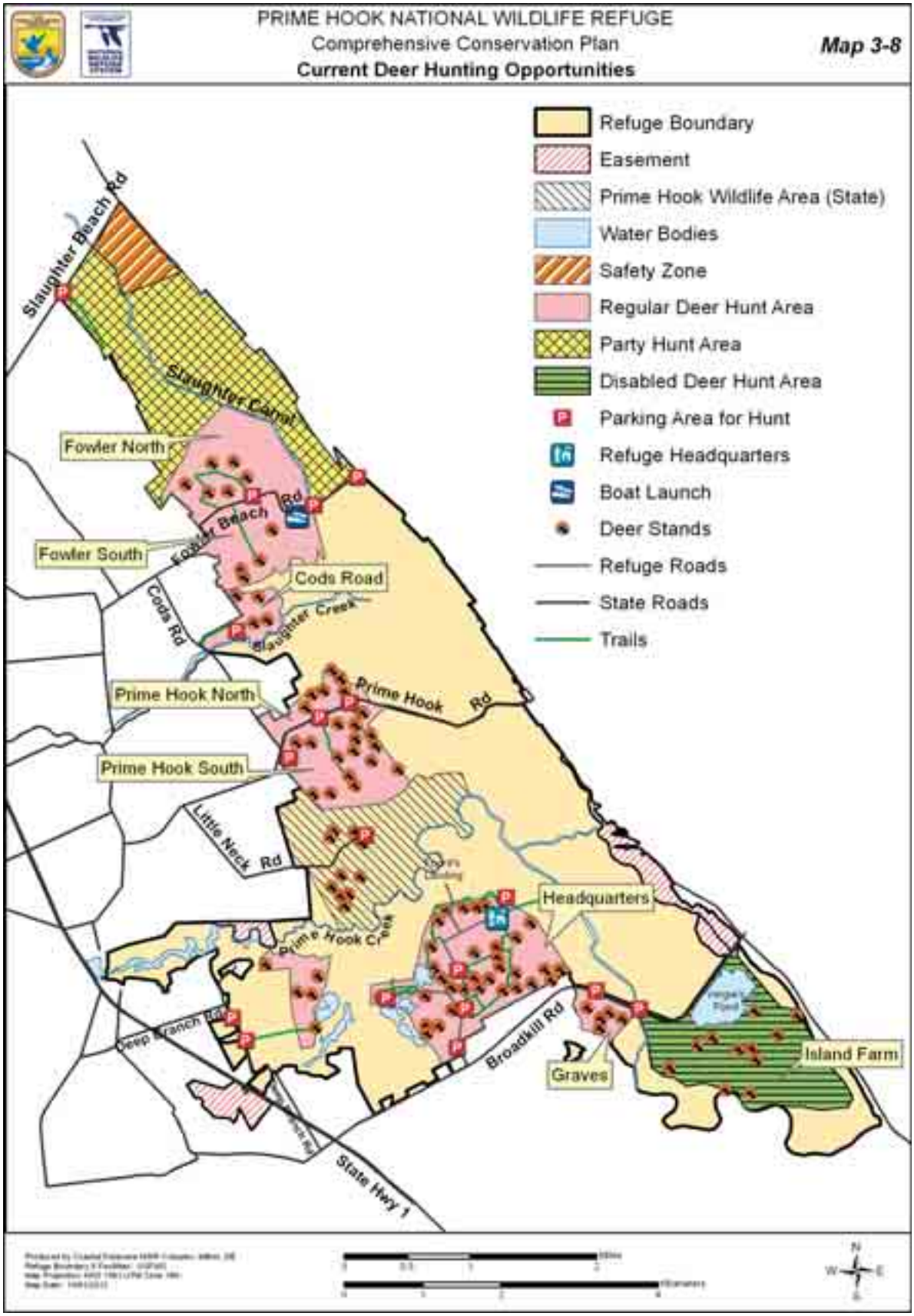
Deer hunters using firearms may enter into a preseason lottery drawing for stands. An application fee of $3 is charged for each hunt for which a hunter applied. Currently there are six total hunts. Successful applicants may claim a permit for their stand reservation at the check station on the morning of the hunt. Successful participants in the standby lottery drawing for stand vacancies may also receive a permit. A daily fee per hunter of $10 is charged for all firearm hunts and a daily fee per hunter of $2 for all archery hunts. For archery hunting, hunters may obtain permits by self-service at the check station. In accordance with State regulations, hunters may take buck and antlerless deer – their license allows them to take two does and two antlerless deer. They may purchase a $10 tag for an antlered buck and additional doe tags may be purchased for $10 each. Only one buck may be taken on the refuge per hunter per year.

Except for the 2 days when the headquarters area is open to hunting, the refuge remains open to other users during the hunting season. Other than the headquarters area, hunting occurs in areas closed to other visitor uses. Scouting is permitted on Sundays from late August through late January. The refuge does not permit the use of dogs or off-road vehicles. No field trials are permitted and there are no shooting ranges open to the public on the refuge.

The Jefferson-Lofland Tract was closed to scouting and hunting in January to minimize disturbance to endangered Delmarva fox squirrel. Stands 9 and 10 in the headquarters area were closed during the late shotgun season to minimize disturbance to bald eagles. The headquarters area was not open during the statewide youth deer hunt to lessen administrative workload, reduce hunting pressure to maximize deer harvest during the hunt in November, and avoid conflict with adjacent landowners who are hunting waterfowl.

Deer hunters have been free roam hunting in Unit I of the refuge for years and upland game hunters free roam hunt in areas in Unit I, Unit II, and Unit III. Free roam hunting of deer was permitted in all deer hunting areas between 9 a.m. and 3 p.m. up until the 2002 to 2003 hunting season, but was prohibited due to complaints of unethical hunting behaviour such as harvesting deer from the stands of other hunters.

Upland Game and Webless Migratory Bird Hunting
During the 2011 to 2012 season, upland game hunting was permitted from September 1 to January 13, providing 80 total hunting days (this includes other migratory birds such as mourning doves). Squirrel hunting was closed


PRIME HOOK NATIONAL WILDLIFE REFUGE
Comprehensive Conservation Plan
Current Deer Hunting Opportunities
Map 3-8
Refuge Boundary
Easement
Prime Hook Wildlife Area (State)
Water Bodies
Safety Zone
Regular Deer Hunt Area
Party Hunt Area
Disabled Deer Hunt Area
Parking Area for Hunt
Refuge Headquarters
Boat Launch
Deer Stands
Refuge Roads
State Roads
Trails
Slaughter Beach Rd
Slaughter Canal
Fowler North
Fowler Beach Rd
Fowler South
Cods Road
Cods Rd
Slaughter Creek
Prime Hook North
Prime Hook Rd
Prime Hook South
Little Neck Rd
Headquarters
Prime Hook Creek
Deep Branch Rd
Broadkill Rd
Graves
Island Farm
State Hwy 1
N
W
E
S

on the refuge due to lack of interest and to safeguard endangered Delmarva fox squirrel. Upland game hunting is permitted on 19 percent (1,995 acres) of refuge land at Prime Hook North and South, Fowlers North, and zones I to IV of Slaughter Canal; however, the southern portion of zone IV was closed to dove hunting. Although the refuge permits hunting of ring-necked pheasant, bobwhite quail, and woodcock, populations of these species are low in areas open to hunting and there is no hunter interest. Rabbits are most frequently hunted. A voluntary self-service permit process at the check station is used. In 2011 to 2012, 100 permits were issued resulting in 76 rabbits, one woodcock, and nine dove taken during 422 hours in the field. Interest in upland game hunting is limited due, in part, to the non-toxic shot requirement for small game. A fee of $2 per hunter is required. Hunters obtain permits by self-service at the check station.

The refuge remains open to other users during the upland game and webless migratory bird hunting season. The use of dogs is permitted for flushing and retrieving small game. Hunters must make a reasonable effort to recover wounded game and may not shoot toward the refuge boundary or into private property. Prime Hook NWR is closed to upland and small game hunting during all firearms seasons for deer, except the handgun season for deer in early January and the antlerless season in October.

Waterfowl (Duck) Hunting

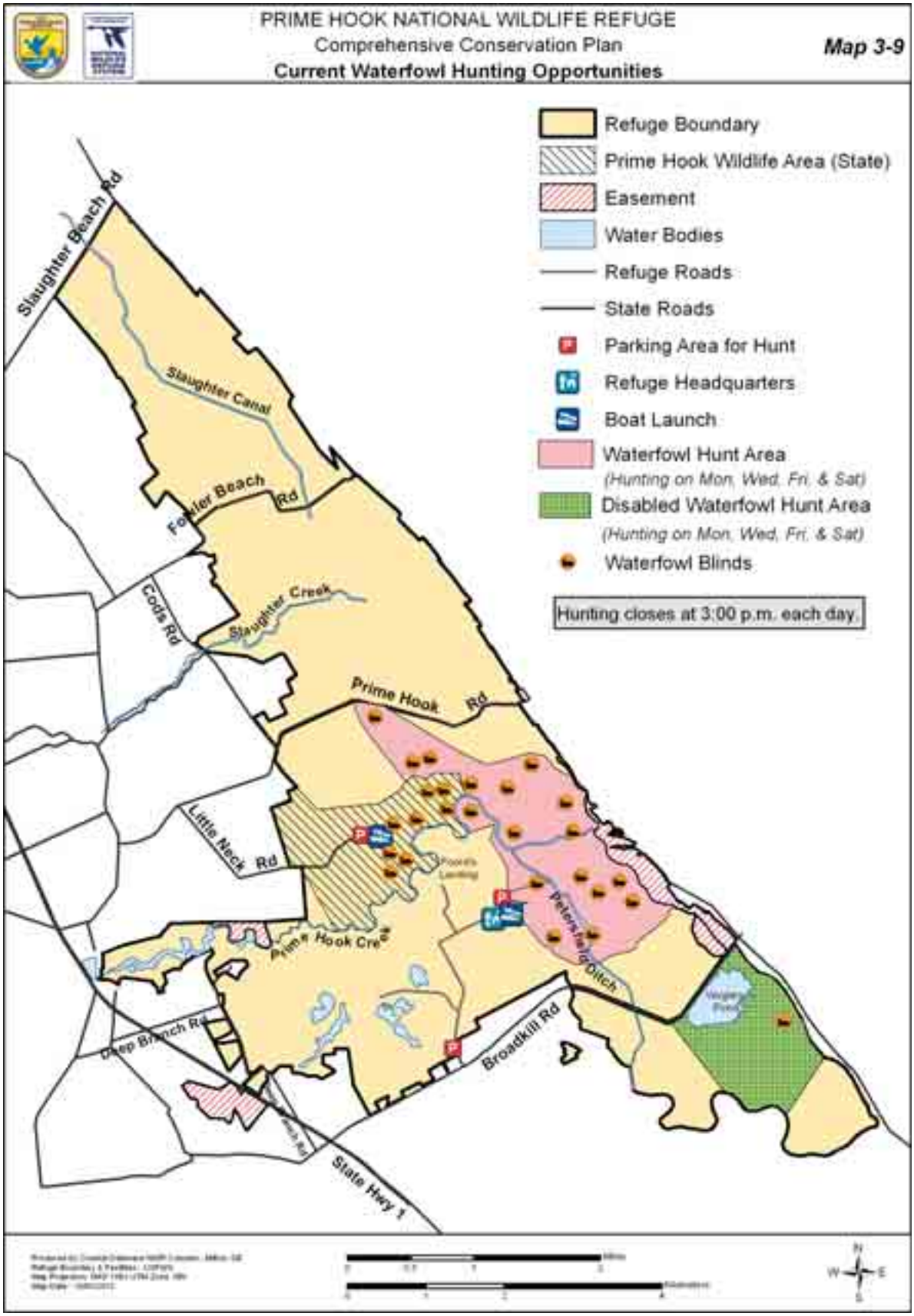
The 2011 to 2012 waterfowl hunting framework permitted Delaware a duck season of 78 days of hunting, including two additional days for a special youth waterfowl hunt. Delaware also offered a 64-day late snow geese season from February 1 to April 14, 2012. Prime Hook was open for a total of 41 days, which includes one of the Statewide youth waterfowl hunts. The refuge was closed for hunting of resident Canada geese and late season snow geese due to low hunter use and low harvest. Refuge staff facilitated the morning lottery drawing on January 14, 2012, for only the State blinds (refuge blinds were closed due to a deer hunt in the headquarters area). Hunting of snow geese was also permitted on the refuge during the duck season. A liberal bag limit of 15 snow geese per day was permitted. Hunting of migratory Canada Geese was permitted during the 2011 to 2012 season, with a daily bag limit of two.

A total of 25 marsh blinds and 1 wheelchair-accessible blind were available for hunting on Mondays, Wednesdays, Fridays, and Saturdays throughout the State duck hunting season. Refuge staff administered the morning standby lottery drawings on the first two opening days of all three seasonal splits. On all other days open to duck hunting on the refuge, including the youth waterfowl hunt, hunters facilitated the morning stand-by lottery drawings themselves. Hunting was permitted until 3 p.m. Overall hunter use for all hunts was slightly higher in 2011 (908) than in 2010 (874). In 2011, hunters harvested 1,050 birds; 1,604 birds were harvested in 2010.

The refuge remains open to other users during the waterfowl (duck) hunting season. The use of dogs is permitted for retrieving downed birds. Shooting outside an assigned blind is prohibited except in active pursuit of crippled waterfowl. The exception to this regulation is when hunting from a temporary blind in ponds 25 or 27. See map 3-9 for an illustration of the waterfowl hunting area.

The refuge is closed to resident Canada goose hunting in early September for the following reasons: low hunter use, low harvest, and the closure of Prime Hook Creek for hunting conflicts with other wildlife-dependent recreational opportunities involving canoers, kayakers, and fishermen on Prime Hook Creek. Since 2001, when the refuge began hunting for resident Canada geese, hunter visits and harvests have averaged 13 hunters and 9 birds a year. Only 3 to 4 days have been hunted each year. Managing this hunt involves closing the easternmost

Map 3-9. Current Waterfowl Hunting Opportunities



3 miles of Prime Hook Creek, which limits access for kayakers and fishermen for selected days during early September. The intermittent closure of Prime Hook Creek for a handful of hunters with minimal harvest numbers does not appear to warrant limiting access for fishermen and wildlife observers when this portion of the creek will be closed from October 1 (sometimes earlier) through March 15 for waterfowl hunting and to minimize disturbance. The intermittent closure of Prime Hook Creek for this hunting season also led to confusion among kayakers and fishermen and poses a safety risk for those who fail to see or read the temporary closure signs.

The refuge closed the late season snow goose hunting from late January to early March for the following reasons: low hunter use, low harvest, and no agricultural cover crops. Since 2001 when the refuge began hunting for late season snow geese, hunter visits and harvests have averaged 17 hunters and 16 birds a year. Eight days, on average, have been hunted. Hunters are permitted to sign out hunting zones (fields) and set up their own temporary hunting blinds. Since agricultural crops are not being planted, opportunities for upland snow goose hunting are very limited. With limited use and harvest during the season, continuing this hunt to provide opportunities for a few hunters does not appear to be warranted but will be continually evaluated. Opportunities to harvest snow geese are still available during the 35 days open to waterfowl hunting on the open marsh from October through January.

Turkey Hunting

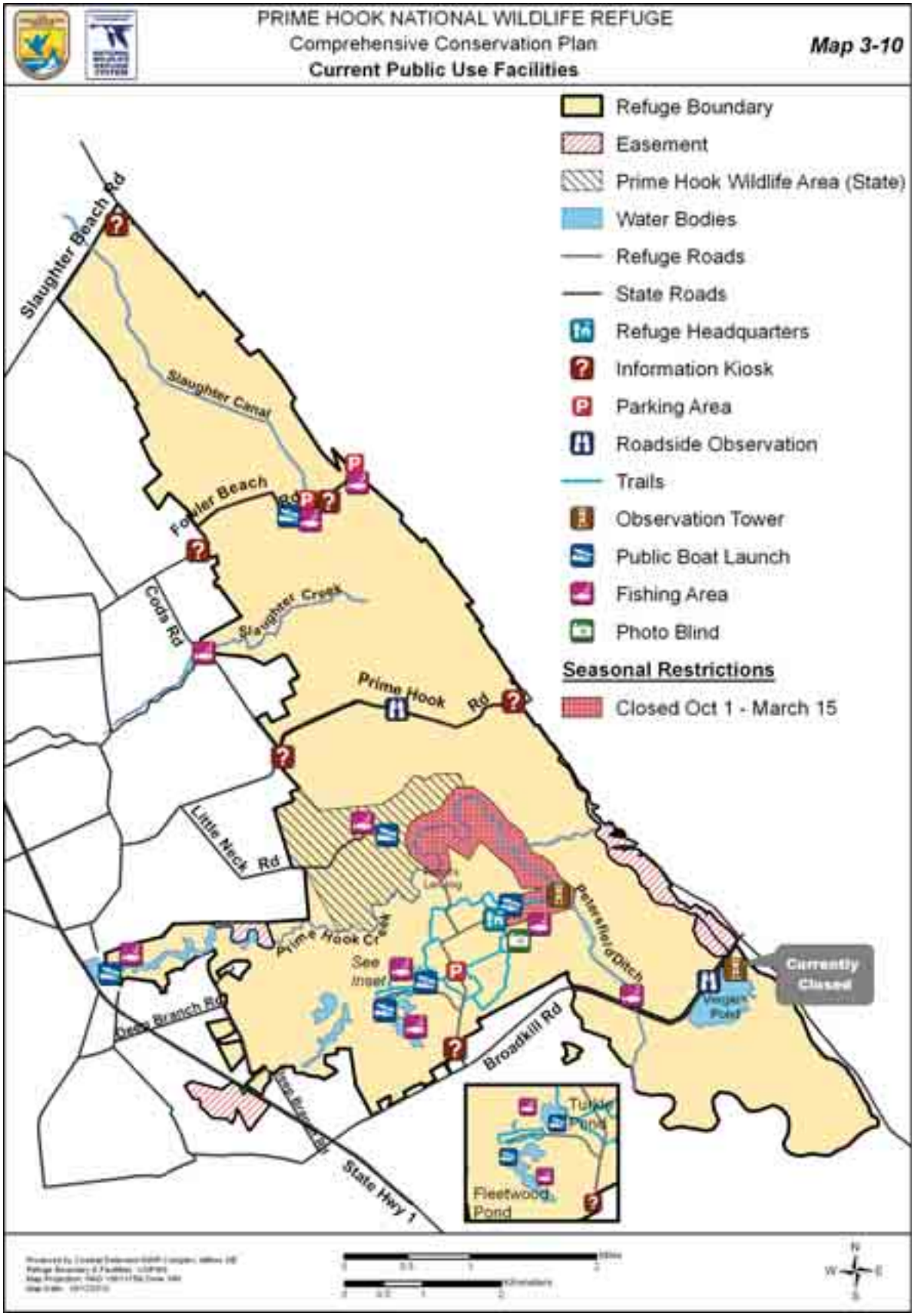
Turkey hunting was initiated on the refuge in 1993. After two seasons of hunting and only one harvested turkey, the opportunity was discontinued. In recent years, hunter and staff observations indicate that a huntable population of turkeys may exist on the refuge, particularly in the headquarters area and in areas near Deep Branch Road. Limited opportunities exist on public lands to hunt turkey and the refuge may be able to contribute in providing additional opportunities.

Fishing Opportunities

Freshwater fishing on Prime Hook is permitted along the Headquarters Canal in Prime Hook Creek, Turkle and Fleetwood Ponds, and Slaughter Creek at Cods Road (map 3-10). These freshwater marshes and ponds are popular fishing areas for largemouth bass, pickerel, white perch, crappie, and other species. Boats up to 30 horsepower are permitted in Prime Hook Creek and Slaughter Canal. Only electric or hand-propelled boats are permitted in Turkle and Fleetwood Ponds. Water control structures at Fowler Beach, Petersfield Ditch, and Slaughter Canal support brackish tidal waters that are popular for fishing for white perch and crabbing from shore. Bank fishing is restricted to designated areas off State maintained highways at these locations. Surf fishing at Fowler Beach along the Delaware Bay shoreline provides opportunities to catch estuarine species such as weakfish, striped bass, and flounder. During fiscal year 2012, the refuge estimates 8,693 fishing visits, including crabbing.

Signs that address fishing regulations can be found at the Headquarters Canal in Prime Hook Creek, Fleetwood Pond, and Turkle Pond. The signs outline refuge fishing regulations, ask visitors not to park on the boat ramp, identify October 1 (sometimes earlier) through March 15 as a time when access to Prime Hook Creek is by permit only, and direct visitors to gain access for canoeing and fishing from Waples Pond. There is a daily ramp fee to launch a boat from Turkle Pond, Fleetwood Pond, and the Headquarters Canal at a cost of $1 per boat. The Prime Hook Wildlife Area also provides a boat launch into Prime Hook Creek. At Fowler Beach and Slaughter Creek, there are water control structures where crabbing and fishing are popular. An unimproved boat launch is located at the Fowler Beach water control structure site. A boat launch is located at both Turkle and Fleetwood Ponds and signs outline the fishing regulations and designate it as public fishing area. A refuge boat launch is also located at the

Map 3-10. Current Public Use Facilities



Brumbley Family Park; however, visitors must cross the Brumbley property to reach the refuge boat launch and the owner charges a $4 fee per boat. No signs designate the area as a launch site, although refuge boundary signs are posted on each side of the ramp.

All roads, parking, and trails associated with the launch sites are fairly rustic except for the road and parking facilities associated with the Headquarters Canal ramp and dock. There is a ramp and a dock at the Headquarters Canal, and ramps located at Turkle Pond, Fleetwood Pond, the Prime Hook Wildlife Area, Slaughter Creek near Fowler Road, and Brumbley's Family Park. A wheelchair-accessible fishing pier is located on Fleetwood Pond. A boat ramp is located about midway on Prime Hook Creek at Foord's Landing and is closed to all public entry.

Prime Hook NWR has a one-page information sheet that highlights fishing areas, boating information, permits, boat launching, fishing hours, and special conditions for fishing on the refuge. In addition, the refuge includes a short passage in its general refuge brochure concerning fishing, canoeing, and boating. The refuge has also produced a brochure for its canoe trail that addresses certain launching sites available on the refuge. No fishing guides operate on the refuge.

Canoeists and anglers are not permitted to launch at the office boat ramp to access the easternmost 3 miles of Prime Hook Creek from October 1 (sometimes earlier) to March 15 to lessen disturbance to migrating and feeding waterfowl and lessen potential conflicts with hunters. Designated beach dunes and overwash areas are 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 re-opened if no nesting activity occurs or when nesting ends for the season.

The refuge has partnered with the Lower Sussex Bass Masters in Milton to host a fishing event for kids the first Saturday in June. The event is held at the Milton Community Park and hosts 200 youngsters and their parents. The event includes fishing along the Broadkill River, exhibits, fish tanks, fish printing, and prizes to promote the recreation of fishing.

Wildlife Observation and Photography Opportunities

The refuge currently does not offer an auto tour route. Refuge staff recognize that an opportunity exists, but concerns about sign vandalism in remote areas of the refuge and the over-proliferation of interpretive signs were two reasons discouraging a signed route. Roadside vehicle pull-outs are located on Prime Hook Beach Road and along Broadkill Beach Road to provide increased opportunities for wildlife observation and photography along refuge impoundments.

Prime Hook NWR currently has approximately 6 miles of hiking trails, 7 miles of canoe trail, roadside pull-offs along State roads transecting the refuge, two observation platforms, one photography blind, two ponds, nine information kiosks, trailhead kiosks, a visitor contact station, five boat ramps, benches, and parking areas (map 3-10). The majority of the refuge's developed visitor use improvements are located near the refuge headquarters. A separate map of this area identifies the specific locations of each facility. An accessible wildlife observation platform is located on the Dike Trail, which overlooks a vast marsh and offers exceptional opportunities for wildlife viewing and photography. The Boardwalk Trail shares an entry off the headquarters parking lot and meanders through uplands and marsh. Both the Dike and Boardwalk Trails offer signs interpreting refuge habitats, wildlife, and history. The Black Farm Trail includes an extension to a photography blind overlooking a pond. Pine Grove Trail loops through a pine and hardwood forest habitat. The Blue Goose Trail serves

to connect the four existing trails and features upland fields, forest, marsh, and several wildlife observation areas. An uncompleted trail is located on the southside of Broadkill Beach Road overlooking Vergee's Pond.

The refuge offers at least 15 miles of canoe access, including the 7-mile brochure-interpreted Canoe Trail. Access to Canoe Trail and its associated marsh habitat is located on the east end near the refuge headquarters parking lot, at a mid-point in the Prime Hook Wildlife Area, and on the west end at the Brumbley Family Park. Canoeists and anglers are not permitted to launch at the office boat ramp to access the easternmost 3 miles of Prime Hook Creek from October 1 (sometimes earlier) to March 15 to lessen disturbance to migrating and feeding waterfowl and lessen potential conflicts with hunters. The review team (USFWS 2004a) agreed that serious consideration should be given to removing the boat ramp at the Brumbley Family Park, developing a special use permit for the landowner who benefits from charging for access, or exploring alternative sites for a ramp where the refuge would have more control.

Vital support from the refuge's Friends group has allowed the refuge to offer outstanding programs and special events. Since 2004, the refuge has hosted the Evening at the Hook Lecture Series on the second Thursday of each month. Topics focus on natural resource conservation, wildlife-dependent recreation, and cultural resources.

Also since 2004, the Vandegrift Memorial Series has been sponsored through an endowment received by the Friends of Prime Hook NWR. These lectures/performances take place once a year. A small fee is charged, typically less than $10 per person. Previous events have featured the BBC film Eggs on Coast; Case Hicks, a Theodore Roosevelt impersonator; and Kiawani Lee, a Rachel Carson impersonator. These programs have taken place at off-refuge sites, including a local church and the Milton Theatre.

Prime Hook NWR offered its Fifth Annual Waterfowl Festival in 2006, and has seen attendance grow from around 50 in the first year to 1,200. The event included a very successful nature photography contest and featured live music, guided walks, fish and wildlife-related demonstrations, exhibits, food vendors, and a silent auction sponsored by the Friends of Prime Hook. It was made possible by the Friends of Prime Hook Refuge in partnership with the local tourism bureau, the town of Milton, local bass fishing clubs, State resource agencies, Ducks Unlimited, and the Delaware Department of Corrections. Due to reduced staffing at Prime Hook NWR, the refuge was forced to discontinue this popular event after 2006.

The Friends of Prime Hook NWR host a nature photography contest that illustrates the talents of local photographers, highlights the natural resources and scenery of the Delmarva Peninsula, and promotes the wildlife-dependent recreation of photography. Last year's event featured more than 300 entries from nearly 80 people. A reception is held to announce the contest winners and kick off a month-long exhibition of all photograph entries for visitors to enjoy.

Since 2004, Prime Hook NWR has partnered with the Town of Milton in the Annual Horseshoe Crab-Shorebird Festival in celebration of International Migratory Bird Day to offer special interpretive activities at the refuge and other activities in town. Refuge activities include guided canoe trips, bird walks, plant walks, pond seining, refuge tours, and field trips. This event has grown to 1,500 people.

Designated beach dunes and overwash areas are closed from March 1 through September 1 for nesting State endangered least terns and American oystercatchers, and the potential use by federally endangered piping plovers.

Areas may be reopened if no nesting activity occurs or when nesting ends for the season.

Environmental Education Program
Informing local students about nature, wildlife, habitat, the seasons of change, and how places like Prime Hook NWR play a role in their well-being has been ongoing for many years since the refuge's early beginnings. The refuge has in the past provided limited field trips to teachers by offering programs on requested topics, offered teacher workshops, and participated in programs such as the Sister Shorebird workshop. More recently, efforts have been made to align our efforts with the curricula in the local school districts and develop key partnerships that provide better opportunities for environmental education at Prime Hook NWR.

The refuge conducts environmental education programs as funding and staff time allow. The demand for programs from local schools, scouting, and other groups far exceeds our ability to provide them. We must rely on support from the Friends of Prime Hook NWR and volunteers to plan and implement these programs.

Currently, there are no facilities specifically designated for environmental education. The refuge currently uses the auditorium and small pavilion located near the refuge office for discussion areas and for field studies.

Over the past several years, refuge staff and the Friends of Prime Hook NWR have been working to develop an environmental education program to better meet the needs of both the refuge and the local school districts (Cape Henlopen and Milford). The Friends of Prime Hook NWR have taken an active role in its development, creating an environmental education committee. Refuge staff and the education committee partnered with the science coalition specialist at Cape Henlopen School District to develop an insect program for second grade students, which has been very successful since 2005. The partnership started with the topic of insects, something tangible and familiar to students and the volunteers leading the groups. In 2008, a watersheds program was developed for seventh grade students through the assistance of a grant by MBNA. The refuge is currently planning a birding program.

Teacher workshops have been offered in the past but without success due to time restraints on the teachers. Refuge staff and volunteers occasionally go to schools to provide programs to classes of various age groups. Based on the definition of environmental education, which identifies any environmental education program as one that addresses a class's academic standards, the review (USFWS 2004a) concluded that most of the offsite school programs may fall into the category of environmental interpretation.

Current evaluation methods include up-front evaluation (coordinating with the field trip leader on what is expected of the trip) and informal follow up with teachers, students, and chaperones.

Interpretation of Key Resources and Issues
Key resource topics or interpretive themes of Prime Hook NWR focus on the awareness and importance of the conservation of waterfowl and other migratory birds, the endangered Delmarva Peninsula fox squirrel and other threatened or endangered species, and their associated habitats. No specific interpretive themes or messages have been developed at this time. Currently, key issues affecting the refuge are climate change/sea level rise, mosquito control, the cooperative farming program, and the beach overwash/Fowler Beach Road repair issue.

Personal services interpretation includes guided birding trips, a monthly lecture series, an annual Vandegrift Memorial Lecture, and an annual nature photography contest. The refuge also partners with the Milton Chamber of Commerce to co-host the annual Horseshoe Crab-Shorebird Festival and with the Lower Sussex Bassmasters to promote youth fishing.

The refuge headquarters building includes a small visitor information area. The visitor information area includes an information desk and sales area, display cases, and a 45-person multi-purpose room that is used for special exhibits, training, and special programs.

The refuge has a large number of brochures and handouts available to the public. Some of the materials are refuge-specific, some specific to the local area, and some are generic to the Service. Information is provided to orient refuge visitors and educate them about refuge resources and regulations.

Traveling or portable exhibits have been developed for the refuge that highlight habitat management, wildlife, public use opportunities, volunteers, and the friends group. These exhibits are used at several local events to provide information about the refuge to participants.

The refuge maintains an audio/visual library, including a professionally produced 12 minute video that highlights Prime Hook. Self-guided interpretive facilities and materials, including signs, maps, and kiosks, are available for the Blue Goose Trail, Photography Blind Trail, Dike Trail, Black Farm Trail, Pine Grove Trail, Boardwalk Trail, and Canoe Trail.

Current compatible uses on the refuge include sport fishing; commercial fishing; commercial trapping of muskrat, raccoon, etc.; turtle trapping; public hunting of waterfowl; public hunting of other migratory birds; public hunting of big game-turkey; public hunting of big game-deer; public hunting of upland game; environmental education; canoeing; walking, hiking, and jogging; wildlife/wildlands observation; photography, picnicking; 5k road race; research; special use permit of the Federal Aviation Administration VORTAC tower; beekeeping; waterfowl retrieval permits; and mosquito control.

All commercial and economic uses will adhere to 50 CFR, Subpart A, §29.1 and Service policy which allow these activities if they are necessary to achieve the Refuge System's mission, or refuge purposes and goals. Allowing these activities also requires the Service to determine appropriateness and prepare a compatibility determination and an annual special use permit outlining terms, conditions, fees, and any other stipulations to ensure compatibility.

Communicating Key Issues with Offsite Audiences

Key resource topics or interpretive themes of Prime Hook NWR focus on the awareness and importance of the conservation of waterfowl and other migratory birds, endangered Delmarva Peninsula fox squirrel and other threatened or endangered species, and their associated habitats. Currently, key issues affecting the refuge are climate change and sea level rise, mosquito control, the cooperative farming program, and the beach overwash/Fowler Beach Road repair issue.

The refuge's affected audiences include hunters, anglers, birders, wildlife enthusiasts, photographers, beach tourists, and retirees. The refuge has dealt with a number of controversial issues over the years that have strained its relationship with the community; however, refuge staff continue to work with diligence and patience to secure the community's trust and understanding.

Public comments have been collected during public scoping meetings and from visitor and community surveys through planning efforts for the CCP.

The proposed alternatives in the CCP will provide the public with a future management direction for the refuge, and additional public meetings will provide greater opportunities to communicate and gather public opinion.

Volunteer Programs and Partnerships with Friends Organizations

Approximately 100 active volunteers participate in a range of services and activities in the areas described below:

Visitor Contact Station: training and mentoring; greeting and informing visitors; answering telephone inquiries; sales outlet ordering; stocking brochures; miscellaneous clerical and office projects; and miscellaneous administration duties.

Biological: horseshoe crab sampling; weekly bird surveys; water level readings and management; shorebird and osprey banding; volunteer bluebird nest box monitoring program; constructing and placing monitoring boxes for the endangered Delmarva Fox Squirrel; and vegetation transects and surveys.

Maintenance: trail maintenance; equipment maintenance; maintenance, repair, and construction of deer stands and duck blinds; designing and installing directional signs for deer stands and duck blinds; designing and constructing trails; building construction; building and installing information kiosks; volunteer patrol for litter cleanup and providing refuge information to visitors; mowing grass and assisting with herbicide spraying; changing and installing boundary signs; landscaping around refuge office; assisting with Department of Correction crews; repairing gates; routine office building cleaning; washing vehicles; and miscellaneous office repairs.

Public Use: planning, organizing, and staffing annual Horseshoe Crab-Shorebird Festival and annual nature photography contest; organizing the annual Vandegrift Memorial Series; maintaining databases on newspaper clippings; planning and implementing environmental education programs; designing and maintaining friends group newsletter; conducting birding field trips; holding monthly lecture series and supplying refreshments; completing and submitting monthly reports; conducting tours for groups; staffing information booths at local events; promoting fishing to children at the Lower Sussex Bass Masters Annual Youth Fishing Event; distributing visitor use surveys for the CCP; updating the friends group Web site; designing and coordinating a refuge library of reference materials; applying for miscellaneous grants; maintaining a database; and organizing and coordinating other volunteers.

Volunteers are managed in a three-tier system. The refuge's visitor services manager serves as the station's volunteer coordinator. A volunteer serves as assistant volunteer coordinator, screening potential applicants and assisting the manager with the administrative aspects of the program. Several other volunteers coordinate specific activities such as trail maintenance, outreach, landscaping, etc. The visitor services manager receives feedback from staff and volunteers on work performance.

Over the past several years, Prime Hook NWR has developed a partnership with the Georgetown facility of the Delaware Department of Correction, which supplies a volunteer prison work crew to the refuge throughout the year. In prior years, the typical 13-person crew visited the refuge on a weekly basis; more than 16,000 hours of maintenance-related work has been provided to the refuge since 2003. Projects have included removing deer stands, rebuilding duck blinds, facility maintenance, mowing, carpentry, painting, and more.

Volunteer contributions have increased considerably over the last several years, from 2,257 hours in 1998 to a high of 11,963 hours in 2006. In fiscal year 2012, 103 volunteers contributed 6,487 hours. Refuge staff praise and thank volunteers for their work. During conversations with refuge volunteers, the review team

stated that it was very clear the volunteers felt appreciated by the refuge staff. The refuge also organizes two volunteer recognition and appreciation events each year. In late summer, the refuge hosts a volunteer barbeque and in late winter or early spring, a volunteer recognition event. Due to large numbers, the refuge rents the Milton Fire Hall for the latter eventwhich includes a formal recognition ceremony and catered dinner.

Volunteer gifts are distributed at the recognition event. A program was established to award volunteers with recognition items such as pins, patches, coffee mugs, etc., based on their cumulative hours. The refuge staff also recognize volunteers who provide considerable hours during the calendar year, including the prestigious "Blue Goose Award" for the volunteer with the highest amount of hours. This is a wooden sandblasted plaque with a painted blue goose and engraved plate.

Prime Hook NWR has developed informal partnerships with a number of community organizations and State agencies including: Lower Sussex Bass Masters; Retired Seniors Volunteer Program; Town of Milton; Chambers of Commerce in the towns of Milton, Lewes and Milford; Southern Delaware Tourism; Delaware Department of Corrections; Sussex Bird Club; Ducks Unlimited; USGS; Delaware Division of Fish and Wildlife; DNHP; local Boy Scout troops; Milton Development Corporation; Milton Theatre; Cape Gazette; Delaware Forest Service; M.R. Designs, Inc; Centex Home Builders; Delaware Division of Parks and Recreation; University of Delaware; and many more.

The Friends of Prime Hook NWR, a 150-member non-profit grassroots membership organization, supports the refuge in many ways. The Friends operate a bookstore and gift shop, serve as refuge volunteers, enhance public use opportunities, provide public outreach for the refuge, seek out and apply for grant opportunities, and much more. This group has been instrumental in supporting the visitor services program by leading guided walks, establishing an environmental education committee to assist the refuge in the developing an environmental education program, sponsoring the Vandegrift Lecture Series and nature photography contest, and assisting with the refuge's various special events. They coordinate the refuge offsite exhibits at local festivals and promote refuge messages to the community.

USFWS

Delmarva fox squirrel

The Friends of Prime Hook NWR function as the cooperating association of the refuge, managing a gift shop at the refuge's visitor facility. Sales items include natural resource-related products such as t-shirts, stuffed animals, jewelry, and books. The gift shop is open weekdays from 7:30 a.m. to 4 p.m., weekends from April through November from 10 a.m. to 4 p.m., and occasionally on weekends during the off-season. The refuge has no concessionaires at this time.

Chapter 4

Chuck Fullmer

Scarlet tanager

Management Direction and Implementation

- Introduction
- Developing the Management Direction
- Alternatives or Actions Considered but Eliminated
- General Refuge Management
- Management Goals, Objectives, and Strategies

Introduction

This chapter describes the process we used to formulate the management direction for Prime Hook NWR, including descriptions of the management actions and alternatives that were considered but not analyzed or chosen as the management direction for the refuge. We then present the chosen management direction for the refuge, including the goals, objectives, and strategies.

Developing the Management Direction

Relating Resources of Concern and Focal Species to Goals, Objectives, and Strategies

As described in chapter 2, the first step in our planning process was to map out the refuge's resources of concern and prioritize focal management species. These identified resources and species were used to develop a set of refuge goals, objectives to achieve those goals, and a series of strategies to implement them.

Refuge goals are intentionally broad, descriptive statements of the desired future condition for the refuge's resources of concern. By design, they are less quantitative and more prescriptive in defining the future desired habitat conditions of our management. Our goal statements include the principal elements of the refuge purposes and Refuge System mission and refuge-specific habitat vision statement developed by the public. All these inputs provided the framework for stepping down specific management objectives and strategies.

Objectives are essentially incremental steps toward achieving a goal; they further define management targets in measurable terms. "Writing Refuge Management Goals and Objectives: A Handbook" (USFWS 2004a) recommends writing "SMART" objectives that possess five characteristics: (1) specific, (2) measurable, (3) achievable, (4) results-oriented, and (5) time-fixed. A rationale accompanies each objective to explain its context and why we think it is important. The objectives outlined in this chapter will guide the future development of refuge step-down plans, which we describe later in this chapter.

We identified strategies for each of the objectives. These are specific actions, tools, techniques, or a combination of these that may be used to achieve the objectives. The list of strategies under each objective represents the potential suite of actions we may implement. We will evaluate most of them further as to how, when, and where we should implement them when we write our refuge step-down plans.

Environmental Baseline

It is important to understand that while the CCP was under development, there were major habitat changes within the refuge. As explained in chapter 3, the formerly freshwater impoundments in Units II and III (particularly in Unit II) have undergone significant change, due to breaches in the barrier island allowing for the free exchange of saltwater in the formerly maintained freshwater marshes. The rapid inundation of saltwater killed substantial amounts of freshwater vegetation and increased the salinity of brackish waters but, to date, has not brought in sufficient sediment to overcome the sediment deficit incurred over the decades of freshwater management. The refuge continues to assess the biological, chemical, and geological impacts of these changes, specifically exploring whether the underlying peat layers, which were not increasing during the decades of freshwater management, have recently experienced increased subsidence or other biochemical changes. Therefore, while the environmental baseline for these habitats is difficult to fully assess, for this analysis we assume that the baseline is the condition of the refuge as of mid-2012.

Alternatives or Actions Considered but Eliminated

Management Alternatives Considered but not Chosen for Implementation

NEPA requires that a thorough analysis be made of a range of management alternatives, including a "no action" alternative that represents current refuge management. Both the draft and final CCP/EIS evaluated three alternatives (A, B, and C). We analyzed the socioeconomic, biological, physical, and cultural

consequences of implementing each alternative, and selected among these alternatives based on their greater or lesser ability to meet the purposes and needs described above. For the final CCP, we chose alternative B which focuses on focal species with proactive habitat management and expanded public use. Alternative B is presented in this chapter as the management direction that the refuge will implement over the next 15 years. Below are brief summaries of alternatives A and C.

Alternative A. Current Management (No Action)
This alternative primarily portrayed current management, representing the required "no action" alternative. It was used as the baseline for comparing the other two alternatives throughout the process of developing the CCP. Had this alternative been chosen, the habitat management program would have continued as it had prior to the development of the CCP, involving no active management of wetlands, no active forest management, and no agricultural management of upland fields. This means that natural ecological processes would have been allowed to proceed with no human intervention. While natural resource protection and conservation actions would have continued, generally speaking, the only habitat manipulation programs we would have conducted would have been the removal of invasive species and enhancement actions for federally listed endangered and threatened species.

We would have continued to offer hunting and fishing opportunities on refuge lands and respond to requests for interpretive and school programs. The refuge would have continued to provide 6 miles of walking trails, 7 miles of canoe trail, and associated viewing and photography infrastructures. Educational, interpretive, and community programs, such as the monthly lecture series and annual photography contest, would have also continued.

Alternative C. Historic Habitat Management
Alternative C habitat management emphasized a return to habitat management programs that were conducted on the refuge through most of its existence, but which were stopped for a variety of reasons (e.g., changes in the environment, court decisions, updates in Service policy). These historic habitat management programs include the use of cooperative farming in upland refuge fields and management of freshwater wetland impoundments, both conducted for the benefit of migratory birds. Under this alternative, the refuge, with partner assistance would have conducted infrastructure and duneline enhancements to reestablish management of freshwater impoundments. Upland fields previously enrolled in the cooperative farming program would have once again been managed through farming practices with the cooperation of local farmers.

Under this alternative, public use would change slightly from current management. Hunting opportunities would have been expanded from current management but would have been less than those proposed under alternative B. Fishing, wildlife observation, and wildlife photography would not have changed much.

Under alternative C, we would have further enhanced local community outreach and partnerships, continued to support a Friends Group, and continued to provide valuable volunteer experiences. We would have also promoted research and the development of applied management practices through local universities to sustain and enhance natural composition, patterns, and processes within their range on the Delmarva Peninsula.

Refuge Boundary Expansion

Prime Hook's 4,000 acres of impoundments represent approximately 40 percent of the total 10,000 acres of impoundments in the State of Delaware and 78 percent of the freshwater impoundments within the State. However, the refuge's impoundments are extremely vulnerable to sea level rise due to their position immediately behind a dynamic coastal barrier, as described in chapter 3. In the

last decade, this sand dune system has been breached several times, resulting in the deposition of sand and saltwater into the Unit II impoundment during storm tides. Storms have also created inlets south of Fowler Beach Road, resulting in constant tidal regime. Consequently, the freshwater impoundment created to provide habitat for migratory birds in Unit II has converted to an open water system, which has also impacted the management of the Unit III impoundment. It would be extremely difficult, costly, and unsustainable to reestablish freshwater impoundment management in these units.

Under the management plan, described later in chapter 4, these impoundments will eventually be restored to a natural salt marsh or brackish wetland complex, with a cessation or significant reduction in communities of freshwater annual plants resulting from impoundment management on the refuge. Although salt marsh and brackish wetlands provide valuable migratory bird habitat, conversion of refuge impoundments creates the potential for significant reduction of waterfowl numbers and loss of shorebird habitat. With the loss of Prime Hook NWR's impoundments, 78 percent of the freshwater impoundments within the State of Delaware will have a reduced function and value as habitat for migratory waterfowl. Since freshwater wetlands have greater diversity than saltwater wetlands, State rare plants are vulnerable due to saltwater intrusion, resulting in the refuge's loss of biodiversity.

Radar research indicates how important the refuge's forests are during the migration of neo-tropical migrants (Dawson and Butler 2010). However, surveys show that the refuge contains 125 to 150 acres of dead, dying, or stressed woodland habitat due to saltwater intrusion. Mitigating for the loss of this critical and habitat is an important step toward the refuge purpose as envisioned under the Migratory Bird Conservation Act.

As rising sea levels prompt changing habitat conditions along the refuge coastline, salt marsh and brackish wetlands will migrate landward, which is a natural response mechanism. In order to continue providing valuable impoundment and forest habitats, the refuge must consider expanding the refuge boundary toward the west. The refuge currently owns 10,144 acres and has approval to acquire an interest in 1,101 additional acres. It is prudent for the refuge to continue acquiring lands within the approved acquisition boundary from willing sellers, and to manage newly acquired land in a manner consistent with management proposed in this CCP. However, ultimately the refuge will need to pursue and expand the acquisition boundary westward to permit the purchase of additional lands inland from willing sellers. This would enable the refuge to pursue forest management and the potential creation of new freshwater impoundments. Land acquisition, however, is increasingly expensive.

As described in chapter 3, some 9,000 years ago the Delaware shoreline was about 3 miles east of its current location east. Since the shoreline of the refuge has retreated some 500 feet over the past 80 years, it is inevitable that the westward migration of land and saltwater will continue.

Expansion of the refuge's acquisition boundary is a necessary future step to meet habitat needs for trust species such as migratory waterfowl, shorebirds, and neotropical migrants, and to contribute to the network of conservation lands and wildlife resources in the regional landscape. However, with input we received from the public during scoping, coupled with reduced land acquisition funding, we are not planning any major refuge boundary expansion as part of this CCP. Approval to explore refuge boundary expansion comes from the Service's Director, and then expansion requires development of a land protection plan. We will continue to consider minor acquisitions adjacent to the refuge from willing sellers if the lands are determined to be biologically important, or provide connections with other protected lands. Land protection efforts that emerge outside of this planning process will include significant public involvement in

decision-making, involve partners in the protection effort, and will use a full range of protection methods, including management agreements, conservation easements, and fee acquisition. Any new land protection plan developed in the future will incorporate these features and contributors.

Shoreline Stabilization

Most oceanfront and bay shorelines in the Northeast have been eroding over the last 10,000 to 20,000 years, in part as a natural process and in part as a process exacerbated and accelerated by human activity. Beaches erode naturally due to physical processes (wind, waves, tides, sea level rise, and subsidence). Higher intensity coastal events such as nor'easters, hurricanes, and storm surges accelerate beach erosion or can reconfigure areas of sediment accumulation and erosion. During storms, sand from the visible beach submerges to form storm bars that protect the beach. During milder weather, sediments moved off shore can move landward, so an eroded beach with substantial submerged sand surrounding it may recover naturally.

Human activities and alterations on the coast can also be as catastrophic as hurricanes, but generally over a longer time interval (Kraft et al. 1975, GSA 2009). Human construction activities have caused substantial erosion on the beach face of barrier islands or along sandy shoreline strands (littoral cells) adjacent to a sandy harbor, like in Lewes, Delaware. Today, coastal beaches are eroding for several reasons, such as human-induced changes in sediment transport processes, sand supply, sea level rise, and increased storminess. Eroding beaches generally migrate landward, which is a natural coastal process even under more recent (5,000 to 7,000 years) historic rates of sea level rise.

An ecologically ideal and sustainable management response is to allow natural retreat. However, urbanization of beaches and their associated shorelines have resulted in residents of adjacent coastal communities advocating that State or Federal agencies actively intervene through hard armoring or soft engineering solutions that temporarily halt the migration of shorelines. Neither solution is free of negative ecological consequences (Komar 1998a). Increased storminess is a predicted consequence of global climate change and will likely result in significant annual changes to the refuge's sandy beach and bayshore habitats. The roles of both traditional hard and soft armoring methods to stabilize sandy beach shorelines were considered during the development of the CCP/EIS.

Hard Engineering Methods to Stabilize Shorelines

Hard engineering methods are often positioned in marine environments to offset erosion in sediment-deficient areas, or to prevent accretion in dynamic areas such as inlets. Hard engineering methods to stabilize shorelines include groins, sea walls, revetments, rock armoring, and bulkheads. Often, hard armoring techniques implemented to solve coastal erosion problems result in accelerated erosion rates and measures used to reduce coastal erosion at one location will often create coastal erosion problems at other coastal locations more removed from the armored areas.

Delaware coastal scientists have noted that if there is an inadequate supply of sand in a given location, hard armoring cannot control erosion (DNREC 2004, Maurmeyer 1978, Kraft et al. 1975). In the absence of an adequate sand supply, hard structures such as seawalls, bulkheads, and revetments placed in the area of wave action may be effective in protecting properties in the upland, but often at the expense of the sandy beach ecosystem and back-barrier island habitats, by curtailing and cutting off sediment flow. Disruption or changes in the littoral drift and flow of sediment negatively impacts sediment budgets of natural dune and beach ecosystems. These engineering techniques also impede the natural landward migration of the shoreline (Kraft et al. 1975).

From the 1920s to the late 1970s, shoreline hardening techniques were used in Delaware. For example, groin fields were established on Broadkill Beach

in tandem with beach nourishment to protect beach houses. Similar shoreline hardening combined with soft hardening techniques were used from the 1940s through the 1970s in Slaughter Beach, where groin fields, bulkheads, and riprap, coupled with beach nourishment had been historically employed to stabilize Delaware Bay shorelines immediately north and south of the refuge (DNREC 2004). However, it is pointed out by DNREC coastal scientists that it is the sand and sediment that ultimately serves best to temporarily protect beach properties, not the groins or other shoreline hardening techniques used in the past.

Importantly, if a hard structure diverts the existing sediment supply from other areas, it will be necessary to perpetually add sediment into the system to compensate for such impacts. Thus, this approach does not meet one of the fundamental parameters for a satisfactory alternative (i.e., that the alternative be sustainable ecologically).

Since the late 1970s, the State of Delaware has no longer included shoreline hard armoring of ocean or bay shorelines as part of its primary coastal management strategies. Additionally, Federal coastal scientists suggest that, before using either hard or soft stabilization of any shoreline, the effect of these coastal management techniques on the local sediment budget must be appropriately analyzed to eliminate or reduce adverse environmental problems and negative impacts on barrier beach island integrity and functioning (NOAA 2011).

Shoreline transgression is necessary to maintain the BIDEH of Barrier Beach Island and salt marsh habitats in the face of rising rates of sea level and climate change. Hard armoring is also a very expensive technique with little to no capability of stemming coastal erosion in the long term. Hard armoring was eliminated from detailed analysis in this CCP because of its adverse impacts, its lack of sustainability and the probably need for perpetual sand replenishment to address its like adverse impacts, its inconsistency with BIDEH policies, and its high cost.

Soft Engineering Methods to Stabilize Shorelines

Beach scraping involves mechanically moving sand from the intertidal zone to the dune or upper beach. Beach scraping is intended to mimic natural beach recovery processes, but at an increased recovery rate, and is regarded by some as being suitable only under certain circumstances for coastal protection, such as when there is sufficient material in the intertidal zone to sustain the beach profile (Wells and McNinch 1991). Beach scraping can have negative consequences on the beach biota (Peterson et al. 2000) and in some situations can worsen shoreline erosion (Kerhin and Halka 1981). Beach scraping is not suitable for severely eroding beaches (Wells and McNinch 1991). In 2010, the community of Primehook Beach was denied a State permit for beach scraping on the basis of several concerns, including the potential for increased erosion (DNREC 2010).

Shoreline stabilization using onsite material can also be accomplished by mechanically moving sand that has washed landward from the dunes back onto the duneline. The material can be reconfigured to create berms and dunes and provide shoreline stabilization without using sand from the intertidal zone as is done with beach scraping. Such stabilization was conducted along Unit II in the fall of 2010, following the preparation of an environmental assessment (USFWS 2010). The project had been delayed by litigation, and by the time it was conducted, Hurricane Irene had washed away much of the material that was to be utilized for the stabilization. The resulting project was smaller than originally planned and lasted only a short time before the closed inlets were opened again during a high tide event. For this reason, this approach has been dismissed from further consideration. There is no longer enough sandy sediment along the Unit II shoreline to make this technique feasible.

No Hunting

An alternative that would have closed the refuge to all hunting was considered but dismissed from detailed analysis. A “No Hunting Alternative” would not

accomplish the purposes we seek to accomplish by the adoption of this CCP, as described in the "purpose and need" section. Closing the refuge to hunting would conflict with the Refuge Improvement Act, which provides that hunting is an appropriate and priority use of the Refuge System, shall receive priority consideration in refuge planning and management, mandates that hunting opportunities should be facilitated when feasible, and directs the Service to administer the Refuge System so as to "provide increased opportunities for families to experience compatible wildlife-dependent recreation, particularly opportunities for parents and their children to safely engage in traditional outdoor activities, such as fishing and hunting" Furthermore, "no hunting" would conflict with Executive Order #13443: "Facilitation of Hunting Heritage and Wildlife Conservation." The order directs the Department of the Interior and its component agencies, bureaus, and offices "to facilitate the expansion and enhancement of hunting opportunities and the management of game species and their habitat." Finally, the CCP's stated purpose and need is to ensure that management of the refuge will best respond to four key areas of concern, including "abide by and contribute to the mission, mandates and policies of the U.S. Fish and Wildlife Service and the National Wildlife Refuge System, and meeting refuge's goals." One of the goals of the Refuge System is to "provide and enhance opportunities to participate in compatible wildlife-dependent recreation (hunting, fishing, wildlife observation, photography, environmental education and interpretation)." An alternative that failed to provide any opportunity to participate in hunting activities, where such activities are compatible with the purposes of the Refuge System, would fail to meet the goals of the Refuge System.

Reduced Hunting

An alternative that would have considerably reduced existing hunting opportunities was considered but dismissed from detailed analysis. The fundamental mission of the Refuge System is wildlife conservation: wildlife and wildlife conservation must come first. BIDEH are critical components of wildlife conservation. According to Section 3.14 601 FW 3 "Biological Integrity, Diversity, and Environmental Health" the Service is mandated to manage populations to maintain and restore BIDEH by "… cooperation and coordination with State fish and wildlife management agencies in setting refuge population goals and objectives. To the extent practicable, our regulations pertaining to fishing or hunting of resident wildlife within the Refuge System are consistent with State fish and wildlife laws, regulations, and management plans." Hunting helps achieve the purposes of the refuge and the Refuge System.

Overabundant deer and snow goose populations have created negative impacts on the refuge, including economic losses, agricultural and landscape damage, habitat degradation and destruction, and deer-vehicle collisions. White-tailed deer cause significant damage to agricultural crops. DNREC (2010) found that 75 percent of Delaware farmers surveyed experienced some form of damage related to deer.

Along with agricultural crop damage, excessive numbers of white-tailed deer also damage the native flora and fauna of Delaware. Numerous studies have indicated that intensive deer browsing related to overabundant deer populations can change the forest species composition and the associated wildlife (DeCalesta 1994, Waller and Alverson 1997). This change would not only affect the forest composition but would also negatively affect the wildlife species that live within these forest communities. 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 exotic or invasive species like Japanese stiltgrass. Delaware's natural

ecosystems are often threatened by exotic plants that find the habitat and climatic conditions favorable. According to the Delaware Division of Fish and Wildlife's "Delaware Deer Management Plan" (2010), "active management of deer is a necessity in Delaware today to maintain populations at levels compatible with the varied interests of the citizens of the state as well as ecological concerns….. Presently, non-lethal management techniques such as contraceptives and non-hunting mortality (i.e., disease, injuries, predation, and roadkills) are not sufficient in maintaining deer populations at satisfactory levels. Lethal control of deer via the regulated deer hunting season is required to effectively regulate the deer population." We believe that annual harvesting of 60 to 100 white-tailed deer on the refuge will likely have a beneficial localized impact toward the biological integrity and biological diversity of the refuge.

Both Canada goose and snow geese cause damage to refuge habitats. 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). Grubbing for rhizomes, especially in salt marshes, results in areas denuded of vegetation, typically referred to as eat-outs. 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. Constant harassment, habitat alterations, and hunting are the most effective long-term solutions to reduce goose problems. With limited staff resources and the potential negative consequences to habitat and other wildlife, harassment is not a feasible option at Prime Hook NWR. Thus, we believe that reducing snow goose numbers on the refuge through a regulated hunt will best reduce the impacts of Canada goose and snow goose herbivory on salt marsh habitats.

Hunting on the Delmarva Peninsula is a traditional outdoor past time and is deeply rooted in American and Delaware heritage. Opportunities for public hunting are decreasing with increasing private land development. Therefore, refuge lands have become increasingly important in the region as a place to engage in this activity. Hunting is an existing use on the refuge and has provided the public compatible use since 1963. Experience has proven that time and space zoning (e.g., establishment of separate use areas, use periods, and restrictions on the number of users) have been effective in eliminating potential conflicts between user groups. The refuge has an excellent safety record.

The Service had a randomized public opinion survey conducted when it began the CCP process. Both visitors to the refuge and residents of nearby communities were sent surveys and the results met statistical standards for demographic proportionality and had high confidence levels. Among a wide range of topics (see chapter 3), survey questions were designed to identify similarities and differences of opinion between consumptive (hunting, fishing, and crabbing) users and non-consumptive users. Both groups were highly supportive of the opportunities for

wildlife observation and appreciated the serenity and natural environment which the refuge provides. Overwhelmingly, both consumptive and non-consumptive users held similar views of the refuge as providing attachment or meaning to their sense of place and identity and for family tradition or heritage.

Both the consumptive and non-consumptive users of the refuge reported visiting the refuge frequently, generally about 12 to 16 times per year. The non-consumptive users were more likely to be older (60s), retired, and female (54 percent). The consumptive users were more likely to be in their late 40s, employed, and male (97 percent).

The consumptive users overwhelmingly felt that opportunities for hunting should be increased. About 55 percent of the non-consumptive users accepted hunting at existing levels or were supportive of an increase in this use. The non-consumptive visitors identified bird watching (73 percent), nature/wildlife viewing (64 percent), hiking/nature trails (56 percent), and special events, environmental education, and guided interpretive tours (collectively 68 percent) as their primary activities.

Proximity to the roads was of key importance to both the consumptive and non-consumptive users, but presumably for different reasons--the consumptive users use roads to access areas for hunting and fishing; many of the non-consumptive users, being older, remain in or near their cars while viewing birds on or near the water. However, non-consumptive visitors also placed the roads as important for viewing forest birds and paddling. One statistical difference between the consumptive and non-consumptive users is that the non-consumptive users preferred to have more areas restored to natural conditions, more hiking trails, and more interpretive exhibits. About 45 percent favored reducing hunting. Only about 10 percent of the survey respondents felt that hunting should not be allowed at all, and it is possible that some of these visitors did not understand that Congress has already determined that hunting and fishing are to be facilitated on refuges as well as facilitating wildlife observation, photography, or environmental education. When asked to rate five potential future services, the non-consumptive users rated an observation tower overlooking the marsh, road-side pull-offs, more walking trails around refuge headquarters, and more scheduled guided interpretive walks as important to them, far more than the consumptive users rated such increased services.

In developing the hunting and public access plan for the CCP, the Service determined that increasing the totality of opportunities to engage in priority wildlife dependent public uses could best address the concern raised by both groups. Therefore, the number of trails has been increased and additional areas are being opened to both consumptive and non-consumptive users; these areas and trails were previously closed to all public uses. By increasing opportunities for wildlife viewing for non-hunters while also increasing hunting opportunities, the Service believes it is responding to the views expressed by both groups. Reducing the hunting opportunities would not as effectively address the purposes and goals of the CCP as expanding all opportunities for increased wildlife dependent public uses. Thus, the Service feels that it has developed a far more reasonable approach to allocating wildlife dependent public use options than reducing hunting options alone.

In developing CCPs, the Service is required, to the maximum extent practicable, to consult with state conservation agencies and coordinate development of the plan with the relevant state conservation plan. For Prime Hook NWR, DNREC requested that hunting opportunities not be reduced below existing levels. A reduced hunting alternative would also conflict with Executive Order #13443 to "… facilitate the expansion and enhancement of hunting opportunities." It would also conflict with Congress' mandate to "provide increased opportunities for…compatible wildlife-dependent recreations…such as fishing and hunting" 16 U.S.C. 668dd(a)(4)(K).

Although there are other methods available to reduce overabundant deer, Canada goose, and snow goose populations, hunting remains an efficient, traditional, and compatible wildlife/habitat management tool that provides an excellent recreational opportunity for many outdoor enthusiasts. Eliminating or reducing the hunt program at the refuge would be contrary to the establishing purpose and the mission of the Refuge System.

General Refuge Management

There are some actions we will take in managing Prime Hook NWR that are required by law or policy, or represent NEPA decisions that have recently undergone analysis, public review, agency review, and approval, and are binding. Others may be administrative actions that do not require public review, but we want to highlight them in this public document. They may also be actions crucial to achieving the refuge purposes, vision, and goals.

All of the following actions, which we discuss in more detail below, will be implemented:

- Using adaptive resource management.
- Managing invasive species.
- Monitoring and abating diseases affecting wildlife and forest health.
- Controlling nonnative and other pest animals.
- Conducting appropriate use and compatibility determinations.
- Providing opportunities for wildlife-dependent recreation.
- Protecting cultural resources.
- Conducting a refuge wilderness review.
- Providing refuge staffing and administration.
- Distributing refuge revenue sharing payments

Using Adaptive Resource Management

The CCP goals and objectives are supported by rationales and management strategies which were developed after a thorough assessment of available science derived from scientific literature, onsite refuge data, expert opinion within and outside the Service, and sound professional judgment. Biological objectives describe desired future conditions for wildlife and refuge habitats.

In the management plan, it is assumed that we employ adaptive resource management as a strategy to ensure a quick and efficient response to new information and events. The need for adaptive management is compelling because our present knowledge and information on refuge habitats and species is incomplete, provisional, and subject to change as new information is acquired. Adaptive management is a proactive process of learning what works on the ground by constantly adjusting strategies to respond to new information, spatial and temporal changes, and environmental and climatic events, whether foreseen or unforeseen, measured against a clearly defined goal or set of conditions.

On March 9, 2007, the Secretary of the Interior issued Order No. 3270 that provides policy on the procedures for implementing adaptive management in Department of the Interior agencies. A published guidebook for managers and practitioners defines adaptive management and the conditions under which we should consider it, and the process for implementing and evaluating its effectiveness. You may view this reference at the following site: *http://www.doi.gov/initiatives/AdaptiveManagement/documents.html* (accessed February 2012). As it relates to refuge management, adaptive management promotes flexible decision-making through an iterative learning process to deal with uncertainty, resulting in more effective decisions. At the refuge level, monitoring habitat management actions and outcomes and key resources of concern will be critical to the process.

Climate change is expected to exacerbate the current rate of habitat fragmentation and loss, change habitat composition and structure, simplify ecosystem function, increase the prevalence of weed and disease species, degrade

water quality, and alter hydrology. It will be especially important to continually evaluate management activities and the status of the refuge's resources in order to respond to negative impacts in a meaningful way as quickly as possible.

At the refuge level, monitoring and assessing management actions and outcomes, and tracking critical resources and indicators of environmental health will be very important. The refuge will be responsible for changing management actions and strategies if they do not produce the desired conditions. Significant changes in management actions and strategies from what we present in this final CCP may warrant additional NEPA analysis and public comment. Minor changes will be documented as an important element of the adaptive management process when NEPA analysis and public comment are not warranted.

Many of the management objectives identify increased monitoring elements. If monitoring activities are conducted by non-Service personnel, these activities must be determined compatible by the refuge manager in a compatibility determination. Our future habitat and species inventory and monitoring plan will detail how and what we monitor and will also incorporate an adaptive management approach to support the goals and objectives of the refuge.

Managing Invasive Species

The establishment and spread of invasive species, especially invasive plants, is a major problem that reaches across all refuge habitat cover-types. We use the definition of invasive species found in the Service Manual (620 FW 1.4E):

> *Invasive species are alien species whose introduction does or is likely to cause economic or environmental harm, or harm to human health. Alien species, or non-indigenous species, are species that are not native to a particular ecosystem. We are prohibited by Executive Order, law and policy from authorizing, funding, or carrying out actions that are likely to cause or promote the introduction of invasive species in the United States or elsewhere.*

The unchecked spread of invasive plants threatens the BIDEH of all refuge habitats. In many cases, invasive species have a competitive advantage over native plants and outcompete them, reducing the availability of desirable native food and cover plants for wildlife. Invasive plants reproduce rapidly over large areas of the landscape and have few or no natural controls to keep them in check. Invasive vegetation usually spreads aggressively by runners or rhizomes, produces large numbers of seeds, and disperses seeds through various means such as wind, water, wildlife, or people. Invasive wildlife is best held in check through alert monitoring; if found, appropriate techniques need to be matched to the particular species of concern.

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 managing invasive species for the 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 or small infestations.
(3) Control 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 (all accessed February 2012):

- National Invasive Species Information Center: *http://invasivespeciesinfo.gov/index.shtml*
- USGS Invasive Species Program: *http://biology.usgs.gov/invasive/*
- Weeds Gone Wild: *http://www.nps.gov/plants/alien/index.htm*

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 used.

Early Detection and Rapid Response
Where prevention is not possible, early detection and rapid response are the next best strategies. 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 species that are likely to invade. The Delaware Invasive Species Council of the Delaware Department of Agriculture is an important source of information: *http://www.delawareinvasives.net* (accessed February 2012).

For some species, an active monitoring protocol may be established to facilitate early detection. For example, artificial substrates may be suspended in waterbodies and checked regularly for the early detection of zebra mussel on the refuge. When small plant infestations are spotted, they should be eradicated as soon as possible. Sites must then be monitored for the appropriate time period considering the species involved to ensure the control was effective.

Prioritizing Invasive Plant 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*; accessed February 2012) 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 (Morse et al. 2004, Hierbert and Stubbendieck 1993, APRS Implementation Team 2000). The "Fulfilling the Promise" team recommends using the following order of priority to determine appropriate actions: smallest scale of infestation, greatest threat to land management objectives, and greatest ease of control.

When limited resources prevent the treatment of entire populations, the following order of priority is recommended: treat the smallest infestations (satellite populations), treat infestations on pathways of spread, and treat the perimeter and advancing front of large infestations.

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. These areas will be inspected often, and new infestations will be controlled 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.

Incorporating Invasive Species Prevention in Impounded and Other Emergent Wetland Areas

To minimize infrastructure development in managed wetland units we will remove or revegetate dikes, waterways, and access roads found to be unnecessary for meeting management objectives. These often are sources of infestation and provide pathways for the spread of invasives. We will plant native grass mixes that establish quickly to stabilize banks and dikes and prevent the establishment of invasive species. Native grass mixes should include annual ryegrass *(Lolium perenne)* so bare soil is not exposed to erosion or invasive plant seeds and rhizomes. This nonnative plant will establish quickly and then drop out of the mix after 1 or 2 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* (common reed) 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

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 resprout. Treatments should be timed to prevent seed set and resprouting. 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 or well-established plants. For some invasive plants, mechanical treatment alone exacerbates the problem. Mechanical treatments are most effective when combined with herbicide treatments.

Herbicides

There are many 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. All pesticides must be mixed, loaded, and applied in accordance with label specifications and all applicators must be certified with the Delaware Department of Agriculture or working under the supervision of a certified applicator.

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 nontarget species at the site or contaminate surface

or groundwater. Proper planning includes using the most target-specific, least hazardous (for 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.

Within refuge lands, all chemicals, including adjuvants designed to enhance effectiveness are covered by Service and Department of the Interior regulations, and a pesticide use proposal is required for all pesticide applications. Attention to protective gear, licensing requirements and other regulations is essential.

Prescribed Burning
Fire is a critical tool for managing ecosystems. It recycles vital nutrients, stimulates growth, and provides quality habitat for a variety of species, especially when it is used to control invasive plants like *Phragmites*, in conjunction with other techniques like herbicides and mechanical removal. Regular fires also help check the risk of catastrophic fire by reducing accumulation of hazardous fuels by clearing underbrush and dead vegetation.

Over 90 percent of hazardous fuels reduction on the refuge has been accomplished through strategic use of fire in conjunction with herbicides to reduce large stands of *Phragmites*. A comprehensive monitoring plan was established in 2002 with 45 transects spread across all four management units as part of the initiation of a large wildland urban interface project conducted in 2002 through 2004. These established transects will continue to be monitored to track *Phragmites* control in relation to original 2002 treatment sites. Maps and the monitoring plan can be located in the refuge's 2009 fire management plan.

Biological Control
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 in which 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 in the U.S.

Methods are in development to biologically control two of our most invasive plant species—common reed *(Phragmites australis)* and mile-a-minute *(Persicaria perfoliata)*. Biological control organisms for common reed are still in the experimental stages; therefore, that strategy cannot yet be explored. However, mile-a-minute biological control organisms are closer to being ready for field use. Biological control of invasive species is not being pursued under this CCP, but may be explored in the future, pursuant to NEPA compliance at that time.

Mile-a-minute is an annual vine of Asian origin that infests refuge forested areas, roadsides, and drainage ditches. In areas in full sun, by early spring it rapidly outgrows and outcompetes native plants, and is often the first colonizer in refuge areas that have been reclaimed from *Phragmites* dominance. It is a weed that poses a particularly strong threat to forest regeneration and could potentially provide considerable setbacks in reforestation and forest enhancement projects.

A biological control program targeting mile-a-minute weed was initiated by the Forest Service in 1996, with field surveys and laboratory host specificity tests conducted in China and subsequent testing continuing under quarantine

conditions in Delaware. A stem-boring weevil, *Rhinoncomimus latipes*, was determined to be host-specific to mile-a-minute (Price et al. 2003, Colpetzer et al. 2004), and a permit application for field release was approved in July 2004. Development of a rapid germination protocol and field successes in Delaware have been documented (Colpetzer et al. 2004, Hough-Goldstein et al. 2008).

Of the 426 plant taxa listed for the refuge, 45 are nonnative; among those are considered invasive on Prime Hook NWR are:

- *(Centaurea bieberstei)*—spotted knapweed
- *(Cirsium arvense)*—Canada thistle
- *(Hydrilla verticillata)*—hydrilla
- *(Lonicera japonica)*—Japanese honeysuckle
- *(Ludwigia leptocarpa)*—water willow
- *(Microstegium vimineum)*—Japanese stiltgrass
- *(Phalaris arundinacea)*—reed canary grass
- *(Phragmites australis)*—alien common reed
- *(Polygonum perfoliatum)*—mile-a-minute
- *(Pueraria montana)*—kudzu
- *(Rosa multiflora)*—multi-floral rose
- *(Sorghum halepense)*—Johnsongrass
- *(Elaeagnus umbellata)*—autumn olive

Spotted knapweed, Canada thistle, and Johnsongrass are mostly found on roadside areas, agricultural fields, and early successional habitats throughout the refuge. Water willow, which is not native to Delaware, but is native in areas further south, dominates about 100 to 200 acres within the Unit III impounded emergent marsh along Prime Hook Beach Road. Japanese stiltgrass (approximately 50 acres) is restricted to Oak Island, where it dominates the herbaceous layer. Japanese honeysuckle is ubiquitous on the refuge in wooded habitats. Reed canary grass, another species native in areas south of Delaware, dominates old field habitats also located in Unit III.

By far, the most problematic invasive plant historically and currently on the refuge is *Phragmites*. Its proliferation in the refuge's marshland and upland interface is a signature of man-made wetland alternations and activities creating constant habitat disturbances (water level management actions, open marsh water management excavations, and eutrophication from off-refuge nutrient sources). These disturbances have made it an annual requirement to monitor and treat *Phragmites*. In 1983, the refuge conducted an environmental assessment on the marsh vegetation rehabilitation and chemical control of *Phragmites*.

A fundamental concern to control *Phragmites* on the refuge is the grave fire hazard it presents as a potential danger to local beach communities adjacent to refuge lands. A second concern is the reduction of environmental health and biodiversity that occurs when native plant species are replaced by aggressive exotics. Competitively superior exotic genotypes have displaced former indigenous *Phragmites* populations in North America, especially in the Mid-Atlantic through heavy shipping channels from European trade (Saltonstall 2002). Commensurate with a shift to an exotic *Phragmites* monoculture is an unhealthy reduction in avian, insect, and other important floral and faunal assemblages.

The biggest invasive problems and accumulation of hazardous fuel-loading has occurred in the refuge's marsh areas. Marsh management practices preceding refuge establishment and lack of funding since contributed to a build-up of highly flammable *Phragmites* fuels on refuge lands immediately adjacent to three private beach communities. Dense stands over 15 feet high with accumulation of dead canes created severe fuel hazards, as these canes can persist for up to four years. The exotic m-haploid type prevalent in the mid-Atlantic can grow over

14 feet tall annually and primarily spreads by the growth of rhizomes that can extend 150 feet from a single cane stem per season. The plant can also reproduce via seed; seeds dispersed by wind or water from off-refuge sites are quickly establishing on refuge sites that have high water tables or are seasonally flooded. By the end of the 1999 and 2000 growing seasons, more than 3,000 acres of *Phragmites* persisted on the refuge.

Within the context of Federal wildland fire policy and wildland urban interface protection concerns and habitat conditions on the refuge, it became evident that wildland urban interface fire protection and prevention required immediate attention. The major focus occurs along the refuge's eastern boundary; Prime Hook Beach and Broadkill Beach were identified in 2002 by the Delaware State Forester and included in the vicinity of Federal lands published in the *Federal Register*. In three beach communities, approximately 750 homes are at risk. Periodic arson-set fires also increase fire risks to these communities, each with poor access and lack of defensible space.

The use of fire in invasive species control of *Phragmites* for public safety and natural resource protection is fully addressed in our updated fire management plan, which will be implemented under this CCP. The use of prescribed fire and full suppression of all wildfires occurred under previous refuge management. Prescribed fire was used by managers to reduce fuel hazards, achieve resource management objectives, and simulate natural fire processes. Natural ignitions or human caused wildfire will not be allowed to burn without suppression.

In addition, a program for continued monitoring and treatment of hazard fuel zones near the three wildland urban interface communities is now formally included in the refuge's fire plan (2009). This continues fuel management practices initiated in 2001 in primary treatment zones (zero tolerance zones, approximately 800 acres) and secondary treatment zones (limited tolerance zones, approximately 2,000 acres) to continue reduction of hazard fuels to reduce risks and threats to nearby communities.

Monitoring and Abating Wildlife and Plant Diseases

We derive guidance on wildlife and plant diseases from the Refuge Manual and directives from the Service Director or the Secretary of the Interior. The Refuge Manual (7 RM 17.3) lists three objectives for the prevention and control of disease:

- Manage wildlife populations and habitats to minimize the contraction and contagion of disease.
- Provide for the early detection and identification of disease mortality when it occurs.
- Minimize the losses of wildlife from outbreaks of disease.

Disease prevention is far more cost-effective and resource protective than disease control. However, when disease outbreaks do occur, aggressive and responsible control activities can save considerable numbers of wildlife (7 RM 17.5).

In 2006, the Service instructed all refuges to prepare an avian influenza (AI) surveillance and disease contingency plan specific to their sites following the criteria established by the national plan. The goal of the national interagency AI plan was to structure a unified national system for the early detection of Asian H5N1-HPAI in migratory birds. Data collected throughout the country were assimilated and used from a national database.

The refuge's approved AI plan (2006) describes local wild avian ecology and management practices and the known risk factors for H5N1-HPAI adjacent to Prime Hook NWR in Sussex County. The poultry industry in Delaware is the

most important agricultural business in the State. Delaware ranks tenth in the Nation in broiler production (approximately 243,000,000 birds). Statewide, the industry is represented by 900 chicken farms, with the largest portion located in Sussex County (Delmarva Poultry Industry 2008 Factsheet–*http://www.dpichicken.org/faq_facts/*; accessed February 2012).

AI sampling of migratory shorebird and waterfowl bird species found on and near the refuge has been ongoing since 2005 in several collaborative efforts with Maryland and Delaware State agencies, universities, and with USDA Wildlife Services. Specific AI disease surveillance and monitoring actions and outbreak responses (bio-containment, work practices, and sanitation protocols) are all described in the refuge's AI surveillance and disease contingency plan.

In Delaware, chronic wasting disease (CWD) is another prevalent wildlife disease of concern. CWD is a spongiform encephalopathy of deer and elk in North America. It is a rare, fatal, and transmissible disease of the central nervous system caused by abnormal prion proteins. CWD is spread by direct contact between infected animals and indirectly through contaminated environments.

The Service recognizes that CWD presents a threat to refuge deer populations and deer populations in the surrounding area. The refuge's approved Chronic Wasting Disease Surveillance and Contingency Plan (2008) provides a mechanism for early detection of CWD on the refuge through collaboration with the State of Delaware in detecting and controlling CWD by assisting DNREC with monitoring.

In addition to wildlife diseases, we will be attentive to diseases that affect forest health. Since we place high value on oak hardwood forests on the refuge, diseases pertaining to oaks are of special concern. Oak trees in the U.S. are affected by more than 80 documented insects and diseases, with escalating international trade likely to introduce new pests. Impacts of these pests range from minor defoliation to rapid mortality. In some years, pests cause the loss of a major portion of the acorn crop, impeding oak regeneration. A few pests have altered or may alter eastern U.S. oak forests on a broad scale. For example, the spread of the introduced gypsy moth, a defoliator, has been aided in the last few decades by the accidental transport of egg masses by humans.

General strategies for disease prevention and control include:

- Continue to conduct disease surveillance in conjunction with other field work.
- Cooperate with State agencies, particularly Delaware Division of Fish and Wildlife and the U.S. Forest Service, in conducting surveillance, providing access for sampling, and following protocols in the event of an outbreak.
- Inform volunteers and others who work in the field about the dangers of Lyme disease and measures to avoid contracting the disease.
- Monitor forests and other habitats for indicators of increased occurrence of pests or disease. For example, note changes in flowering or fruiting phenology, physical damage, decay, weakening, sudden death, particularly of canopy and source trees of major host species. Note changes in wildlife use of habitats such as the absence of breeding birds that used to be seen regularly.
- Use silvicultural practices such as thinning, prescribed burns, and stand improvements that may relieve stress.
- Follow protocols outlined in national, State, and refuge-specific disease prevention and control plans.

Controlling Nonnative and Other Pest Animals

Many exotic animals, and at times native animals, can interfere with management objectives. The Refuge Manual (7 RM 14.4A) defines an animal pest as "any terrestrial or aquatic animal which interferes, or threatens to interfere, at an unacceptable level, with the attainment of refuge objectives or which poses a threat to human health." In order to meet management objectives, pest animals will be controlled on the refuge to maintain acceptable population sizes. Acceptable population sizes vary with species and management situation. The impacts of specific pest animal species or groups are described further below.

In controlling animal pests, whether alien or native species, we use an integrated approach. Integrated pest management is defined as "a dynamic approach to pest management which utilizes a full knowledge of a pest problem through understanding of the ecology of the pest and ecologically related organisms and through continuous monitoring of their populations. Once an acceptable level of pest damage is determined, control programs are carefully designed using a combination of compatible techniques to limit damage to that level." We will use integrated pest management to control pests, which is a sustainable ecosystem-based decision-making process for managing invasive species, pests, and diseases through a combination of biological, physical, cultural, chemical, and other practices. The goal of integrated pest management is to remove or reduce only the target organism(s) with the least possible risk to other organisms. Pest animals that present problems to refuge management include overabundance of resident Canada geese; mute swans; nutria; beaver; muskrat; and furbearers, such as raccoons and foxes; and birds, such as gulls and crows, that can cause unacceptable levels of predation on migrating and breeding shorebirds.

We will use the following strategies in animal pest management:

- Determine the need for site-specific control based on the potential to negatively affect wildlife and habitat management objectives on the refuge.
- Employ integrated pest management techniques when a species is having a significant impact on an area resulting in major habitat replacement or damaging rare species.
- Monitor results to ensure that pests do not exceed acceptable levels.
- Use predator management as one of several actions to support State and federally endangered or threatened migrating birds and to increase the productivity of breeding federally listed and State-listed bird species.

Although we will employ an adaptive management approach to pest animal problems, we also expect that lethal control or removal of individual animals will be required. Unfortunately, establishing general thresholds for lethal action is difficult. Instead, a case-by-case analysis and specific site characteristics will be used to determine the best solutions as needed to fulfill habitat and wildlife management objectives. For example, an annual predator management program will be used to increase the productivity of State-listed endangered and threatened shorebird species and protect migrating shorebird species using refuge beach habitats. In the case of lethal control of resident Canada geese for habitat protection, the appropriate permits are acquired annually from the Service Migratory Bird Office.

Trapping or lethal control of mammals will be relied on as a management practice to control predators and manage pest animals that negatively impact refuge habitats or impoundment infrastructure (e.g., nutria or muskrat that burrow in refuge dikes). Trapping to control beaver, muskrats, or nutria can help to protect desirable vegetation, achieve desirable interspersion of wetland vegetation, and protect rarer species. Reasons for using trapping as a major tool for controlling animal pests on the refuge include protecting migratory birds and

threatened or endangered species, habitat or wildlife population management, and rare vegetation communities and associated invertebrate species. Trapping is also useful for surveys and monitoring of some species, facilities protection, research, feral animal control, disease control, and public health and safety.

Resident Non-Migratory Canada Geese
Herbivory by resident Canada geese during the growing season impacts wetland vegetation, rendering the resident individual of this species as a pest at that time of the year. Research at nearby refuges has shown a reduction in the amount of plant biomass that would be available to migrant birds at the end of the growing season (Laskowski et al. 2002). To address well-documented concerns regarding the impacts of resident Canada geese on habitats and public property, the Service-issued new regulations for control of non-migratory resident geese (71 FR 45964).

Mute Swan
Similarly, the nonnative mute swan's feeding behaviors pose a threat to the ecological integrity of wetland habitats. Introduced to North America in the 1800s, mute swans escaped captivity and established wild populations, which have grown exponentially in recent decades (Atlantic Flyway Council 2003). Mute swans can consume large quantities of submerged aquatic vegetation, damaging sensitive wetland areas, and reducing food availability for native bird and fish species. They can exhibit aggressive territorial behavior toward native bird species and humans. The Atlantic Flyway Council Mute Swan Management Plan (Atlantic Flyway Council 2003) recommends that the Service and other land managers actively control this species. The species was removed from Federal protection by the Migratory Bird Treaty Act Reform of 2004 and is excluded from State protection under State regulation, permitting their control as the refuge deems necessary. Any apparent invasion of mute swan on refuge lands or waters will warrant an immediate lethal removal program.

Nutria
Nutria are native to South America and were first introduced into the U.S. to California in 1899 and then to southern states in the early 20th century for fur farming and weed control. Nutria use marsh vegetation to create resting platforms and consume whole plants, including roots and tubers, creating holes in the marsh which eventually become open water when sediment erodes with tidal action (Harris and Webert 1962, Foote and Johnson 1993, Linscombe and Kinler 1997). Since their introduction, nutria have contributed to the destruction of more than 7,000 acres of marsh on Blackwater NWR (TCBNWG 2003). Fortunately, at this time, there have been limited sightings of nutria in the State of Delaware, though they have become a serious pest in the Maryland portions of the Chesapeake Bay, and may yet find easy access to Delaware through the Choptank and Nanticoke River drainages. The refuge will be monitored for nutria. Any apparent invasion of nutria into refuge marshes will warrant an immediate lethal removal program.

Beaver and Muskrat
Beaver and muskrat are native aquatic rodents and as such, are an important component of the refuge ecosystem. However, at times both species do pose a nuisance for human and refuge management infrastructure. When nuisance animals are impacting refuge management capabilities, they may be trapped and removed.

Red Fox, Raccoon, Gulls, and Crows
Red fox, raccoon, gulls, and crows have been documented as predators upon nesting birds, eggs, and chicks. Predation is a natural process and is not normally considered a management issue for the continued productivity and survival of species across a biologically diverse and healthy landscape. However, some habitats have been so fragmented and reduced by human impacts that

intervention is considered critical for the continued survival of some species. Some shorebirds, such as the federally threatened piping plover and colonial beach nesting bird populations, are especially vulnerable to loss of suitable nesting habitat due to high sensitivity to human disturbance.

Given the plight of migratory birds requiring beach or island nesting habitats, the refuge may utilize a predator management program for the benefit of these species. The program would entail lethal removal of animals that frequent specific tracts or habitats where birds would likely nest (i.e., problem predators). Refuge staff or contractual employees will conduct removal immediately prior to or during the nesting season.

Conducting Appropriateness and Compatibility Determinations

Chapter 1 describes appropriate refuge uses policy and specific requirements necessary to prepare written compatibility determinations. Appendix E includes the approved, refuge-specific findings of appropriateness and compatibility determinations.

Compatibility determination analyses must consider impacts of the use analyzed. The compatibility determination section titled Anticipated Impacts of the Use summarizes the short- and long-term and cumulative impacts of the use and how the use will affect:

- Refuge purposes and the Refuge System mission.
- Refuge goals, objectives and management strategies.
- Fish, wildlife, plants, and their habitats.
- BIDEH of the refuge and Refuge System.
- Other refuge uses.
- Public safety.

As previously noted, hunting, fishing, wildlife observation and photography, and environmental education and interpretation are priority wildlife-dependent uses of the Refuge System. The refuge manager has determined that all six priority public uses are compatible, although some have stipulations as detailed in each determination. As priority uses, they will receive preferential consideration in refuge planning and management before the refuge manager analyzes and considers other recreational opportunities for appropriateness and compatibility.

Activities Not Allowed

We have reviewed prior uses and evaluated recent requests for non-priority, non-wildlife-dependent activities. Activities evaluated by the refuge manager and determined not to be appropriate or compatible on refuge lands, include recycling trash using State-sponsored recycle containers located on the refuge, ice skating, camping, horseback riding, geocaching/metal detecting, off-road and mountain biking, off-road vehicles including ATVs, operation of model boats and airplanes, swimming and sunbathing, waterskiing, personal watercraft, 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. Of these uses, the only one with a documented appropriateness finding is “recycling trash using State-sponsored recycle containers on the refuge.” The recycler dumpsters were placed on the refuge to allow the general public, not just refuge users, to dispose of their recyclable materials. The increased traffic, unsightly dumpsters, and the trash around the area subsequently resulted in a finding of not appropriate by the refuge manager. In addition, two other recycling centers were within 5 miles of the refuge. From our review of the refuge files, the other uses listed here were never formally evaluated or conducted, and therefore, we have review them in accordance with all compliance procedures. Appendix E documents the refuge manager’s decision on their appropriateness. Most of these activities are provided elsewhere nearby, so the lack of access on the refuge does not eliminate the opportunity. According to Service policy 603 FW 1, if the refuge manager

determines a use is not appropriate, it can be denied without determining compatibility.

Specialized Uses
These uses require specific authorization from the Refuge System, often in the form of a special use permit. We make appropriateness findings for specialized uses on a case-by-case basis. Before we consider a specialized use, we must make an appropriateness finding as defined in section 1.11A(3) of the appropriate refuge use policy. For example, in addition to the six priority recreational and educational uses, we have determined that several other activities are appropriate and compatible under certain conditions. These include research, allowing the State to collect rare plant species seeds to benefit the Delaware Division of Fish and Wildlife's Landowner Incentive Program, mosquito population monitoring and limited use of chemicals to control mosquitoes, and operation of a Federal Aviation Administration tower. All of these activities require a special use permit and adherence to specific conditions to ensure the compatibility of these uses.

Facilitating and Conducting Research and Investigations
The Refuge Manual and the Service Manual both contain guidance on conducting and facilitating biological and ecological research and investigations on refuges. The Service published three objectives in the Refuge Manual 1982) for supporting research on units of the Refuge System (4 RM 6.2):

- To promote new information and improve the basis for, and 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 natural resources, appropriate resource management, and environmental health.
- To provide the opportunity for students and others to learn the principles of field research.

In 2006, the Service Manual provided further guidance on the appropriateness of conducting research on refuges in part 603, the appropriate refuge uses policy. It states that:

> *We actively encourage cooperative natural and cultural research activities that address our management needs. We also encourage research related to the management of priority 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.*

All research conducted on the refuge must be determined in writing to be both appropriate and compatible, unless we determine it to be an administrative activity. Research projects must contribute to a need identified by the refuge or the Service. In the past we have conducted many research projects on the refuge and expect additional research opportunities to arise in the future. Non-Service organizations and personnel conducting research on the refuge must provide the Service with a copy of all data collected and/or reports. The research organization/agency in conjunction with the Service will retain the use and ownership of all data and reports. In determining the appropriateness and compatibility of future research activities, we will follow Service policy guidance and employ the following objectives:

- Seek qualified researchers and funding to help answer refuge-specific management questions.

- Participate in appropriate multi-refuge studies conducted in partnership with USGS.
- Facilitate appropriate and compatible research by providing temporary housing and equipment, if available, for persons conducting fieldwork.
- Pursue peer-reviewed publications of research and ensure the Service is acknowledged as a contributor in research conducted on the refuge by others.

Commercial and Economic Uses
All commercial and economic uses will adhere to 50 CFR, Subpart A, §29.1 and Service policy which allow these activities if they are necessary to achieve the Refuge System mission, or refuge purposes and goals. Allowing these activities also requires the Service to determine appropriateness and prepare a compatibility determination and an annual special use permit outlining terms, conditions, fees, and any other stipulations to ensure compatibility. The following policies and regulations were consulted:

- Appropriate use policy
- Compatibility policy
- 5 RM 17 (Refuge Manual)
- 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 Refuge System mission.
- Proposed standardized fee schedule for special use permits—Memorandum 4/19/93 ARD Donald Young—finalized in 8/93

A fee will be required for appropriate and compatible commercial uses, except for fee exemptions specified in the Service Refuge Manual 5 RM 17.9C. Fees will be required for commercially guided canoeing, birding, or nature tours, and commercial photography. Examples include interpretive guided tours on refuge waterways and guided birding trips by non-profit organizations (e.g., Chambers of Commerce). Fees will be waived for guided tours (with or without fees) that are sanctioned as continuing education from a recognized organization, and public use of the auditorium for wildlife-dependent oriented organizations. Examples include bus tours, classes from Sussex Academy of Lifelong Learning, Elder Hostel, etc. A fee may be required if the cost to the Service in preparation for the activity is unreasonable. See the compatibility determination for additional detail.

For commercially guided recreational uses, a non-refundable administrative fee of $100 will be charged, 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 at approximately $40. The

staff is required to determine fair market value and cost recovery or to conduct competitive bids. In determining the fee, the staff could easily exceed the $100 administration fee. In addition to the administration fee, the permit fee will be 5 percent of gross revenues or $50, whichever is greater. Guides will be required to meet certain conditions before they are permitted to guide on the refuge. These conditions include certifications in an organization such as the American Canoeing Association, first aid/CPR, State or Federal licenses, and interpretive guide certification. Liability insurance will also be required for all commercial operations.

Providing Opportunities for Wildlife-dependent Recreation

The Refuge System Improvement Act of 1997 designated six priority public uses that are to receive enhanced consideration on national wildlife refuges: hunting, fishing, wildlife observation, photography, environmental education, and interpretation. We will strive to meet the criteria for a quality wildlife-dependent recreational program on the refuge as specified in the Service Manual (605 FW 1) and as stated in chapter 1.

The term "quality" is often used when discussing the various wildlife-dependent recreational opportunities on the refuge. This is a subjective term since there is a substantial diversity in what people are seeking in outdoor recreation. A quality experience to one visitor may be completely different to another. However, the term "quality" is emphasized in Chapter 605 FW 1, General Guidelines for Wildlife-dependent Recreation by stating that, "The overarching goal of our wildlife-dependent recreation policy is to enhance wildlife-dependent recreation opportunities and access to quality visitor experiences on refuges while managing refuges to conserve fish, wildlife, plants, and their habitats." Throughout the CCP, the Service uses the term "quality" to emphasize enhanced opportunities or access, realizing that each visitor will enjoy them in their own unique way.

The refuge provides opportunities for all six priority recreational uses. We believe we are offering quality programs that meet public demand and our wildlife population and habitat goals. In chapter 3, we described in detail the facilities and programs we offer to support these uses. 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.

A detailed visitor and community survey and final refuge report conducted by USGS in 2007 indicated that hunting, photography, and wildlife observation were highly desired in the area. Although all the priority public uses are important and the refuge offers them to some degree, hunting, wildlife observation, and photography will receive the greatest emphasis in prioritizing refuge resources for visitor services. Our Regional Visitor Services Program Team identified hunting as an "area of emphasis" for this refuge, followed by wildlife observation and photography as a tool to assist refuge managers and staff in a declining budget environment and to direct attention to what refuges do best. In 2006, each refuge in the region was assigned a first and second priority area of emphasis based on many criteria such as refuge purposes, local interest in the recreational activity, opportunities for unique experiences, and opportunities to attract national/international exposure. One of the uses of these areas of emphasis is to support CCP teams as long-range goals, objectives, and alternatives are developed.

Below we provide a summary of the public use strategies. In addition to published 50CFR regulations and State regulations, refuge-specific regulations also apply and are highlighted below in the following strategies.

Strategies Common to All Public Use Programs

- Evaluate newly acquired refuge lands for potential quality wildlife-dependent recreational opportunities, if deemed compatible.

- Provide effective outreach and communication for and about the refuge's existing public use programs.
  - Coordinate with State and other partners to develop or participate in host programs that encourage new user groups, e.g., Becoming an Outdoors Woman, youth hunts, youth fishing event with Lower Sussex Bassmasters in Milton to celebrate National Fishing Week.
  - Monitor and evaluate the public use programs through staff observation and visitor contact.
  - Continue yearly review of refuge public use regulations with staff and State partners to ensure clarity and address any emerging issues or concerns.
  - Continue to work toward developing one brochure for hunting regulations and one brochure for all other public use regulations to inform the public of public use opportunities and refuge-specific regulations.
  - Ensure public notification of public use program changes through news releases and other means.
- Provide adequate law enforcement to enforce regulations, and continue to collaborate with enforcement officers from the Delaware Division of Fish and Wildlife.
- Maintain existing infrastructure, including accessible facilities, to support wildlife-dependent recreation. These include hiking and canoeing trails, roadside pull-offs, observation platform, photography blind, wheelchair-accessible fishing pier, visitor contact station, parking areas, boat ramps, boardwalks, kiosks, roads, and benches.
- Provide access to launch boats, canoes, and kayaks at the headquarters boat ramp, Turkle Pond, Fleetwood Pond, and Slaughter Canal at Fowler Beach Road. Additional access provided at the Prime Hook Wildlife Area and Brumbley's Family Campground near Waples Mill Pond (the ramp at this location is on Service lands; however, access and parking are through the campground).
- Evaluate the future management of the Prime Hook Wildlife Area with the Delaware Division of Fish and Wildlife. Refuge staff have issued waterfowl hunting permits for the Prime Hook Wildlife Area, which is managed by the Delaware Division of Fish and Wildlife, through the refuge's permitting system. State and Federal personnel maintain the facilities (duck blind construction and grassing) yearly. A portion of Prime Hook Creek borders both the refuge and Prime Hook Wildlife Area, which is used by anglers, wildlife observers, hunters, and photographers. No formal agreement exists. An evaluation of the cooperative management of the State area should occur and, if necessary, a formal agreement should be developed.
- Days open or closed to either consumptive and nonconsumptive users are subject to change by the refuge manager for management reasons, changes in hunting seasons, or for unexpected circumstances.
- General regulations common to all public use programs:
  - Except for hunting, the refuge is open from one-half hour before sunrise to one-half hour after sunset except all boats must be off the water at sunset.
  - Areas may be closed on the refuge without prior warning.

- Boat motor restrictions
  - The maximum permitted motor on Prime Hook Creek and Slaughter Canal is 30 horsepower.
  - Air thrust boats and jet skis are not permitted.
  - A slow no wake zone of one-half mile has been established on the Headquarters Ditch.

- Except for hunting, only electric motors or manual propulsion is allowed on Turkle and Fleetwood Ponds.
  - All boaters are required to operate their craft and possess all safety equipment in accordance with Delaware State and U.S. Coast Guard regulations.
  - 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.

- Beach access 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.
  - Overnight camping and open fires are prohibited.
  - Dog walking is not permitted on the refuge.

Protecting Cultural Resources

As outlined in chapter 3 under "Prehistoric and Historic Cultural and Environmental Setting and Human Land Use History," the Service has a regular process for ensuring protection of archaeological sites and historic structures from activities. The process includes review of projects by professional archaeologists in the Regional Office and consultation with the Delaware Department of Historical and Cultural Affairs (the Delaware State Historic Preservation Office, SHPO). Project leaders submit descriptions of their proposed projects, maps, and plans to the Regional Historic Preservation Officer (RHPO), who determines what is needed to identify archaeological sites in the project area and helps the refuge avoid sites when called for. Rarely, the Service will mitigate an unavoidable impact to a site, in consultation with the SHPO and interested parties. Any future ground disturbing activities would go through this process. Activities such as shoreline modification, commercial logging, and salt marsh restoration will require RHPO review and SHPO consultation under this process.

In addition, the Service protects sites from unauthorized excavation through the application of the Archaeological Resources Protection Act (ARPA). The Regional Director issues permits for any non-Service excavations on Service land. Unpermitted excavation would be the subject of law enforcement investigation by a team including an archaeologist. If possible, a case would be prosecuted.

From time to time, human remains are inadvertently discovered. This has never happened at Prime Hook, but increased erosion can be expected to reveal remains of European settlers as well as Native Americans in the future. The Service applies the Native American Graves Protection and Repatriation Act

if Native American remains are recovered. When it is possible to associate the remains with a Federally recognized tribe, they are repatriated to the tribe.

In order to strategically address the loss of archaeological sites and potential exposure of human remains at Prime Hook to erosion by sea level rise, the Service, in consultation with the SHPO, will prepare a cultural resource management plan for the refuge within five years, subject to the availability of funds. The plan will be consistent with resource management objectives in this CCP. The management plan will identify problems with specific sites, and specific protective measures such as survey, evaluation, excavation, stabilization, monitoring or other appropriate strategies that can alleviate or minimize impacts depending on the values of specific archaeological sites. The management plan will use existing sea level change information to schedule these management strategies for each site or area in a timely fashion. The plan will include a budget and provisions for evaluating the success of strategies implemented.

Conducting a Refuge Wilderness Review

The Service revised its Wilderness Stewardship Policy in November of 2008, to improve the Refuge System's management of lands considered for designation as wilderness under the Wilderness Act of 1964. The revision provides refuge managers with the first-ever guidance on wilderness review of Refuge System lands and whether areas should be recommended to Congress for wilderness designation.

The updated policy ensures consistency with several new refuge management policies established in recent years including Refuge System mission, goals and refuge purposes, appropriate use and wildlife-dependent recreation, and the Wilderness Act and Refuge Improvement Act. It also reflects other developments in the policy and science of managing the Refuge System and wilderness.

The Service priorities in implementing the wilderness policy consider the following order when conducting wilderness reviews on refuge lands: the Refuge Administration and Improvement Act, the Endangered Species Act, and the Wilderness Act. We first determine what needs to be accomplished to meet refuge purposes, ensure these activities comply with the Endangered Species Act, and ensure these activities comply with the Wilderness Act (610 FW 1.4).

Chapter 610 of the Service Manual addresses wilderness stewardship policy in the Refuge System, where wilderness is defined in 610 FW 1.7:

> *A wilderness, in contrast to those areas where man and his works dominate the landscape, is hereby recognized as an area where the earth and its community of life are untrammeled by man, where man himself is a visitor who does not remain. An area of wilderness is further defined to mean in this Act as an area of undeveloped Federal lands retaining its primeval character and influence, without permanent improvements or human habitation, which is protected and managed so as to preserve its natural conditions and which (1) generally appears to have been affected primarily by the forces of nature, with imprint of man substantially unnoticeable; (2) has outstanding opportunities for solitude or a primitive and unconfined type of recreation; (3) has at least five thousand acres of land or is sufficient in size as to make practicable its preservation and use in an unimpaired condition; and (4) may also contain ecological, geological, or other features of scientific, educational, scenic, or historical value.*

The Refuge System planning policy requires that we conduct a wilderness review during the CCP process. One of the eight goals stated in this policy is to ensure that we preserve the wilderness character of refuge lands (602 FW 1.5(H)). Part of the CCP planning policy is to help achieve the goals of the National Wilderness Preservation System and specifically address the potential for any new special

designations (602 FW 3.4). We do this by conducting a wilderness review and evaluating any new information about refuge lands that may warrant wilderness study (appendix F). Roadless islands of any size are also eligible for wilderness designation. The wilderness review in appendix F concluded that three small roadless islands located within Unit II fail to meet the criteria for wilderness designation due to the impacts of human manipulation of the surrounding marsh areas for mosquito control and the impoundments, the proximity of roads and aural impacts of vehicles and boats, and the non-natural fluctuation of water levels and reduced salinity when the barrier was intact thereby creating an artificial freshwater system. The impact of a century of human manipulation of the marsh system has meant that the larger area of the refuge has lost its "primeval character" despite recent natural events which are influencing the system.

Providing Refuge Staffing and Administration

Congress determines the annual budgets that our Washington headquarters and regional offices distribute to the field stations. The management activities described in this chapter pertain to staffing, administration, and operations that include the integration of Prime Hook NWR with Bombay Hook NWR into the Coastal Delaware NWR Complex.

Permanent Staffing and Operational Budgets

Our objective is to sustain levels of annual funding and staffing that allow us to achieve refuge purposes, as interpreted by the goals, objectives, and strategies in this CCP. We have achieved our most highly visible projects, like the construction of our headquarters office and visitor center, through special project funds that typically have one- to two-year duration. These funds are important but their flexibility is limited because they cannot be used for any needs that may arise. Funding for land acquisition derives from two sources: the Land and Water Conservation Fund and the Migratory Bird Conservation Fund. These funds are directed toward specific land acquisitions.

In response to declines in operational funding nationwide, Region 5 developed a *Strategic Workforce Plan for the National Wildlife Refuges in Region 5* (2006 to 2007) to support a base budget approach. Its goal is a maximum of 75 percent of a refuge station budget to cover salaries and fixed costs, while the remaining 25 percent or more will be for operating and maintenance funds. The strategy is to improve the capability of each refuge manager to do project work of the highest priority, and not have the refuge's budgets tied to inflexible fixed costs.

Appendix H lists our refuge operations needs system (RONS) and service asset maintenance management system (SAMMS) construction and maintenance projects currently listed in those databases. We also included new projects not yet in the databases, but proposed under this CCP. Once approved, if funding is not available, we will continue to seek alternate means of accomplishing our projects, for example, through our volunteer program, challenge cost share grants, or other partnership grants and internships. The SAMMS projects include a list of backlogged maintenance needs.

Under this CCP, and within the guidelines of the new base budget approach, we will seek to fill our currently approved but vacant positions, which we believe are needed to accomplish our highest priority projects. This CCP proposes additional staff to provide depth in our biological and visitor services programs. We identify our recommended priority order for new staffing in appendix H. We also seek an increase in our maintenance staff since they provide invaluable support to all program areas.

Facility and Fleet Management

This CCP includes the periodic maintenance and renovation of existing facilities to ensure the safety and accessibility for staff and visitors. Our current facilities are described in chapter 3. They include administrative facilities such as the

refuge office, maintenance shop, pole buildings, office trailer, hunter check-in station, biological lab, and several small storage sheds. Visitor facilities to be maintained include visitor contact station (includes auditorium and store), volunteer/Friends Group office, hiking trails, canoe trail, roadside pull-offs along Broadkill Beach and Prime Hook Beach Roads, observation platforms, photography blind, kiosks, boat launch ramps, and numerous interpretive signs. Any new facilities recommended in thid CCP, once constructed, will be placed on the maintenance schedule. All facilities and equipment maintenance and upgrades will incorporate ecologically beneficial technologies, tools, materials, and practices.

Refuge Operating Hours
We will open the refuge for public use from one-half hour before sunrise to one-half hour after sunset, 7 days a week, to insure visitor safety and protect refuge resources. However, the refuge manager does have the authority to issue a special use permit to allow others access outside these timeframes. For example, research personnel or hunters may be permitted access at different times, or organized groups may be permitted to conduct nocturnal activities, such as wildlife observation and educational and interpretive programs. Designated areas may be closed for public safety or to avoid conflicts with other user groups, such as the closure of the headquarters area for deer hunts.

Distributing Refuge Revenue Sharing Payments

As we describe in chapter 3, we pay annual refuge revenue sharing payments to Sussex County based on the acreage and appraised value of refuge lands in our jurisdiction. These annual payments are calculated by formula determined by, and with funds appropriated by, Congress. We will continue those payments in accordance with the law, commensurate with changes in the appraised market value of refuge lands, or new appropriation levels dictated by Congress.

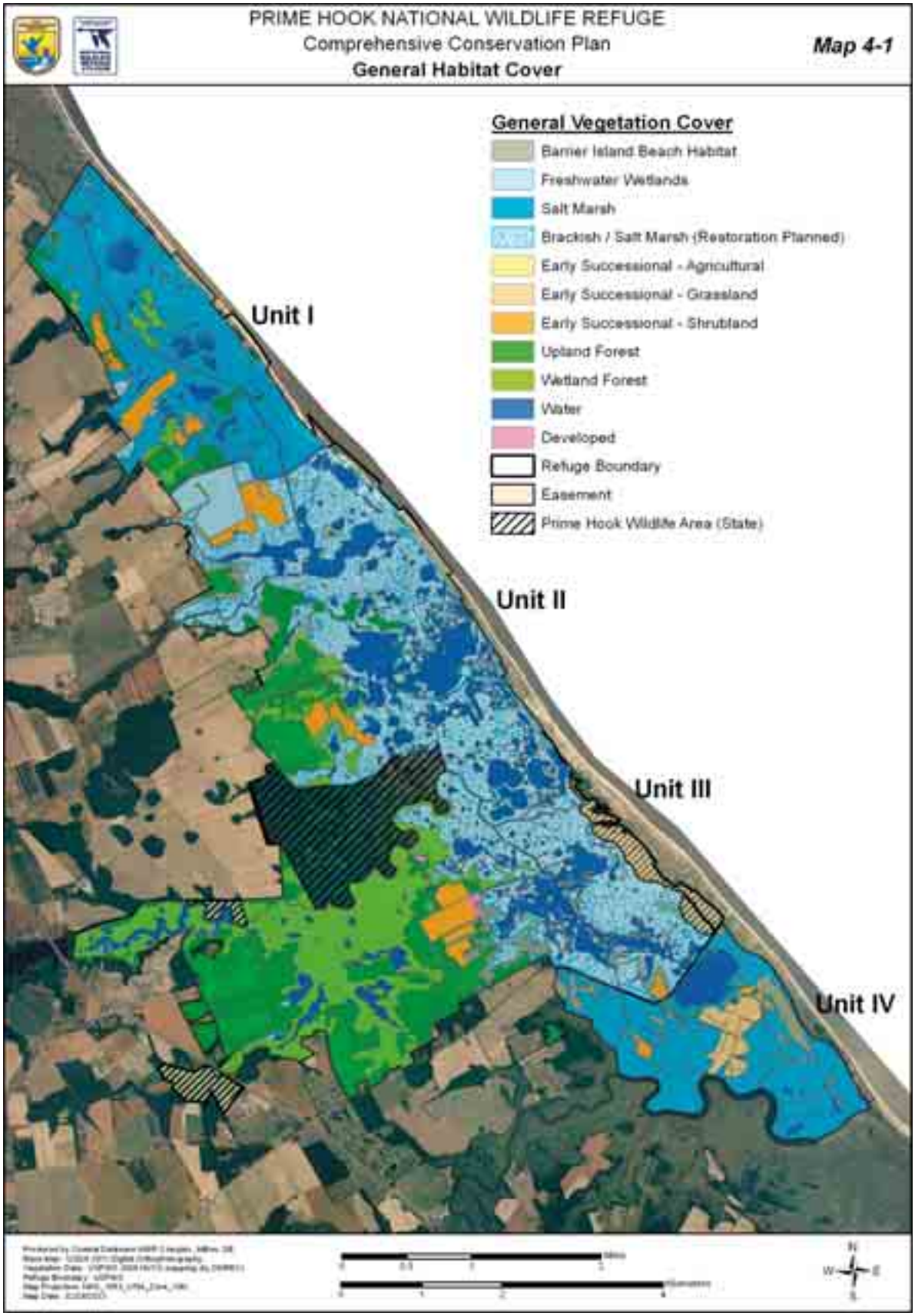
Management Goals, Objectives, and Strategies

The management direction presented here, in our professional judgement, will best achieve the refuge's purposes, vision, and goals, and the Refuge System mission and goals, as described in chapter 1. It includes the actions that best respond to public issues and opportunities identified during the planning process and public scoping meetings, and the actions that will contribute to conserving Federal trust resources of concern on the Delmarva Peninsula and in the Northeast region. Unless otherwise noted, all actions will be implemented by refuge staff.

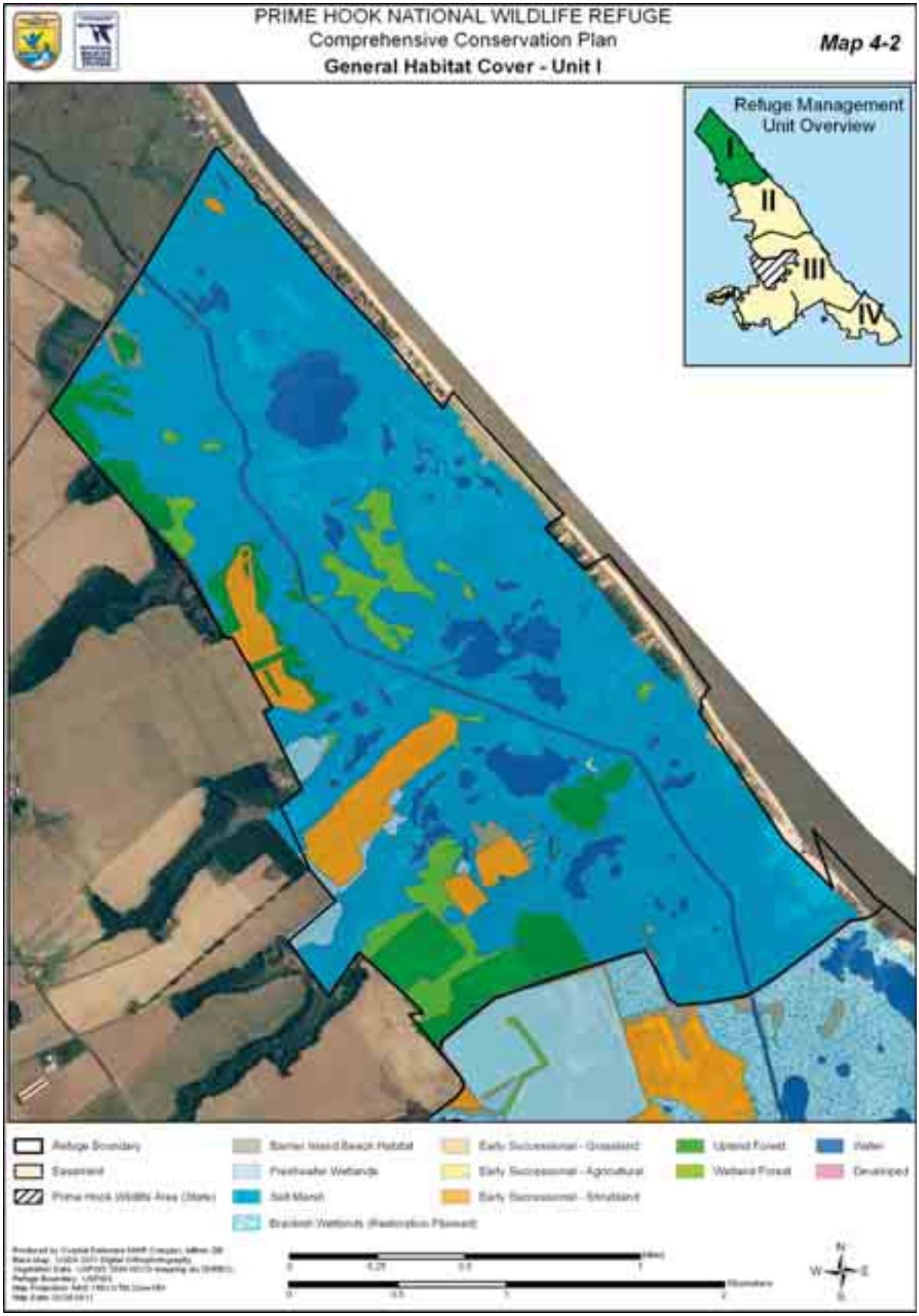
The biological and habitat goals, objectives, and management strategies are based on the following underlying hypotheses and assumptions that were used to decide the future management direction for the refuge, including the desired habitat conditions depicted in map 4-1 to map 4-5:

- Focal species management would be the best approach to conserve continental migratory bird populations, while maintaining, enhancing, and restoring BIDEH of refuge lands.
- Managing upland habitats and improving refuge forest management are the best approaches to optimize Delmarva fox squirrel and forest interior bird conservation.
- Increasing avian diversity and abundance on refuge habitats is best accomplished by conserving, protecting and restoring native plant community cover types.
- Selecting certain focal bird, fish, and insect species as indicator and umbrella species and yardsticks to gauge ecosystem function, BIDEH, and improves environmental health monitoring.

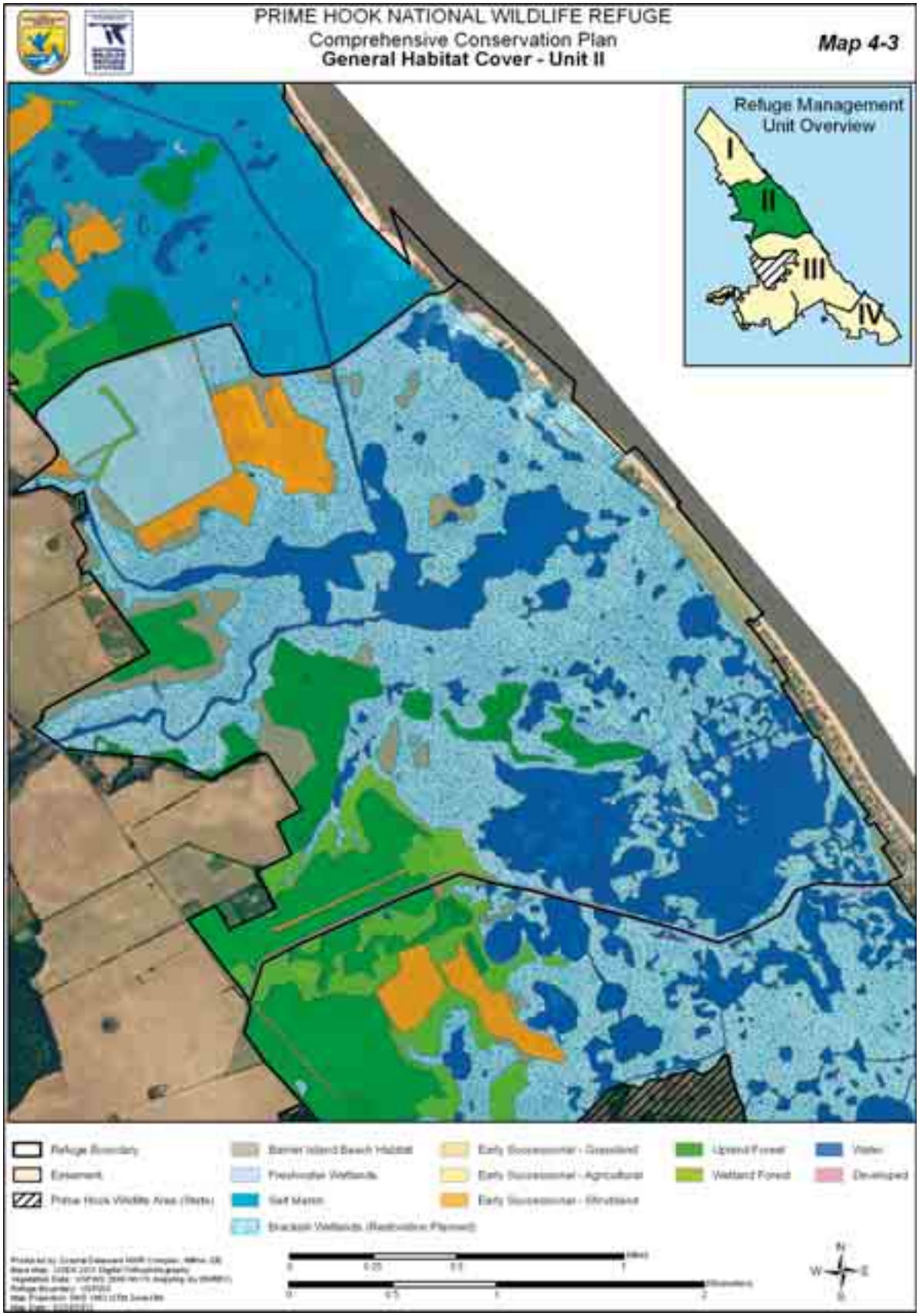
Map 4-1. General Habitat Cover



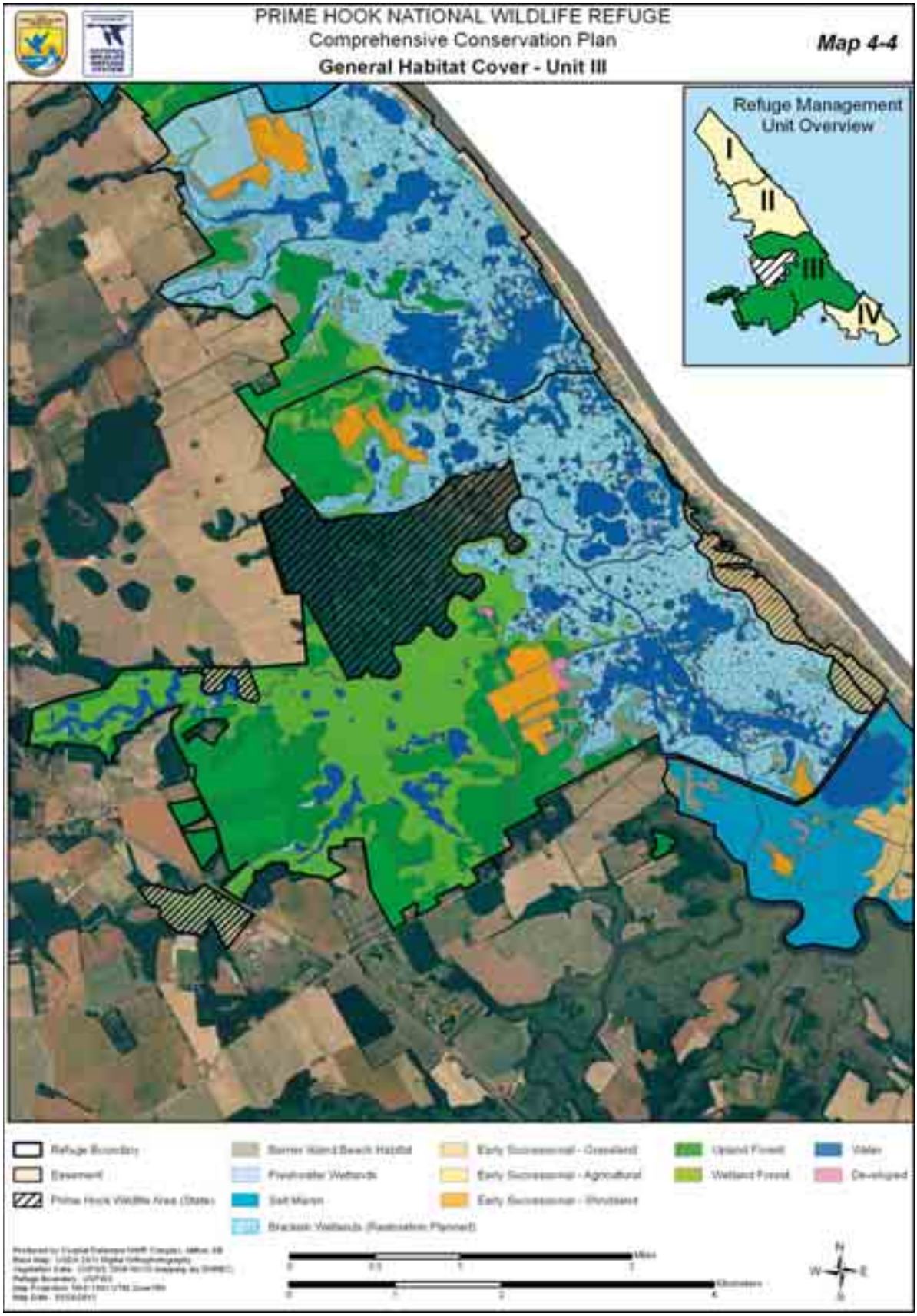
Map 4-2. General Habitat Cover in Unit I



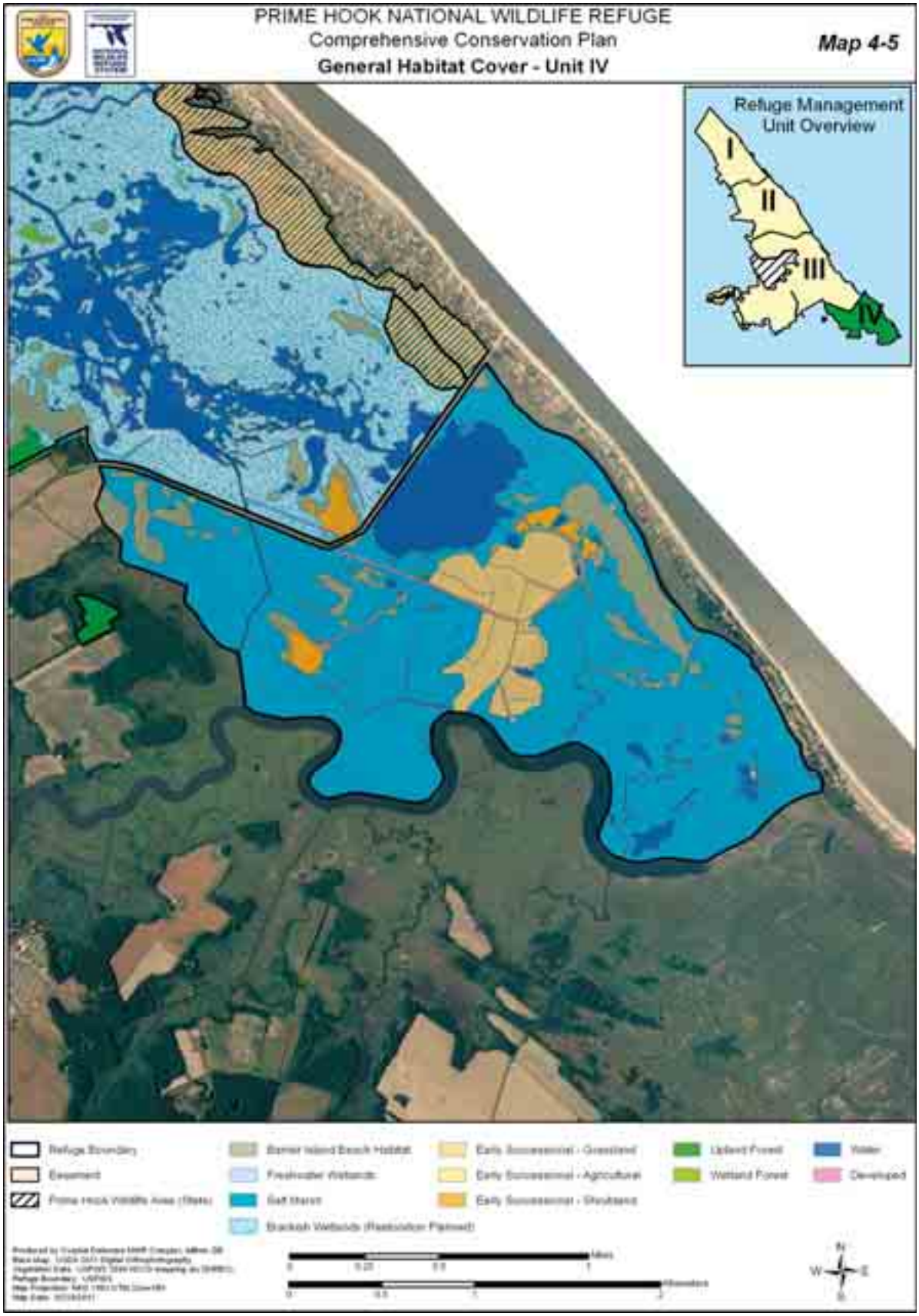
Map 4-3. General Habitat Cover in Unit II



Map 4-4. General Habitat Cover in Unit III



Map 4-5. General Habitat Cover in Unit IV



- Modify mosquito and integrated pest management strategies to advance pollinator conservation and protection and reduce negative non-target impacts on refuge invertebrate resources.

- Restoring healthy salt marsh systems in Units II and III, as well as degraded areas of Units I and IV, along with conserving appropriate vegetation communities in brackish and freshwater areas closer to streams and freshwater sources, will foster sustainable coastal habitats and contribute to biological integrity.

The management direction incorporates the principles of SHC and focal species management, as both reflect the most recent advances in the fields of conservation science and delivery of conservation actions on the ground by the Service. The refuge will implement manipulative management tools and interventions that mimic natural processes to enhance habitat restoration where deemed most appropriate. At the same time, the refuge will strategically reduce the use of management actions that are contrary to the directions of the BIDEH policy, such as artificial maintenance of extensive freshwater wetlands that are vulnerable to sea level rise, but can pursue careful sediment placement or marsh restoration to enable sediment-deficient salt marshes to subsist in light of sea level rise. We will use a combination of passive and active management approaches to foster or achieve more ecologically sustainable habitats than those that occur on the refuge at present.

The Service is aware that physical forces in the changing climatic environment, and the biological responses that they generate, are rapidly altering our ability to follow management prescriptions designed just a few years ago. Accelerating climate change and its coastal manifestations—sea level rise, increased coastal storm activity and force, changes in plant and animal population distributions associated with changing temperature regimes—will necessitate revising management strategies for the long term, particularly where management of coastal wetlands and impoundments is concerned. This plan outlines a proactive habitat management approach in response to these changing conditions.

Most notably, for salt marsh enhancement where intrusion of tidal waters and the collapse of the peat substrate has occurred, we will pursue strategies to compensate for lost marsh platform elevation, in order to support the growth of salt marsh vegetation. This may include the addition of dredged sediment through a carefully planned restoration project, and/or smaller actions to encourage natural accretion of sediment. Additional sediments may also be needed to enhance overwash flats and to potentially create low dunes or islets within the marsh. However, the purpose of these actions is not to rebuild a barrier island in the same alignment as the former barrier island but to allow for a diverse array of maritime habitats which would naturally occur in a Mid-Atlantic bay, marsh, and beach/spit system. In upland habitats, there will be an emphasis on restoring native forest cover in previously farmed or otherwise open fields.

The habitat condition objectives and general management strategies include the following:

- Managing for natural range of conditions in upland habitats (native forest, early successional grassland, and shrubland habitats) to restore lost elements of BIDEH for priority resources of concern.

- Managing the refuge's wetland marsh systems consistently with BIDEH, and considering their sustainability in light of sea level rise and climate change.

- Developing wetland restoration efforts to restore salt marsh communities in portions of the refuge's impounded wetland complex to promote adaptation in the face of sea level rise.

- Restoring mature upland forested habitats, through planting and active forest management, to manage for priority resources of concern—such as the federally endangered Delmarva fox squirrel and forest interior-dwelling birds—and improving the environmental health of connecting waterways and wetland habitats.

- Increasing the diversity and abundance of targeted focal bird species.

- Increasing and enhancing native plant resources that conserve invertebrate resources and pollinators that support avian conservation objectives.

- Reducing chemical use associated with nontarget negative effects on invertebrates and pollinators.

- Using certain bird, fish, and insect species as umbrella or indicator species.

For public use, we will expand existing opportunities for all six priority public uses, with additional emphasis on hunting and wildlife observation and photography. Map 4-6 depicts the proposed public use.

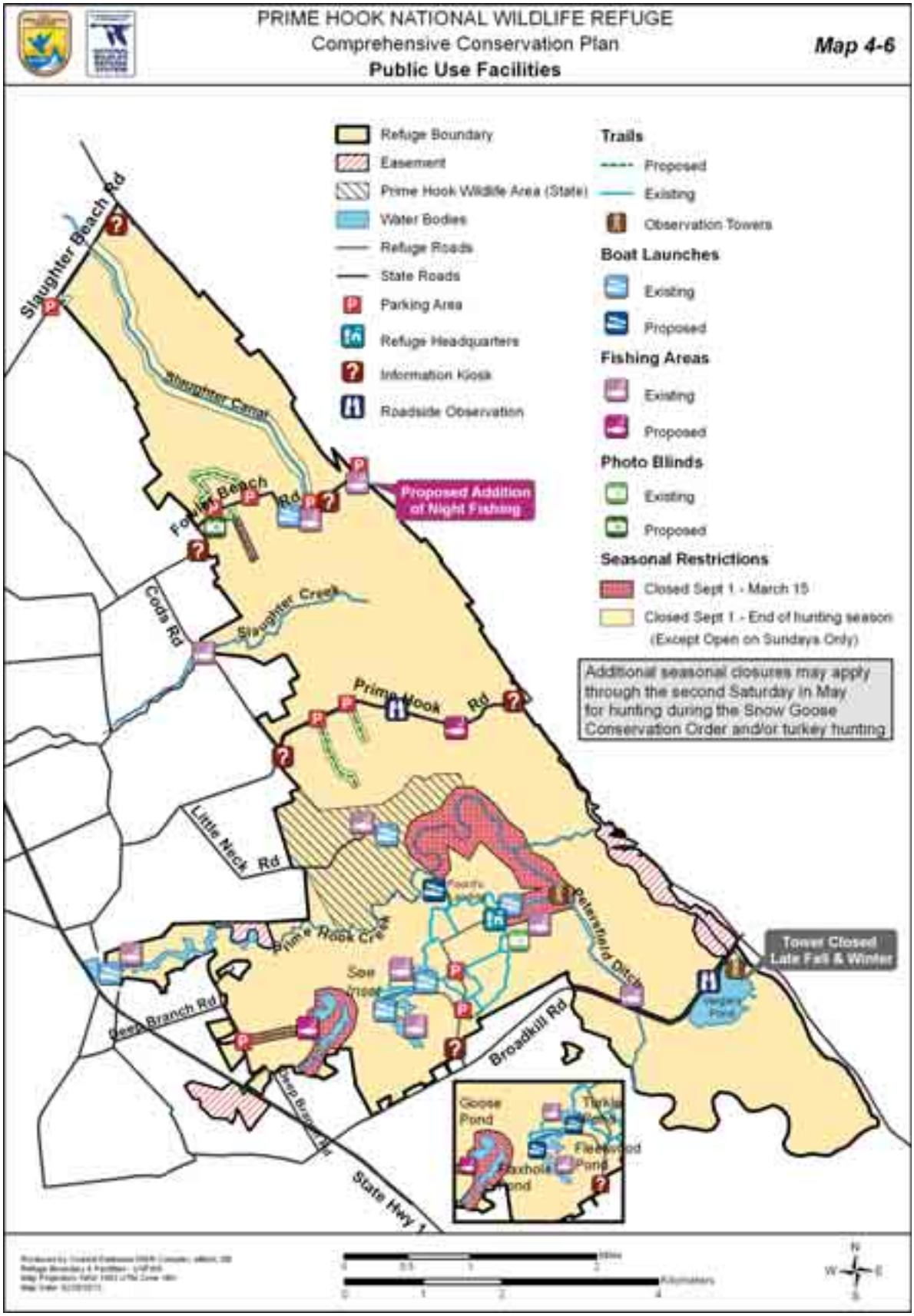
We will modify the hunting program for greater administrative efficiency and open additional areas of the refuge for the hunting program, with careful consideration of public safety and balancing this expanded use with other options for non-consumptive wildlife-dependent public uses.

We will expand some aspects of the hunting program to include additional days and acres throughout the hunting seasons established by the State. Deer hunting acreage will increase from 4,020 to 5,221 acres, waterfowl hunting from 1,722 to 3,432 acres (which meets the 40 percent "inviolate sanctuary" rule of the total 10,144 acres in the refuge), upland game and migratory bird (excluding waterfowl) hunting will remain at 1,995 acres, and turkey hunting will be added, from 0 to 3,729 acres.

In an effort to improve the hunting experience through advanced scouting and allowing hunters to choose their preferred location, permanent deer stands (78 total) and duck blinds (25 total) will be phased out over a 5-year period. Providing elevated deer stands, and to a lesser degree waterfowl blinds, is part of the burdensome and inefficient existing hunting program which is inconsistent with the hunting programs for most of the national wildlife refuge system outside of Delaware. There are many areas on the Delmarva Peninsula, other than Prime Hook NWR, that offer public hunting opportunities in free-roam areas where the hunter can use their own blind or stand, if desired. For hunters who may be unable to climb trees using portable deer stands or who may wish to hunt from permanent deer stands or duck blinds, the State-owned Prime Hook Wildlife Area, adjacent to the refuge, will continue to provide these opportunities.

Hunting will not occur in areas or times currently allowed to other non-consumptive users. Many of the proposed "new" hunting areas are currently open to some type of hunting or have been previously open either under refuge management or private ownership. Our mandate is to provide high-quality opportunities for priority uses when they are compatible with refuge purposes, goals, and other management priorities. The Refuge Improvement Act does not establish a hierarchy among the six priority uses, but requires the Service to

Map 4-6. Public Use Facilities



facilitate them when they are compatible and appropriate. In fact, we maintain or enhance opportunities for all six priority public uses. In other words, expansion of hunting opportunities at the refuge will not come at the expense of other priority public uses.

Opportunities for hunting and fishing will also be enhanced. These enhancements consist of expanding fishing and hunting areas, increasing the number of hunt days, reducing the administrative burden of the hunts, eliminating permit hunting fees except for lottery hunts, providing better outreach and information materials, phasing out the permanent hunting structures, and providing opportunities for preseason lottery hunts for waterfowl and deer. We will expand new areas and provide new opportunities for wildlife viewing, photography, and interpretation primarily by opening existing roads and trails and providing new infrastructure. In addition, a photography blind overlooking a restored wetland site is proposed. Furthermore, new visitor infrastructure, including additional building space for environmental education programs, an interpretive auto tour route using advanced technology, and additional guided field trips will be developed.

We will also enhance local community outreach and partnerships, continue to support a Friends Group, and continue to provide valuable volunteer experiences. As described under goal 6, we will pursue establishing demonstration areas on the refuge to promote research, and developing applied management practices to benefit the species and habitats identified in this chapter.

We propose to achieve a staffing level that meets minimum requirements for a refuge of this size and stature, potentially adding five new positions (clerk, biological technician, maintenance worker, law enforcement officer, and public use specialist). Any staffing increases will be based on available permanent funding sources, and will be considered in the context of regional and refuge priorities.

We will seek to expand the current office building to accommodate additional visitors for environmental education and interpretive programs. This office expansion will also provide needed space for storage of visitor services, supplies, and biological equipment. We will continue the use of travel trailers, which are used for interns, researchers, volunteers, and temporary employees.

Below we describe in detail the goals, objectives, and associated rationales and strategies that we will use to implement the habitat management and public use objectives. We have provided additional discussion and strategies specifically regarding our response to climate change and sea level rise.

GOAL 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.

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

Permit the natural evolution and functioning of sandy beach, overwash, dune grassland, and mudflat habitats along approximately 1.5 miles of refuge coastline in Unit I to conserve spawning horseshoe crabs and listed BCR 30 migratory bird species. Over time, permit the development of these features and communities along an additional approximately 1.5 miles of the shore of Unit II, as salt marsh restoration is pursued. 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, or least and common terns 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:

- 1.5 piping plover chicks per nesting pair, on average, over a 5-year period
- 0.35 American oystercatcher chicks per nesting pair
- 1 least or 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 2003d). 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 DNREC (2005b).

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 saltwater flows and eolian actions that contribute to active sand deposition or erosion. Natural ecological processes responsible for shifting mosaics of sandy beach, mudflats, and inland salt marsh habitat migrations have been impeded or altered by human activities within the Delaware landscape.

Storm-maintained ecosystems are critical during breeding and migration periods for the highest priority shorebird species identified in BCR 30 and birds of conservation concern (USFWS 2008a), 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 all depend 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 Delaware wildlife action plan 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 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. 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 bayshore areas. The highest quality dunes remaining along the Delaware Bay shore occur from Big Stone Beach (about 7 miles north of the refuge) south to Beach Plum Island (about 1 mile south of the refuge) (Clancy et al. 1997) and have been identified as a key wildlife habitat of special conservation concern in the State plan and the BCR 30 plan. Beach strand habitats along the bay 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, assorted mollusk shells, whelk casings, 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 year-round and for nesting birds in the spring and summer.

Strategies

- Allow the natural processes of inlet formation, sand migration, and overwash development.
- Avoid artificial dune stabilization where tidal flow from Delaware Bay is naturally restoring Unit I salt marsh habitats or transitioning refuge impoundments into a salt marsh.
- Develop site-specific restoration recommendations for Unit II, with the continued input of a diverse group of wetland management and restoration experts, State and Federal officials, academic scientists, and community representatives for short-term and long-term shoreline management to maximize the success of salt marsh restoration efforts.
- Control invasive plant species (mostly *Phragmites australis* and *Salsola kali*).
- Seasonally protect beach berm, wrackline and associated dune edge, and overwash from human disturbance to protect listed and candidate breeding and migrating shorebirds, establishing and enforcing nesting area closures from March 1st to September 1st.
- Use high-visibility law enforcement patrols to implement beach closures.
- Develop a refuge-specific piping plover contingency management plan should piping plovers establish nesting sites on refuge overwash areas.

- 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.

- Fence and post areas annually to protect breeding and migrating shorebird species at critical times from human disturbance. In years when piping plovers, American oystercatchers, or least and common terns nest, maintain suitable nesting habitat through beach closures, predator management, and public education.

- Eliminate dog use of refuge beach strand habitats to protect nesting and migrating shorebirds during the same time frame.

- Assess red fox, raccoon, feral cat, and other predator problems along refuge beach strand habitats and implement predator control in collaboration with USDA Wildlife Services. Work with State and Federal endangered species specialists to determine the number of American oystercatcher, least and common terns, and piping plover that can be supported by these refuge habitats.

Monitoring Elements

Develop a comprehensive monitoring and survey programs to measure our success with respect to our objectives. The results may trigger adjustments to management strategies, or a reevaluation or refinement of our objectives. Details of planned monitoring will be developed in a subsequent inventory and monitoring plan. Examples of monitoring or surveys that we may implement include:

- Determine the 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 to detect newly established invasive species and immediately address those populations through the appropriate control measure. This approach will incorporate a combination of plant identification and inventories, maintain updates of new invasive species present in the region, and provide knowledge of the appropriate management techniques prior to conducting control efforts.

- Establish annual habitat assessment protocols of overwash areas and mini-inlet openings and closures along Unit I and Unit II beach strand habitats to monitor expansion and contraction of overwash acreages, creation and plugging of mini-inlets, and tidal flow changes feeding Unit I salt marshes using GPS/GIS tools.

- Use presence or absence of the beach dune tiger beetle as an indicator species of healthy overwash, dune grassland, and sandy beach habitats.

- Conduct shoreline position and topography monitoring along the full length of refuge coastline, consistent with National Park Service protocols and in coordination with other Northeast Region refuges.

- Conduct surveys to determine presence or absence of northeastern beach tiger beetles to assess the health of overwash, dune grassland, and sandy beach habitat.

- Develop and implement weekly bird monitoring protocols. Utilize data to document the ongoing effectiveness of water level management activities and adjust management protocols as necessary.

- Continue monitoring of rare flora and fauna and work on establishing BIDEH metrics to evaluate annual habitat condition of barrier beach island habitats on refuge and State lands.
- Monitor habitat impacts from public use and impacts to resources of concern during the spring and summer periods.
- 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 Delaware's 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.
- 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 Rationale
The shoreline on the western side of the Delaware Bay, which includes coastal areas within the refuge boundary, is characterized as a lagoon-barrier-marsh shoreline (Kraft et al. 1976). 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 and John 1976b). This is caused by several geological processes:

- The continental shelf and coastal plain are known to be experiencing deep subsidence
- Global sea level rise
- Erosion and redistribution of sediments as shorelines shift in a landward and upward direction in response to the rise in relative sea level.

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 that allow 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 and John 1976a, Drew 1981, Riggs and Ames 2007, Defeo et al. 2009).

Even non-storm tidal surges can produce waves that overtop beach berms on the Delaware Bay shoreline, resulting in overwash fans on the marsh side of the shoreline. Through time, overwash events bury the marshes and associated peat deposits, fill in old inlet channels, or create new ones. 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 and John 1976a, Drew 1981, Defeo et al. 2009, Pilkey and Young 2009). Shoreline transgression enables wetlands behind shorelines to accrete sediments and keep up with sea level rise. Restored tidal flows also 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.

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. Shoreline position information has high data value because 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 yields a better understanding of local sediment budget cycles, trends, and storm episode influences (Psuty et al. 2010). Collecting a record of the changes in the shoreline position over time will monitor variations 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 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 the 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 that results in wave action and longshore drift systems helps 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 deeper than 5 feet and no more than several hundred feet wide), dominated by inlet and overwash processes (Kraft et al. 1976a).

Climate Change and Sea Level Rise Adaptation Strategies and Monitoring
Management to maintain beach habitats requires long-term mitigation and adaptation strategies. Adaptation will allow the beach to migrate inland as the sea rises. Adaptive measures accept the reality of sea level rise and coastline retreat and seek to increase coastal resilience, a concept with ecological, morphological, and socioeconomic components (Carpenter and Folke 2006). Measures to promote resilience include the protection, vegetation, and maintenance of sediment supply to beach habitats, and the provision of buffer zones that allow the landward migration of the coastline. Monitoring is an

important component of managing this dynamic system. Strategies include those listed above plus:

- Conduct shoreline surveys according to National Park Service protocols (Northeast Coastal and Barrier Network-Geomorphological Monitoring Protocol) for shoreline position (Natural Resource Report (NPS-NCBN-NRR-2010/185)). Protocols include a number of highly detailed standard operating procedures that are intended to ensure scientific consistency and repeatability. Minimally, conduct these surveys in early spring (mid-March to late April) and early fall (mid-September to late October), periods that coincide with the peak expression of seasonal beach variability.

- Coordinate refuge shoreline monitoring efforts with other coastal refuges to integrate the Northeast Coastal and Barrier Network database to foster Departmentwide sharing of standardized monitoring data. Implement the vital signs program's shoreline position monitoring protocol and shoreline topography monitoring protocol.

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 approximately 60 acres of Atlantic Coast interdune swale, more than 70 acres of maritime red cedar, and more than 180 acres of successional maritime forest communities for migrating passerines and other maritime shrub and forest-dependent species. This approach will allow us to maintain existing shrub and forest habitats or to plant the appropriate native species as invasives are removed or disturbed areas are restored to accelerate the pace of natural native species regeneration.

- 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—*Catocala muliercula*
  - Southern broken dash—*Wallengrenia otho*
  - Delaware skipper—*Anatrytone logan*
  - Little glassywing—*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 or shrub-dominated communities, to red cedar woodlands and maritime shrub-forested areas.

Prime Hook NWR's maritime red cedar community is recognized 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 the refuge's NVCS alliance and association descriptions (Prime Hook NWR 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 (McCann 1993, Clancy et al. 1997).

The McCann study demonstrated that often these habitats support more than twice as many migratory landbirds as 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 stopover place where migratory passerines congregate to forage in dense Mid-Atlantic shrub and maritime forested habitats that have significant populations of invertebrates and high 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 Prime Hook NWR and along the Delaware Bay also support the importance of maintaining and managing healthy maritime shrub and forested habitats. High densities of migratory songbirds during fall migration events along the Atlantic Coast and Delmarva Peninsula have been attributed to a higher proportion of hatching year birds and 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 (Mizrahi 2006, Dawson and Butler 2010).

Strategies

- Maintain or enhance native vegetation communities using prescribed fire where appropriate; consult with the Service's regional fire wildlife biologist to determine, if, when, and where prescribed fire would be appropriate to reduce invasive species, 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.

- In an effort to minimize non-target affects on-refuge, the Service will permit the use of adulticides as a management tool once the Delaware Mosquito Control Section's surveillance program has detected and documented a mosquito-borne human health threat on or near the refuge (e.g., within the flight range of vector mosquitoes, the average of which, according to the Rutgers Center for Vector Biology, is generally considered to be less than 5 miles for the eastern saltmarsh mosquito, *Ochlerotatus sollicitans)*.

Monitoring Elements

Conduct appropriate monitoring and survey programs as funding and staffing permit to measure our success with respect to our objectives. The results may trigger adjustments to management strategies, or reevaluations or refinement of our objectives. Details of planned monitoring will be developed in a subsequent inventory and monitoring plan. Examples of monitoring or surveys that we may implement include:

- Reevaluate existing refuge breeding bird survey points to determine whether they are placed appropriately to monitor birds of conservation concern identified in the Delaware wildlife action plan, 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.

- Evaluate the effectiveness of prescribed burning to reduce invasive species or maintain shrub habitats by conducting post-burn surveys to measure the area, intensity, and success of the burn.

Objective 1.3 North Atlantic Low and High Salt Marsh Habitats

By 2020, enhance the ecological integrity of 2,200 acres of existing salt marsh by 10 percent over baseline condition, as quantified by the regional salt marsh integrity index. Maintaining a mix of North Atlantic high and low salt marsh vegetation composed of less than 5 percent invasive plant cover and pool, panne, and irregularly flooded tidal salt shrub communities consistent with local reference sites will ensure that the quality and natural function of the marsh and tidal hydrology are restored and sustained. This will provide food resources and habitat for nesting species (e.g., seaside sparrow, salt marsh sharp-tailed sparrow, coastal plain swamp sparrow, Henslow's sparrow, sedge wren, black rail, clapper rail, least tern, gull-billed tern, black skimmer, willet, American black duck), migrating and wintering habitat for 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 percent 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 maritima, 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 1985). Protective legislation helped to slow 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 20 acres per year (Hadisky and Klemas 1983). Other states in the region experienced similar trends.

Habitat analysis mapping for Delaware shows less than 7 percent of herbaceous wetland habitats remain on the landscape (appendix A) while salt marsh communities are listed as habitats of conservation concern in the DNREC (2005b). 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, with 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 in the region, State, and 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.

Salt marshes provide neighboring communities with flood protection. The presence of salt marsh vegetation in coastal marshes can reduce shoreline erosion by completely dissipating wave energy within 100 feet of the shoreline, which in turn increases the potential for sediment deposition (Morgan et al. 2009, Knutson 1988, Broome et al. 1992).

The regional salt marsh integrity index is a measure of ecological integrity, which includes both physical and biological factors and provides a basis for comparing and monitoring the health of salt marsh units on individual refuges and regionwide.

Mosquito Management in Salt Marshes
The Delaware Mosquito Control Section (hereafter referred to as the 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. Prime Hook NWR is adjacent to residential beach communities where nuisance issues are amplified. Conflicts arise among 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. The refuge acknowledges a responsibility to permit management of mosquitoes when it is in the documented interest of public health to do so. 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. These mosquito management methods were described in detail in chapter 3, under the discussion of invertebrates. Control of mosquitoes on refuges will be guided by sound science. This includes the Interim Guidance for Mosquito Management on National Wildlife Refuges (USFWS 2005) and other appropriate Service policy and guidance.

Integrated Pest Management Approach
The Section currently uses thresholds to determine how, when, and where to conduct mosquito control treatments. These thresholds may require revision under the mosquito management plan to bring them in line with refuge management policies.

Pest management strategies for mosquito control will be implemented by using a tiered risk-assessment decision-making process that reduces the use of adulticides.We will not permit the use of adulticides solely for nuisance relief. Use of adulticides will be permitted in instances of a documented human health threat from mosquito-borne disease . The refuge acknowledges this public responsibility. We are also choosing to employ Bti products over methoprene products, when possible. By favoring the larvicide that would have the least adverse impacts on nontarget invertebrates, we will produce fewer disruptions to food webs critical for migratory birds.

Strategies

- Assist with the development and use of the region's salt marsh integrity index to develop a multi-metric method to score condition of the salt marsh community; use the index as a performance measure to improve annual habitat management planning and restoration actions when scores are low.

- Enhance or restore any degraded wetlands, including salt marsh and adjacent upland habitats that buffer all refuge salt marsh habitats.

- 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 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 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, such as the seaside sparrow, as indicators of BIDEH for salt marsh habitats.

- Within 1 to 2 years of CCP approval, develop monitoring protocols and an annual biological monitoring and inventory program to document annual salt marsh condition, prescriptive management actions taken, and response to management actions.

- Consider continuing or resuming snow goose hunting to alleviate some snow goose use in salt marsh areas, to reduce salt marsh.

Mosquito Control Strategies

- Modify mosquito integrated pest management strategies to conserve and protect non-target species by restricting the use of adulticides unless they are required during situations of a documented human health threat.

- Collaborate with State vector control personnel to develop specific action thresholds that will trigger chemical larvicide treatments; begin efficacy reporting of all treatment events to comply with Service end-of-the-year reporting requirements.

- Prepare a refuge mosquito management plan in collaboration with State mosquito control officials, to address human and wildlife health risks from mosquito-borne diseases and use action thresholds that trigger chemical interventions to be incorporated in a refuge decision making response matrix.

- Per mosquito management plan thresholds, permit limited use of larvicides in OMWM systems if appropriate data supports the assertion that the system has failed to function properly and is ineffective for controlling mosquitoes.

- OMWM excavation will be limited to the maintenance of currently existing 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 the effects on obligate salt marsh passerines may be required before any decision will be made to resume construction of new open marsh water management treatments in previously grid ditched marshes.

- Educate refuge users and other public audiences about avian diversity and how it may help buffer human populations from mosquito-borne and other diseases.

Monitoring Elements
As funding and staffing permits, conduct appropriate monitoring and survey programs to measure our success with respect to our objectives. The results may trigger adjustments to management strategies, or reevaluations or refinement of our objectives. Details of planned monitoring will be developed in a subsequent inventory and monitoring plan. Examples of monitoring or surveys that we may implement include:

- Establish ongoing salt marsh monitoring program utilizing the region's salt marsh integrity index.
- 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 measures. This strategy will incorporate a combination of plant identification and inventories, maintaining updates of new invasive species present in the region, and knowing the appropriate management techniques prior to conducting control efforts.
- 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.
- Continue research using OMWM, scoring data collected specific to refuge salt marsh habitat conditions, and incorporate in salt march integrity index assessments.
- Develop habitat monitoring protocols in cooperation with other refuges to quantify impacts (both positive and negative) of snow goose herbivory, increases or decreases of moist-soil invertebrate production, loss of low marsh acreage, and wintering carrying capacity of refuge habitats.
- 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.
- Monitor elements for mosquito control.

Climate Change and Sea Level Rise Adaptation Rationale
Delaware Bay wide average salt marsh accretion rates have been estimated to range from 3.0 to 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 sea level rise may ultimately exceed and overwhelm the rate of marsh accretion, resulting in stress and potential loss of existing marshes.

Delaware'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 to 100 years in impounded and natural wetlands, by analyzing the presence of radioisotopes (^{210}Pb and ^{137}Cs) 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 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 NWR.

The early results indicate that the refuge's unimpounded salt marsh in Unit I is keeping pace with sea level rise. Based on radiometric sediment core analysis, estimated annual accretion over the past 50 to 100 years ranged from 3.1 mm/year to 6.9/mm/year. This is evidence that the processes discussed in objective 1.1 should be allowed to proceed naturally (Ashton et al. 2007). However, for Unit II and northern Unit III, these preliminary results showed that the marsh accretion rate was only about 1.6 to 1.7 mm/year, or about half the rate of recent local sea level rise. Since the breach occurred, this Unit has been largely inundated by bay waters and it is likely that it will require an infusion of sediments and/or strategies to accelerate natural accretion to support extensive, viable salt marsh. Thus, an effective monitoring program is necessary to develop an appropriate marsh restoration plan. For further discussion refer to the rationale under objective 1.1.

Climate Change and Sea Level Rise Adaptation Strategies and Monitoring
Strategies include those listed above and under objective 1.1, plus the following:

- Within 1 to 2 years, establish a refugewide marsh elevation and water monitoring program, to include the following components and steps:
  - Establish three monitoring stations within each of two existing salt marsh areas (and an additional six stations in each area of impounded wetlands), with surface elevation tables and marker horizons; read surface elevation table 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 hydrology.
  - Establish geodetic benchmarks in select upland refuge sites and calibrate to newly established surface elevation tables, 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 or national protocols to connect prior survey data points (vegetation data, groundwater wells, bird points, etc.) to the same common geodetic control as used above.
  - After a minimum of 3 years, evaluate surface elevation table data to determine if the sampled areas of the marsh 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 sea level rise will force a shift in quantity and quality of available waterbird habitat on local and regional scales. 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.

- Continue to review new research and all monitoring results, seeking ways to adjust our management or restoration as deemed necessary, e.g., as new research and monitoring data on sea level rise and obligate salt marsh breeding birds come to light, one option to explore may be to fill or 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 adding supplemental sediment, planting desirable species, or other techniques (see objective 3.1).

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 and increase quality habitat for the endangered Delmarva fox squirrel, forest interior breeding and wintering landbirds, reptiles, amphibians, and other forest-dependent 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 to be conducted on approximately 1,679 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 4-1.

Table 4-1. 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 that minimally takes 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 will surround red maple-seaside alder and Atlantic white cedar swamp, and the second core area will be restored to upland forest surrounding depressional swamp habitats (map 4-1).

Restoring additional upland forested habitats is essential to increasing the refuge population size of Delmarva fox squirrels and providing larger forest tracts for breeding, area sensitive forest interior dwelling species. 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 Delmarva fox squirrel and using silvicultural prescriptions as determined necessary through monitoring to meet the desired conditions criteria.

- Sustain and enhance mast producing trees (e.g., white and red oaks, hickories, walnuts) greater than 12 inch dbh to comprise at least 40 percent of the total canopy cover and with shrub canopy closure of less than 30 percent, providing suitable habitat structure for Delmarva fox squirrel.
- Sustain mature canopy closure 80 percent or greater, with a multi-layered tree species profile and canopy gaps to maximize annual mast production and ensure regeneration of shade-tolerant tree species (e.g., oaks).
- Sustain oak-dominated mixed hardwood patch sizes of greater than 250 acres. Use the presence of long-horned beetle 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. 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 (Statewide habitat gap analysis map, CCP appendix A). Extensive forest habitat loss and fragmentation provided the impetus for the state to designate upland forested blocks larger than 250 acres as key wildlife habitats in its wildlife action plan. While the Delaware Department of Agriculture's Forest Service owns and manages 9,000 acres, 81 percent of the State's remaining forested cover-type is in private ownership (ELI 1991, DNREC 2005b).

The loss of upland forest 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, severe habitat fragmentation and loss had caused the extirpation of the Delmarva fox squirrel from Delaware (ELI 1999). Many of the songbirds that have experienced regional and State declines are bird species that are area sensitive to forest fragmentation and its associated impacts, such as increased nest parasitism by edge species, increased rates of predation, and loss of quality nesting and wintering forested habitats. DNHP estimated that 41 percent of Delaware's historically common forest-dependent birds have been extirpated or today are extremely rare.

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 provide higher quality forest patches (DNREC 2005b).

The federally endangered Delmarva fox squirrel 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 Delmarva fox squirrel, forest interior dwelling birds, 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, juxtaposed 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 Delmarva fox squirrel 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; we expect that it will take at least 100 years to fully implement some of our forest management goals and objectives. This timeframe is based on our prediction of how long it will take to achieve the desired forest matrix composition and structure of existing stands. 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 mature forest stands will have mature trees (greater than 30 cm dbh) and a closed canopy (greater than 80 percent), suitable for the Delmarva fox squirrel (Dueser et al. 1988, Dueser 2000, Morris 2006). They may have patches of shrubs in the understory, which would be suitable for forest interior dwelling species of interest, such as Kentucky warbler (table 4-1).

Silvicultural management can also be used to reduce the potential impact of gypsy moth and southern pine beetle threats to Delmarva fox squirrel habitat. The gypsy moth and southern pine beetle are the two most significant potential disease threats of the forests at the refuge. 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 percent 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 Delmarva fox squirrel habitats.

Upland forest management enhancement will also benefit nesting and migrating bald eagles on the refuge. In July 2007, the Service removed the bald eagle from the list of endangered and threatened wildlife. 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 there are 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 and summer roosts average between 5 to 10 birds and winter refuge roosts may contain 15 to 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.

Strategies

- 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 (table 4-2).

- 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 Delmarva fox squirrel (good, fair, poor).

- Maintain or enhance forest health through the development of monitoring protocols for insect and disease vectors.

- Treat detected insect or disease infestations using 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 Delmarva fox squirrel and migratory birds.

- Increase 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 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 4-2 as thresholds for stand improvement interventions to maintain and enhance wildlife habitat needs for priority focal management species. A time-of-year restriction. April 1 through July 31 would preclude any forest stand improvement as this is the main breeding season for the birds that utilize the refuge.

- Manage bald eagle nest sites in accordance with State and national bald eagle guidelines (USFWS 2007c), utilizing forest management techniques 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 inches dbh to develop larger, well-formed crowns and with a species composition target of one-third white oak, two-thirds red oak, and a mixture of hickory and walnut trees (McShea and Healy 2002).

- Do not cut den trees and trees adjacent to den trees during silvicultural treatments. Adjacent trees provide shade the bole of the den tree, keeping it cooler.

- To promote establishment of den sites, leave trees interfering with mast tree crown development standing and kill by girdling or using systemic herbicides (BNWR 1994).

- Explore opportunities to supplement the refuge Delmarva fox squirrel population through translocations.

- Implement field management prescriptions outlined in the HMP (appendix B).

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 reevaluation or refinement of our objectives. Details of planned monitoring will be developed in a subsequent inventory and monitoring plan. 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 strategy will incorporate a combination of plant identification and inventories, maintaining updates of new invasive species present in the region, and knowing the appropriate management techniques prior to conducting control efforts.

- Establish forest inventory schedules on Prime Hook NWR to document stand-specific information of tree species composition, health of crown overstory trees, regeneration in stands, presence or 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 mixed hardwood patch sizes greater than 250 acres.

- Coordinate with the Chesapeake Bay Field Office to implement improved Delmarva fox squirrel monitoring techniques, such as motion-activated cameras, trapping and nest box checks, as recommended.

Table 4-2. Objective 2.1 mixed hardwood forest community maintenance and enhancement prescriptions

Target Forest Conditions	Condition to Trigger Management Action, as feasible
>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

Climate Change and Sea Level Rise Adaptation Rationale

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 Service 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 percent of forest bird species show high vulnerability to climate change. However, more than half 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 which incorporates climate variables and tree species distributions (to quantify habitat availability) to model the current distribution patterns of 147 common bird species in the eastern U.S. (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 and the Hadley Center for Climate Prediction and Research model. The two models span the spectrum of predicted climate

change using projected atmospheric carbon dioxide concentrations. Some forest species identified by NABCI to be especially vulnerable to climate change are predicted by the Forest Service atlas to increase in Delaware, perhaps presenting future conservation opportunities, even if they are not currently priority resources of concern (NABCI 2010, Matthews et al. 2007). Examples include chuck-will's-widow and hooded warbler. Species 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.

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 that are applicable on a local scale. For example, the refuge seeks to protect its largest patches of forest, which are the areas that are most buffered against 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 recommends that forest management also focuses on processes (such as fire regime and hydrology) rather than strictly on structure and composition, which will increase the resilience of forests to accommodate gradual changes (NABCI 2010). 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.

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 will 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 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).

Climate Change and Sea Level Rise Adaptation Strategies and Monitoring
In forests, climate change will likely result in shifts in forest composition and structure (Iverson and Prasad 1998) that will greatly change the availability of habitat for many species. Shifts in the dominant vegetation type or even small changes in the understory composition may result in significant changes in animal communities. The goal of adaptation is to reduce the vulnerability of ecosystems to climate change and increase their resilience to climate-induced changes in ecological conditions.

Forest management strategies include those listed above, as well as the following:

- 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 1 year of CCP completion, conduct a complete forest inventory of forest lands and repeat the monitoring every 10 to 15 years.
- Consider establishing a continuous forest inventory monitoring system.

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 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 squirrel. Create approximately 870 additional acres of forested habitats to maintain at least two core habitat patches (approximately 435 acres/patch) with connecting corridors.

Rationale

Population numbers and refuge acreage to improve Delmarva fox squirrel 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 this species will simultaneously conserve and protect migratory birds of greatest conservation concern.

Contemporary human activities and land use changes have extirpated Delmarva fox squirrel from Delaware's landscape through the loss of forest, while habitat fragmentation of the refuge's upland habitats has been one of the primary factors in limiting the expansion of its numbers (ELI 1999). Although refuge populations have been stable since the reintroduction of squirrels in 1986 and 1987, this small population of an estimated 20 to 30 squirrels has little probability of being sustained for the long term with current refuge habitat acreage and without supplementing the population.

The most recent population viability analysis data have been incorporated into reforestation objectives. From it, a minimum viable population on the refuge of 130 individuals would be the smallest number of individuals required to maintain a population with a 95 percent probability of persisting for 100 years. This provides a quantitative measure for sustaining Delmarva fox squirrel on the refuge for the long term. Reforesting 700 to 800 acres and creating new habitat, whether by active planting or natural succession, would take 50 to 100 years for areas to mature with the potential of providing habitat for at least 250 individuals.

The loss of upland forests has also 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. Many of the songbirds that have experienced regional and state declines are those bird species that are sensitive to forest fragmentation. DNHP estimated that 41 percent of Delaware's historically common forest-dependent birds have been extirpated or 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 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 data since 1966 there has been a 60 percent decline in occurrence of individual birds of neotropical migrant species in Maryland and an 83 percent 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, including on the Delmarva Peninsula, are playing a critical role in these declines (Jones et al. 2001).

The conservation of forest interior dwelling species requires the inclusion of their nesting requirements including minimal area and 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 (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 Delmarva fox squirrel acts as an umbrella species not only by encompassing the structural nesting characteristics of forest interior dwelling species, but also by providing for a wide variety of other forest-dependent species. Although the squirrel does not necessarily require interior forest habitat, it does require more forest cover acreage than the refuge currently contains in order to achieve and maintain a viable local population for the longer term. Expanding forest acreage and baseline habitat to meet Delmarva fox squirrel life history requirements 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 goose during the fall, winter, and spring. A secondary objective of the farming program was duck production, in which croplands in grass or clover stages of rotations were designed to provide nesting habitats for ducks. In recent years, it has been apparent from anecdotal observations that duck species seldom or never used cropland field habitats, likely due to wetland and aquatic habitats being readily available on the refuge. 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. 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 2007a), 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.

Strategies

- Reduce fragmentation of refuge forested habitats through reforestation projects (planting) to increase forest habitat available to the endangered Delmarva fox squirrel and improve management of area-sensitive wildlife, such as many of the breeding songbirds listed as refuge priority resources of concern in appendix D, table 6.

- Use population viability analysis modeling data to set refuge Delmarva fox squirrel population objectives, refine objectives as new data becomes available and 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 Delmarva fox squirrel.
- Explore opportunities to supplement the refuge Delmarva fox squirrel population through translocations as suitable forest habitat is restored.
- Install speed bumps in refuge entrance road to reduce Delmarva fox squirrel road mortalities on the refuge.
- Implement field restoration prescriptions outlined in the habitat management plan (appendix B).

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 reevaluation or refinement of our objectives. Details of planned monitoring will be developed in a subsequent inventory and monitoring plan. 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, and knowing the appropriate management techniques prior to conducting control efforts.
- Continue to work with partners to improve population monitoring methodology, habitat assessment techniques, and habitat improvement projects.
- Coordinate with the Chesapeake Bay Field Office to implement improved Delmarva fox squirrel monitoring techniques, such as motion-activated cameras, trapping, and nest box checks, as recommended.
- Assess landbird point count monitoring program and, as necessary, locate new points in areas undergoing reforestation to monitor bird community response.

Climate Change and Sea Level Rise Adaptation Rationale
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 powerline rights-of-way, 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 low 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 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 mitigating 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 of sufficient 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). 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).

Climate Change and Sea Level Rise Adaptation Strategies and Monitoring
Forest restoration strategies include those listed above and in objective 2.1., as well as the following:

- 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 and 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 Forested Wetland Communities

Protect and manage approximately 1,200 acres of forested wetland cover-types with less than 10 percent invasive species for breeding and migrating birds of greatest conservation need. Improve habitat quality and manage appropriate patch sizes (greater than 250 acres) for breeding Acadian flycatcher, prothonotary warbler, yellow-throated vireo, migrating and wintering landbirds, and other species of conservation concern, such as carpenter frog and 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
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 2005b).

Yellow-throated vireos utilize a diversity of forest types from mixed upland forests to mature deciduous forests 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 and 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. This species 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 percent of maximum breeding densities in patches below 168 acres (70 ha) (Whitcomb 1981).

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 adapted to tolerate saturation of the root zone for varying duration and frequency throughout the growing season. Nationally and locally, forested wetlands have 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 of refuge forested wetland communities were contracted by the Service conducted by the DNHP in 2004 and 2005 (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 and 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 refuge forest community types listed above, except buttonbush coastal plain pond. A description of rare flora and fauna found within these habitats is located in chapter 3, tables 3-6 and 3-7.

Strategies

- Protect large patches (greater than 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 Delmarva fox squirrel, 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 the regional fire wildlife biologist for the best habitat management recommendations.

- Reduce 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 percent 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 the 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 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 permit to measure our success with respect to our objectives. The results may trigger adjustments to management strategies, or reevaluation or refinement of our objectives. Details of planned monitoring will be developed in a subsequent inventory and monitoring plan. 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 strategy will incorporate a combination of plant identification and inventories, maintaining updates of new invasive species present in the region, and knowing 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 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 establishing monitoring plots and assess conservation status every 3 to 5 years.

Climate Change and Sea Level Rise Adaptation Rationale
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 entering the Delaware Bay and other bodies of water.

Climate Change and Sea Level Rise Adaptation Strategies and Monitoring
Forest wetland management strategies include those listed above and in objectives 2.1 and 2.2.

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, Migrating, and Wintering Birds

Provide up to 4,200 acres of healthy 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 and brackish 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 to 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 percent cover, once salt marsh vegetation is established.
- Reestablishment of native salt marsh vegetation communities, with a moderate (20 to 25 percent) component of open water and 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 in area, which are attractive to wetland-dependent breeding and migrating birds 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 is on active restoration of healthy salt marsh and brackish wetland conditions within wetlands formerly managed as freshwater impoundments. This objective represents the refuge's most significant and tangible shift in habitat management, and is covered here in detail. This shift in habitat management serves as an immediate response to local manifestations of climate change, and is a proactive adaptation in anticipation of likely 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) suggest changes in landcover and losses of tidal wetlands on the refuge in the next 50 to 100 years. Portions of the refuge's marshes 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 but was established in part using existing roads as dike infrastructure that had not been formally engineered for long-term water level management. In developing 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 indicates that the wetlands on the refuge were historically salt marsh, although there had always been areas of freshwater marsh due to natural freshwater inputs or altered hydrology resulting from human activity.

As information in chapter 3 outlines, portions of the managed impoundments are losing ground to sea level rise and other manifestations of climate change, such as shoreline erosion. 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 under current 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, makes greater contributions to vertical accretion (Cahoon et al. 2009). Impounded freshwater wetlands would be difficult and costly to reestablish, and more importantly are not sustainable in a dynamic coastal setting for the long term.

The reality of these various factors, operating in combination to create significant management challenges, requires a shift in refuge wetland management objectives and strategies. 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 CCP. It is neither responsible nor sustainable to indefinitely maintain freshwater impoundments along a coastal environment.

It has been determined through analysis of the many complex factors outlined in chapter 3 (influence of climate change on physical environment and refuge management) that continued management of freshwater impoundments for the long term is not appropriate. There is no inexpensive and practical way to freeze the dynamic nature of the impoundment complex at this ecologically and geologically unstable point. Continued freshwater impoundment management would simply not be sustainable. Management action will be necessary to stabilize the health of the degraded system. If no active restoration is undertaken, it is unclear how quickly or effectively the area, in Unit II in particular, would revert to salt marsh vegetation on its 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). In the absence of a healthy marsh community or sufficient wetland elevation within the interior of Unit II, the shoreline along the bay will remain vulnerable to breaches and overwash during storm events. The most practical and economical management alternative to restabilize the impounded wetlands is carefully executed restoration. Furthermore, an established salt marsh will be able to migrate landward into adjacent refuge uplands, as sea levels rise, in a process that represents the natural adaptation of the coastal ecosystem.

Ultimately, restoration of the refuge impoundments to healthy brackish and salt marsh will encourage the conditions most resilient to sea level rise, while 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 will 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 reducing wave energy. Wave heights are reduced by 60 percent within the first 20 feet of the marsh, which in turn also 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 below-ground 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) and serve as 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 saltwater to a system that 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 achieving tidal flooding up to the spring high tide elevation in order to restore ecologically sustainable estuarine communities by restoring sufficient tidal exchange to flood and 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 establishing 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 from 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 compose only 20 percent 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) 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 primary wildlife urban interface treatment zone for the purposes of 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 saltwater into the impoundment complex is a preferred management option (Smith et al. 2009), the feasibility of such an approach depends 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 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 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 saltwater 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 Road by DelDOT, when and whether sediment from outside sources is added, etc. may all affect the pace and choice of restoration actions but not the long-term goal, which is 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 the Northeast Region 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 decisionmaking process and have technical expert review, and consistency with other refuges, Prime Hook NWR plans to use the coastal impoundment structured decision-making 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 wetland restoration plan is outside the scope of this CCP process. However, there have been a number of formal discussions regarding restoration options and strategies with a diverse group of wetland management and restoration experts, state officials, and the Army Corps of Engineers.

The refuge has been in contact with the Army Corps of Engineers and with DNREC since the summer of 2011 regarding the potential use of dredged

sediment to restore wetland elevation in the impoundment complex. Such sediment could come from the Main Channel Deepening Project, maintenance dredging. Because the material is a State resource, DNREC has primary authority over how and where it is used. Marsh restoration at the refuge is only one of several beneficial use possibilities that are being considered.

In May 2011, 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 (USGS, 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. The group reviewed preliminary monitoring data and toured the refuge's shoreline and wetlands firsthand. They provided feedback and recommendations at the end of the meeting and during follow-up discussions. A similar follow-up workshop was held in April 2012, which included the participation of additional academic experts (e.g., Court Stevenson of the University of Maryland) as well as several community representatives. Participants examined the primary restoration options that the refuge faces, and also proposed restoration scenarios to be examined in more detail through hydrological modeling. A summary of this workshop can be found online at: *http://www.dnrec.delaware.gov/coastal/DNERR/Pages/CTP%20Pages/Prime-Hook-Restoration-Workshop.aspx (*accessed August 2012).

Throughout the summer of 2012, the refuge continued discussions regarding restoration options with two engineering firms and with the Partnership for the Delaware Estuary, to further evaluate and develop restoration options and techniques, including actions that could be taken soon after the CCP is finalized. These partnerships will continue into the implementation phase of marsh restoration. These have included both large-scale wave attenuation strategies and products suitable for the high-energy shoreline interface, and small-scale living shoreline projects suitable for the marsh interior. The resulting suggestions from these various meetings and discussions have been incorporated into the CCP as potential restoration strategies, outlined below.

For example, although an infusion of additional sediment is critical for restoring lost elevation behind the fragile refuge shoreline, the refuge also considers strategies to encourage and accelerate natural accretion of sediment within the wetland complex. The refuge has examined both short and long-term solutions, which vary tremendously regarding cost, deployment time, and engineering analysis requirements. Engineered solutions do exist for attenuating waves and encouraging sedimentation in moderate- and high-energy settings, such as various manufactured concrete structures (e.g., wave attenuation devices, beach prisms, reef balls). These type devices are designed to attenuate wave energy thus reducing erosion and would be more effective than concrete structures not designed for these purposes, such as jersey barriers (designed specifically for traffic control). Relative to rock and rubble structures, these type structures can be designed to provide an effective means to stabilize the shoreline and breach locations. Although wave attenuation may be lower with manufactured structures than with rock and rubble structures, they can allow for passage of fish, crabs, and other species (Douglass et al. in press). One cost estimate obtained suggested at least $1 million for an installation of wave attenuation devices near the mouth of the breaches that would be sufficient to have the necessary effect (Cardno JFNew Consulting, personal communication). The Coastal Engineering Manual provides extensive design methodologies for implementing rock and rubble mound structures (USACE 2002). As with manufactured concrete structures, rock and rubble mound structures require hydrodynamic modeling to design

properly and can be costly to implement on the scale necessary at the refuge. There are no means to attenuate wave energy through the breaches that would not require careful planning and engineering, to ensure that the water and energy do not simply scour around the structure(s) and impact the refuge potentially forming new breaches and inlets at other locations throughout the shoreline.

Geotubes are another structural technique that have some potential. However, geotubes do not contribute sand to the local sediment system, can affect adjacent shoreline negatively, are prone to failure and vandalism, and are not designed to withstand large-scale storms (McKenna 2001). Geotubes would also likely require the addition of sand to anchor the tubes, a nourished beach in front of the tubes, and may require frequent maintenance as sand is washed away (Gibeaut et. al 2003, McKenna 2001).

Living shoreline techniques using materials such as coconut logs, oyster shell breakwaters, and grass plantings are suitable in low energy settings and can help restore marsh in targeted areas (PDE 2012, PDE 2011). The refuge has been in close contact with the Partnership for the Delaware Estuary regarding potential living shoreline projects on the refuge, and has already shared preliminary site information for consideration.

It has been the consensus of these diverse partners that the refuge has a number of potential restoration options, both big and small, which have been included here, but that additional hydrological modeling and analysis is important before the implementation of large-scale restoration efforts. The refuge proposes to continue working with diverse wetland management and restoration experts, State and Federal officials, and community representatives as restoration short- and long-term plans are developed. Potential restoration strategies to be considered are derived from the salt marsh restoration scientific literature and consultation with wetland experts and other partners. 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). The impacts of the potential restoration strategies outlined below were evaluated in chapter 5 of the draft and final CCP/EIS, and some or all of the strategies may be implemented in some combination, as determined to be appropriate, feasible, and fundable, during later restoration planning.

Strategies

- Implement water level management and vegetation control strategies, to the extent conditions warrant and permit:
  - If feasible, seek to keep Unit III water levels, in accordance with deed restrictions, at or below a level of 2.8 feet mean sea level between October and March 10th, but if future storm events preclude the ability to manage water levels, then natural levels will prevail.
  - Control invasive species using chemical control, prescribed fire, and other techniques as appropriate so that 95 percent 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 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 regional impoundment management structured decision-making model in order to evaluate and validate management options for refuge impoundments.

- Discontinue all management and construction of dunes on private land.

- In partnership with DNREC Delaware Coastal Program, and a private contractor, continue development of a model to predict the hydrodynamic response of the wetland complex under a wide variety different potential management and restoration scenarios, such as closed inlets, opened inlets, one inlet opening in response to a storm event, purposeful inlet deepening, Fowler Beach Road removed, Prime Hook Road culverts closed, additional Prime Hook Road openings installed, water control structure at Slaughter Canal/Fowler Beach Road removed, etc. The model will help evaluate what hydrological and vegetation responses may be expected under each scenario.

- Continue consultation with State and Federal coastal scientists, non-profit organizations, engineering firms, academic scientists, other subject matter experts, and community representatives to further explore management options and develop a wetland restoration plan for refuge impoundments.

- Host public forums during restoration planning and implementation to describe the process and techniques under consideration and provide the opportunity for public input.

- Within 1 to 3 years, implement short-term restoration strategies, even as large-scale and long-term restoration plans are developed. These strategies may include some or all of the following:

  - Continue development of a hydrological model, as described above, to evaluate long-term restoration options.

  - Partner with the Partnership for the Delaware Estuary to plan and implement appropriate application of living shoreline techniques (e.g., coconut logs, Christmas tree fences, oyster shell breakwaters) within the Unit II interior along public roads and neighboring private property 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.

  - Further evaluate the potential applicability and installation of engineered wave dissipation devices, such as pyramid-shaped or spherical concrete structures designed explicitly for moderate or high-energy settings. Examples include GeoTubes, wave attenuation devices, beach prisms, artificial reefs.

  - Work with DNREC on shoreline stabilization with material from Delaware River Deepening project, maintenance dredging, and other sources within the Delaware Bay. Reevaluate the easement limiting water level management to a height of 2.8 feet with the impoundment, possibly renegotiating or removing the agreement.

- Within 15 years, implement a comprehensive 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 will become applicable. Specific potential strategies include:

  - 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 and DNREC to assess the availability of suitable dredge material to assist in restoring lost elevation within Unit II or Unit III necessary for the establishment of *Spartina*.

  - 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 be naturally transported into the back barrier wetlands to improve elevations for vegetation growth.

  - If predicted from hydrodynamic modeling analysis to be beneficial for marsh restoration, work with DelDOT on the abandonment and appropriately-timed removal of Fowler Beach Road 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. DelDOT has sole authority over decisions regarding Fowler Beach Road.

  - 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 through planting of salt marsh plants, such as *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* will still be treated in areas identified in the fire management plan as a Primary Wildlife Urban Interface Treatment Zone.

  - Work with DelDOT to ensure that improvements to Prime Hook Road will permit optimal management or restoration of Unit III, based on the outcome of modeling analysis. DelDOT has sole authority over decisions to alter Prime Hook Beach Road.

Monitoring Elements

- Resurvey all water-control structure staff gauges to a single geodetic reference and accurately reposition gauges to reflect current mean sea level.

- Within 1 to 2 years, establish a refugewide 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 and marker horizons.

- Expand efforts to use real time kinematic surveys and underwater sonar technology to monitor elevation throughout the wetland complex, which is less precise than surface elevation table measurements, but can be conducted on a broader geographic scale.
- As deemed necessary, continue to collect water quality samples through grab-sampling and automated sampling; samples are analyzed in partnership with the State through a cooperative agreement.
- Implement the National Park Service's vital signs program's shoreline position monitoring protocol and shoreline topography monitoring protocol. Coordinate refuge shoreline monitoring efforts with other coastal refuges to foster Departmentwide 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 integrated waterbird management and monitoring; 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 regional salt marsh integrity index and other suitable monitoring programs 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 and open water change analysis.
- Utilize early detection rapid response techniques that detect newly established invasive species and immediately address those populations through the appropriate control measure.
- Develop improved monitoring and inventory program, such as outlined in the integrated waterbird management and monitoring program, to assess annual habitat conditions created through management and restoration in all wetland areas and associated bird use.
- Implement water and soil salinity monitoring to inform decisions about wetland response to management and restoration.
- Obtain location and distribution data of known rare plant and animal populations from DNHP and store on the 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

Over the next 15 years, protect and improve the water quality of 6,000 acres of impounded marsh and waterways and 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, blueback 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, 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's 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 blueback 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.

Restoring salt marshes that function naturally requires reestablishing desirable vegetation on the marsh plain, restoring a natural hydroperiod, and maintaining or creating elements of marsh habitat such as tidal creeks, ponds/pannes and vegetated areas. These tidal creeks are part of the intertidal drainage system that allow fish foraging and the exchange of sediments. So the natural function of salt marshes not only is tied to the vegetation on marsh plain but the well developed system of tidal creeks. Weinstein et al. 1997 and 200 outlined the importance restoring the hydrology by maintaining or creating tidal channels. The number of ditches quantified in the strategies below are for freshwater impoundment management. We may need to restore some of these ditches if determined they are no longer needed. The marsh restoration plan may tell us which ones to keep or restore.

Strategies

- 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 of Units I and IV by permitting natural coastal processes, such as overwash and inlet formation, to proceed unhindered.

- 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 composed of native vegetation (trees and shrubs), by connecting isolated or disjunctive patches around refuge creeks, waterways, and marshes, through assisted reforestation projects or allowing natural succession to occur.

- Maintain and/or restore water movement and circulation within existing drainage networks of the refuge's former impoundment complex to improve the hydrology of the salt marsh by developing as appropriate tidal drainage systems; drainage networks may 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. Ditches not needed for marsh restoration may be plugged or allowed to fill in.

- 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 NWR's aquatic and terrestrial resources.

- Implement field management and restoration prescriptions outlined in the habitat management plan (appendix B).

Monitoring Elements

Conduct appropriate monitoring and survey programs as funding and staffing permit to measure our success with respect to our objectives. The results may trigger adjustments to management strategies, or reevaluation or refinement of our objectives. Details of planned monitoring will be developed in a subsequent inventory and monitoring plan. Examples of monitoring or surveys that we may implement include:

- Conduct refuge fishery inventories every 5 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 to public use regulations on these closed systems.

- When cleaning ditch systems ensure that at least 75 percent of the ditch depth is free of sediment along ditch courses and the entire length is free of obstructions that impede water flow.

- Conduct water quality monitoring, in cooperation with partners; parameters to measure include salinity, dissolved oxygen, ammonium, nitrate and nitrite, ortho-phosphorus, total dissolved nitrogen, phosphorus, and chlorophyll A/ pheophyton.

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 a mosaic of early successional habitats mixed with transitional forested areas to conserve migratory birds, breeding landbirds, and 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 stage distributions that mimic historic conditions. Transitional habitats will usually be small in size and imbedded within a habitat matrix of wetland 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 (included those areas planted in trees or transitioning through natural succession for Delmarva fox squirrel management purposes).

Maintain at least 20 percent of the above acreage in an early successional condition (shrubland 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, the State Wildlife Action Plan (2005) and BCC (USFWS 2008a) 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

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.

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 exemplifies 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 to 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 (figure 4-1).

Peterjohn (2006) suggests that it is more practical to direct management toward 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. 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 and juvenile mature-forest dependent birds during migrational periods. Dense shrub cover also decreases the need to move widely

in search of food and reduces energy loss and exposure to predators. Fruits have high sugar content that aids in accumulating fat reserves to facilitate migration (Parrish 2000).

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. These species do not like later successional stages where shrubs 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.

Review of the life history requirements of targeted birds shows 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 4-3).

- Field specialists: restricted to larger (5 to 50 acres/2 to 20 ha) 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 33 feetwide (10 meters).
- Multiple habitat species: requiring other habitats in addition to shrublands for breeding.

Table 4-3. 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
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

The Vitz and Rodewald study (2007) results have shown that during the post breeding period, birds (especially red-eyed vireo, worm-eating warbler, ovenbird, hooded warbler, and scarlet tanager) seek out the structurally complex and low vegetation structure (greater than or equal to 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 post breeding season condition for migrants.

Strategies
See strategies listed under objective 4.2.

Objective 4.2 Grassland Bird Habitat Management

Manage for an interspersion of habitat structures for 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 124 acres (50 hectares) or more of grasslands adjacent to salt marsh habitat to meet the needs of priority species that would be especially attracted to such a landscape context, such as breeding Henslow's sparrows and wintering northern harriers.

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

Rationale
Grassland birds are those birds that rely on grassland habitats 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 4-4). For each bird species, these grassland habitats can provide protective cover for nesting and brood rearing 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, and sow bugs 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 4-4. 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

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 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 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 and Smith 1992). Maintaining grassland habitats near high salt marsh areas will 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 will benefit.

As with shrubland management, maintenance of grassland communities will require periodic disturbance, resulting in a range of seral stages over time or space. The result of this is a diversity of grassland structure (short, medium, tall) at any one time and 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; croplands in

grass or clover stages of rotation 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. Waterfowl production is no longer a management objective for Prime Hook NWR, so promoting early successional grass or clover to provide nesting cover is unnecessary. Finally, the elimination of farming on the refuge is consistent with recommendations in the Service's final EIS 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. Managing a portion of these previously farmed acres as grassland and other transitional habitats better serves numerous refuge objectives.

Strategies for Objectives 4.1 and 4.2

- Implement field management prescriptions outlined in the HMP (appendix B).
- 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, maintain early successional grassland patches near salt marsh habitats, or retain field openings adjacent to upland mature forests.
- Increase shrubland and forested buffered areas (greater than 200 meters) adjacent to refuge creeks, depressional swamp and emergent wetland habitats, 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 maintain shrubland habitats.
- Develop rotational management action schemes for prescribed fire, mowing, application of herbicides, etc., to create and maintain habitat conditions specified in objectives 4.1 and 4.2; more information on optimal disturbance schedules for shrubland management and other best management practices is currently being reviewed by the regional shrubland management work group.
- Engage the public in outreach and education about the benefits of pollinators, instilling a greater appreciation for invertebrates and their essential links to BIDEH.

Monitoring Elements for Objectives 4.1 and 4.2

Conduct appropriate monitoring and survey programs as funding and staffing permit to measure our success with respect to our objectives. The results may trigger adjustments to management strategies, or reevaluation or refinement of our objectives. Details of planned monitoring will be developed in a subsequent inventory and monitoring plan. 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, and knowing the appropriate management techniques prior to conducting control efforts.
- 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 annual habitat work plan.
- Develop GIS layers (e.g., RLGIS or similar) needed to document restoration and habitat management actions by field number, along with refuge management actions database to tract shifting mosaics of transitioning habitats.
- Explore the possibility of applying a 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

Sea Level Rise and Climate Change Strategies and Monitoring
Sea level rise and climate change strategies are the same as those listed above and under objectives 2.1, 2.2, and 2.3.

GOAL 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 other public uses as may be allowed without interfering with refuge purposes and objectives for wildlife.

Objective 5.1 Hunting

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

Rationale
Hunting on the Delmarva Peninsula is a traditional outdoor pastime and is deeply rooted in our American and Delaware heritage. Off-refuge opportunities for public hunting are decreasing with increasing private land development. Refuge lands have 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 engaged in by many visitors each year. When managed responsibly, this activity can instill a unique understanding and appreciation of wildlife, their behavior, and habitat needs, as well as their role in the surrounding environment. General hunting information can be found in Chapter 3, Existing Environment, Refuge Administration—Refuge Visitor Services Program.

Section 605 (FW 2) of the 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 refuge's previous hunting program was inefficient and overly complex, requiring a significant amount of staff resources. A recently conducted regional visitor services review found the 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) seems 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." In other words, a major portion of refuge staff time and operating budget are currently devoted to the hunting program's fee-based permit system, the continued replacement and upkeep of over 100 permanent waterfowl blinds and elevated tree stands, and administration of all hunts and associated lotteries.

The opinions by the visiting public and community landowners were surveyed in 2004 and 2005 by 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 rated it 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, and hunting ducks and hunting deer with muzzleloader and shotgun were more important than other hunting activities.

In the 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. Most hunters seemed to prefer the refuge to maintain or improve the elevated tree stands, and the waterfowl blinds. 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 asked to see increases in hunting and fishing areas and access.

Summary. To improve the refuge's hunting program, we 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 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. We will expand some aspects of the hunting program to include additional days and acres throughout the hunting seasons established by the state. Deer hunting acreage will increase from 4,020 to 5,221 acres, waterfowl hunting from 1,722 to 3,432 acres (which meets the 40 percent "inviolate sanctuary" rule), upland game and migratory bird hunting remains at 1,995 acres, and turkey hunting is added, from 0 to 3,729 acres. However, we will only issue no more than five turkey hunting permits, and the vast majority of the refuge will remain open to wildlife observation and other non-consumptive uses during the turkey hunting season. Furthermore, we are providing 3,185 acres of sanctuary area (no-disturbance areas) for waterfowl and other wildlife. 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. Specific descriptions of these sanctuary areas can be found later in this chapter 4 (under Waterfowl Hunting), but are roughly Unit II, the lower half of Unit III, and Unit IV (map 4-8).

Areas. Increases in proposed hunting acreages will provide new hunting opportunities from current management; however, many of these proposed "new" hunting areas are currently open to some type of hunting or were previously open either under refuge management or private ownership. For example, Unit I is currently open for deer and upland game hunting and is now proposed to be open for waterfowl hunting—same land, but with a new opportunity. The refuge lands currently closed to hunting and proposed to be open for any type of hunting that are not currently being hunted for any species includes: an area located north of Prime Hook Road commonly referred to as Oak Island (deer only), an area north of Route 16 referred to as the Millman Tract (deer and turkey), an expanded area of the existing Jefferson Lofland Area and Headquarters Area (deer and turkey), an expanded area of the Unit III waterfowl hunt area (waterfowl only), and an area west of Petersfield Ditch in Unit IV. Of these areas, Oak Island was previously hunted under refuge management up until 1995 and the Millman Tract

was hunted under private ownership up until the Service purchased it in 2001. The expanded areas of the Jefferson-Lofland Area, Headquarters Area, and nearly all of the proposed Unit III waterfowl hunt area were previously hunted under refuge management. No prior hunting of the area west of Petersfield Ditch is known.

Administration. Other changes to the hunting program will lower administrative burdens to staff resources and improve hunting quality. More specifically, these changes include:

- Eliminating permanent hunting structures.
- Allowing hunters to free roam in most areas that can tolerate pedestrians or navigation without adverse impacts on a first-come, first-served basis following State regulations.
- Adopting one-time seasonal permits for all hunting areas except lottery hunts.
- Enhancing youth and disabled hunting opportunities.
- Establishing seasonal closures to minimize wildlife disturbance and avoid conflicts with other uses.
- Establishing preseason lottery drawings for high demand deer, waterfowl, and turkey hunt areas.
- Eliminating daily standby permit drawings.
- Eliminating permit fees except for lottery hunts.

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 will also be required to have a signed copy of the current Prime Hook NWR 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 also be required to have a daily permit issued in advance of the hunt date through a contractor. Hunters will not be required to check-in or check-out on the day of any hunt.

For most areas, hunter numbers will not be limited to a specific hunt location. Hunters will have the ability to free roam for deer, waterfowl, upland game, and turkey in designated areas on a first-come, first-served basis. Non-ambulatory hunters are allowed to hunt in all hunt zones in accordance with refuge policy and regulations. Only non-ambulatory hunters may hunt in the Island Farm Unit, where we have provided non-ambulatory hunt blinds to accommodate hunters with this need. For the Statewide youth hunts, all designated hunt areas will be open for waterfowl, deer, or turkey hunting on a first-come, first-served basis. We don't know the exact number of hunters who will participate in refuge hunting opportunities; however, we do anticipate a slight increase from current levels.

Lottery. Preseason lottery drawings are proposed for high demand areas, including the lottery deer hunt area (headquarters area), disabled deer and waterfowl hunt areas, 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 more than 100 deer hunters

show up for 32 available shotgun hunting opportunities and 80 waterfowl hunting parties (with up to 3 people per party) show up for 25 to 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 one in three chance of getting a hunting spot. As a national wildlife refuge, Prime Hook NWR will provide hunting opportunities through these preseason drawings for local, in-State, and out-of-State hunters. Knowing in advance allows hunters to prepare, plan, and scout, which ultimately improves the quality of their hunting experience.

Preseason lottery drawings will be administered by a contracted company that will feature online and telephone services to collect hunter information and required fees (covered later in this section), and issue permits. These services will 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 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 (no more than 30 hunters) will have access to the hunt area and may choose their hunting location on a first-come, first-served basis on the day of the hunt. For the lottery waterfowl hunt area and disabled deer and waterfowl hunt areas, hunters will 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. Only the first 2 days of each of the State's seasonal splits for waterfowl will be included in the preseason drawing for the disabled waterfowl area and will be first-come, first-serve thereafter. For the lottery waterfowl hunts, the selected hunter may take two additional people on that hunt day. Federal blind sites in addition to eight 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 may be administered by the Delaware Division of Fish and Wildlife.

For any vacant hunting opportunities not selected during the preseason lottery drawing, hunters will 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 will be available by telephone during business hours on weekdays to assist. Hunters will be allowed to claim only one permit per day to prevent someone from claiming all available vacancies at one time. The licensing contractor will supply refuge staff with a list of permitted applicants. No daily standby lottery drawings will be conducted.

Deer stands and waterfowl blinds. Permanent hunting structures, such as deer hunting stands and duck hunting blinds, will be phased out over a 5-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 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. In the case of waterfowl hunting, the phasing out of permanent waterfowl hunting blinds in the lottery hunt area will require hunters to provide their own means to camouflage themselves (boat blind, pop-up blind, etc.). Waterfowl hunters will 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.

Visitor safety at refuges is a high priority when developing compatible wildlife-dependent recreation programs, such as hunting; however, it is ultimately the responsibility of every hunter to be safe. An accident involving hunter safety results from either a lack of hunting ethics or a violation of hunting regulations. Use of portable deer climbing stands will be recommended but not required. For hunters who may be unable to climb trees using portable deer stands or who may wish to hunt from permanent deer stands or duck blinds, the state-owned Prime Hook Wildlife Area, which adjacent to the refuge, will continue to provide these opportunities. There are many areas on the Delmarva Peninsula, other than Prime Hook NWR, that offer public hunting opportunities in free-roam areas or from designated permanent structures. Additional information about free roam hunting and the use of deer stands and duck blinds on the refuge and on the Delmarva Peninsula can be found in the visitor services section in chapter 3 or the hunting management plan in appendix C.

Disabled. The refuge's proposed action offers opportunities for all disabled individuals. Areas will be reestablished for non-ambulatory wheelchair users to ensure that these individuals have opportunities for quality hunting experiences. Wheelchair hunters often have limited mobility, and there are no or limited opportunities on the refuge to hunt unless refuge staff provides them with accessible infrastructure such as ground blinds and vehicular access. These hunters may not have the option to hunt other areas, as they are limited by the accessibility that the refuge provides them. Other disabled, yet ambulatory hunters are provided opportunities to hunt in the free roam areas, are not required in any fixed location, and may choose how far they are capable or willing to travel to hunt. Because these proposed changes do not exclude hunters with other types of disabilities from the refuge's hunting program, these methods are in compliance with the intent of the Americans with Disabilities Act.

Non-ambulatory hunters have commented about their frustration with the current hunting system. The number of non-ambulatory hunters on the refuge has decreased since 2005, when access was granted to all individuals with any permanent disability (not just non-ambulatory hunters) to hunt in the disabled hunting area along with additional hunting days. Hunter success rates for deer have also decreased from an average of 32 percent from 2000 to 2005 to an average of 18 percent from 2005 to present.

Youth hunting. The Service proposes to enhance youth hunting opportunities by collaborating with State partners and non-governmental hunting organizations to develop hunter training programs that instruct beginning hunters in the knowledge and skills necessary to become responsible, respected individuals who strive to learn all they can about the species being hunted and to become knowledgeable in firearms safety, hunter ethics and wildlife conservation. The Service will also develop mentored hunting programs for both youth and adults and offer programs developed by the National Archery in the Schools program (NASP) to encourage family participation in archery shooting. Portions of any area open to hunting may be used to facilitate these mentored hunts and these areas will be temporarily closed to the general hunting public during those times.

Season dates, bag limits, and harvest methods for the hunting program at Prime Hook NWR 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 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 will apply to lands now a part of the refuge and lands added to the refuge in the future.

Additional information regarding the proposed hunting program can be found in the compatibility determination in appendix E, and in the hunting management plan in appendix C.

Strategies

- Continue to provide hunting opportunities for deer, waterfowl, upland game (rabbit, quail, pheasant) and webless migratory birds (mourning dove, snipe, and woodcock).
  - Continue to provide deer and waterfowl hunting opportunities for disabled hunters.
- Expand hunting opportunities for deer, waterfowl (including snow geese), upland game, webless migratory birds, and turkey (for details, refer to objectives 5.1a through 5.1d).
  - Support Presidential Executive Order 13443: 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 current program.
  - Put seasonal closures in effect for some areas to minimize wildlife disturbance and avoid conflicts with other public recreational programs.
  - Provide high-quality hunting opportunities for turkey.
- Clearly sign all areas closed to hunting.
- 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 the lottery deer hunt area, lottery waterfowl hunt area, disabled deer and waterfowl hunt areas, and lottery turkey hunt area.
- Increase the application fee for preseason lottery drawing to $5/hunter.
- Require a processing fee of $2 to $3 per hunt for vacancies remaining after the preseason lottery drawing.
- Adjusted permit fees are as follows:
  - Deer and turkey—$10 per daily permit (per blind for non-ambulatory disabled hunters; application and permit fees for turkey hunting may be waived if the lottery drawing is administered by the State).
  - Waterfowl—$15 per daily permit per blind site.

- The 50 percent discount on permit fees to interagency senior and access passholders does not apply.

- Youth hunters age 15 years and younger must obtain a free seasonal permit. Only hunters aged 16 years and older can apply for or obtain a lottery hunt area permit.

Permit fees. The refuge collects boat ramp launching fees and hunting permit fees under the guidance of the Federal Lands Recreation Enhancement Act, 16 U.S.C. 6803(c), Consolidated Appropriations Act (PL 108-447). This law grants the Secretary authority to collect recreation fee revenues for public recreation. The Recreation Enhancement Act 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. The act replaces the Recreation Fee Demonstration Program and authorizes the Recreation Fee Program for 10 years through 2014. At least 80 percent 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 remaining 20 percent is sent to the region to be distributed to other refuges. In previous years, the refuge has received money from these regional funds for visitor services (appendix I).

This 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 the cost to hunt. Therefore, the refuge proposes to eliminate permit fees to hunt on the refuge except for the lottery hunts (see chapter 3 for discussion of fees in the current hunting program).

Fees will be required to manage the lottery hunts for deer, waterfowl, and turkey. Application and permit fees for turkey hunting may be waived if the lottery drawing is administered by the State. The Refuge Recreation Act requires that funds be available for the development, operation, and maintenance of the permitted forms of recreation. The proposed 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 to $3 per hunt) are the minimal amounts needed to offset the cost of facilitating the preseason drawings and managing 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 5 years of the CCP. Preseason lottery drawings will be administered by a contracted company that will collect information and required fees, conduct the drawing, and issue the permits. This may reduce our costs by more than $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, disabled deer and waterfowl hunt areas, and lottery turkey hunt area. See discussion earlier in this section or objectives 5.1a, 5.1b, or 5.1d for more information.

  - Conduct a preseason drawing to issue permits and collect fees for all available hunting dates. Drawings will be administered by a contracted company that 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 website 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. Hunters will have the option to forfeit their permit to the contractor if circumstances prevented them from hunting on that day, without compensation, i.e. no refunds, to make their reservation available to other hunters.

- Permits are non-transferable. No daily standby drawings will be conducted.
- Permit and application fees apply.
- Preseason drawings for turkey hunting may be conducted by the Delaware Division of Fish and Wildlife and if so, application and permit fees may be waived.

- Enhance disabled hunting opportunities, particularly for non-ambulatory wheelchair users (see objectives 5.1a and 5.1b for more information).
- Enhance youth hunting opportunities:
  - Collaborate with State partners and non-governmental hunting organizations to develop hunter training programs that instruct beginning hunters in the knowledge and skills necessary to become responsible, respected individuals who strive to learn all they can about the species being hunted and to become knowledgeable in firearms safety, hunter ethics and wildlife conservation.
  - Develop mentored hunting programs for both youth and adults and offer programs developed by NASP to encourage family participation in archery shooting.
  - Portions of any area open to hunting may be used to facilitate these mentored hunts and these areas will be temporarily closed to the general hunting public during those times.
- 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:
  - Deep Branch Road Trail (includes Goose and Flaxhole Ponds; Unit III), Eastern Prime Hook Creek (from Foord's Landing to headquarter ramp) (Unit III), and hiking trail on Fowler Beach Road (southside of Unit II): 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 or turkey hunting. If and when the photography blind is available on the southside of Fowler Beach Road, this portion of the trail will be open year round and open every Sunday during the hunting season.
  - Headquarters area (includes Turkle and Fleetwood Ponds) (Unit III): Closed only for a maximum of two days for deer hunts and portions may be closed for turkey hunts.
  - Island Farm Area in 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.

- Hiking trails on Fowler Beach Road (Unit I), Prime Hook Road (Unit III), and Slaughter Beach Road and Slaughter Canal (Unit I): Open only on Sundays from September 1 through the deer and waterfowl hunting seasons, which typically end in February. Additional seasonal closures may apply through the second Saturday in May for hunting during the snow goose conservation order or turkey hunting.

- Add a new full-time law enforcement officer to enforce regulations.
- 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 for access to Prime Hook Creek at Foord's Landing.
- Enforce general regulations for all hunting programs
  - Hunters may not be on the refuge any earlier than two hours before shooting time.
  - 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 a blind is prohibited.
  - Practice or target shooting on the refuge is prohibited.
  - Hunting blinds/stands 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 lead slugs are permitted for deer or fox hunting.
  - Individuals assisting non-ambulatory disabled deer hunters are not permitted to hunt; however, up to two individuals may hunt while assisting a non-ambulatory disabled waterfowl hunter. Wheelchair hunters are required to have an assistant.
  - Designate Slaughter Canal as a slow no wake zone.
  - Digging for any reason is prohibited.
  - 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 being a traditional outdoor pastime, deer hunting aids Statewide efforts to control deer populations and complements habitat management on the refuge. We intend to consult with the Delaware Division of Fish and 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.

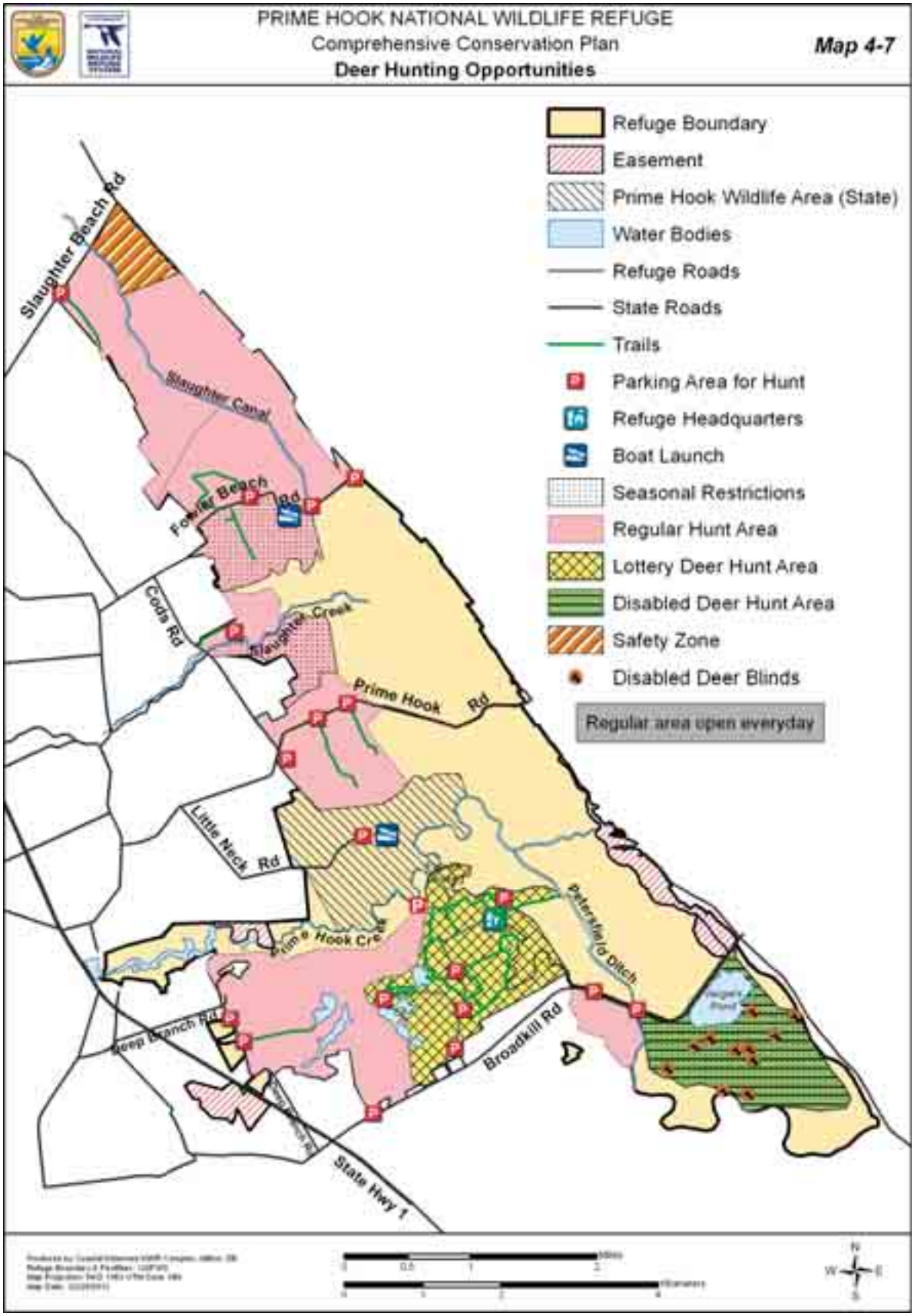
In addition to the information presented under objective 5.1, deer hunting will be increased to include an additional 1,201 acres beyond current management for a total of 5,221 acres. We will open these acres for archery (to include the use of crossbows), muzzleloader, or shotgun (to include the use of handguns) hunting, where appropriate, and will phase out permanent deer stands. Seasonal closures will occur not only to protect wildlife, but also to minimize conflicts between different hunting activities and other non-consumptive recreational uses (e.g., minimize conflict with anglers on Prime Hook Creek and close hunting in late November in designated areas to minimize bald eagle and waterfowl disturbance). Non-ambulatory hunters are allowed to hunt in all hunt zones in accordance with refuge policy and regulations. Only non-ambulatory hunters may hunt in the Island Farm Unit, where we have provided non-ambulatory hunt blinds to accommodate hunters with this need. Map 4-7 depicts deer hunting opportunities and infrastructure.

Strategies

In addition to objective 5.1 strategies:

- 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 to 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 potential conflicts are minimized with other user groups.
- The refuge will participate in the Statewide youth deer hunt.
- The driving or pushing of deer is prohibited on the refuge.
- Hunting will be on a first-come, first-served basis except for lottery hunts.
- Check in and check out by hunters will not be required for any deer hunt.
- Expand deer hunting opportunities from 4,020 acres to 5,221 acres, an increase of 1,201 acres (map 4-7).
  - The refuge has adopted State hunting regulations and seasons for the regular deer hunt area with the following restrictions:
    - No access by boat from Slaughter Creek on Cods Road
  - There is no infrastructure to support boat launching.

Map 4-7. Deer Hunting Opportunities



- Seasonal closures to deer hunting from the Monday before Thanksgiving through March 15 will occur on the designated area north of Prime Hook Beach Road (Oak Island) and south of Fowler Beach Road to minimize disturbance to waterfowl and nesting bald eagles. The disabled deer hunt area in the Island Farm will be closed following the November shotgun season to minimize wildlife disturbance.

- Phase out permanent deer hunting stands over a 5-year period or when they become unsafe, whichever comes first.
  - Hunters may free roam in hunting areas except in the disabled deer hunt area.
  - Portable stands are permitted.
  - Eliminate maintenance mowing except for disabled hunt areas.
- 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 and Wildlife.
- Enhance hunting opportunities for individuals with disabilities, particularly for non-ambulatory wheelchair users.
  - Reestablish areas for non-ambulatory wheelchair users in a designated area in Unit IV.
  - Provide a limited number of hunting days during the early muzzleloader hunting season, the Statewide non-ambulatory hunt in November, and the early shotgun hunting seasons in the disabled hunt area to minimize deer disturbance and maximize quality hunting experience. A total of 11 ground blinds are currently available and required. Additional sites in this area may be provided.
  - The refuge may 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 disabled deer hunt area for a limited number of days during the firearms deer hunting seasons.
  - A limited number of permits (no more than 30 for the lottery deer hunt area) 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-served basis. Hunters in the disabled deer hunt area must hunt from 1 of 11 ground blinds in the area.
    - 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 participate in the Statewide non-ambulatory deer hunt. The lottery deer hunt area will not be open for this hunt.
    - General regulations for deer hunting.
  - Enhanced opportunities for scouting will be allowed 2 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 will be increased to include an additional 1,710 acres from current management for a total of 3,432 acres. Seasonal closures will occur to protect wildlife and minimize conflicts between different hunting activities or other non-consumptive recreational uses (e.g., close hunting in late November in designated areas to minimize bald eagle and waterfowl disturbance). We will phase-out permanent waterfowl hunting blinds. In all hunt areas, hunting is proposed to remain at 4 days per week and to cease at 3 p.m. to minimize wildlife disturbance and provide quality hunting experiences. Non-ambulatory hunters are allowed to hunt in all hunt zones in accordance with refuge policy and regulations. Only non-ambulatory hunters may hunt in the Island Farm Unit, where we have provided non-ambulatory hunt blinds to accommodate hunters with this need.

The addition of new free-roam waterfowl hunting areas in salt marsh habitats in Unit I will provide quality opportunities, particularly when refuge impoundments freeze. Sanctuaries totaling 3,185 acres are provided as disturbance free areas for wildlife where no recreational activity is permitted. Map 4-8 depicts waterfowl hunting opportunities and infrastructure. In the lottery waterfowl area, the Service limits the number of hunting parties through the use of designated blind sites. In free-roam areas, hunters are limited by the available access for parking and boat launching and by hunters thinning themselves out as a way to minimize conflict with other hunting parties.

Strategies

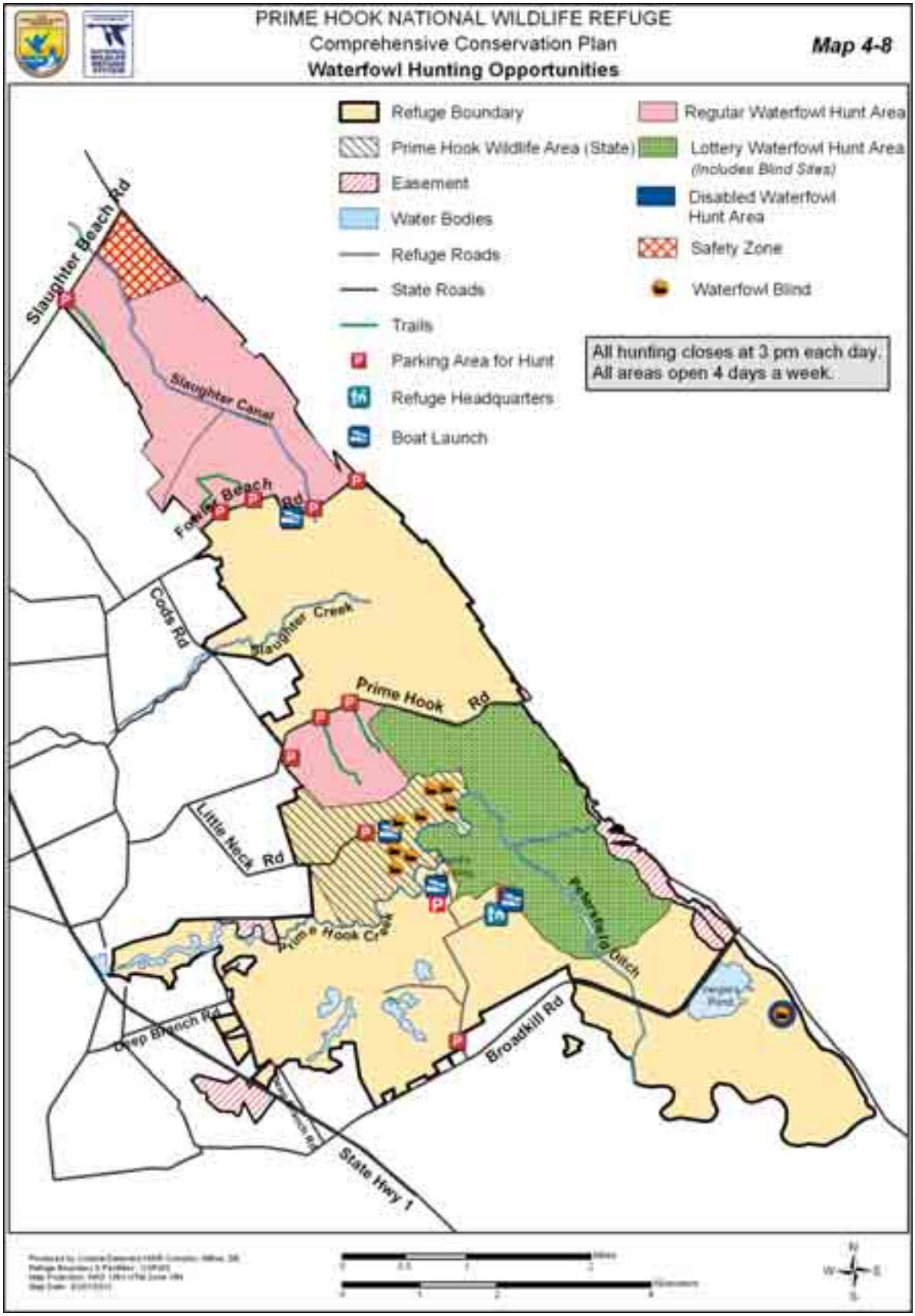
In addition to objective 5.1 strategies:

- Create waterfowl sanctuaries (disturbance free areas) in Unit II (approximately 1,800 acres), Unit III (approximately 390 acres), and Unit IV (approximately 995 acres)
  - The Unit II impoundment area will be closed annually to all public use.
  - Except for the disabled waterfowl hunt area (approximately 25 acres), most 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 or for wild turkey.

To support waterfowl conservation efforts, the refuge has designated about 3,185 acres as waterfowl sanctuaries that will be closed to hunting and other recreational use on a seasonal or annual basis. These sanctuaries lie in Unit II (1,800 acres), the southern half of Unit III (390 acres), and most of Unit IV (995 acres) and provide resting and feeding habitat for waterfowl to concentrate rather than dispersing throughout the refuge. These sanctuaries function to provide migrating waterfowl with a more balanced and effective network of feeding and resting areas, to minimize disturbance to feeding and resting waterfowl, and to provide waterfowl hunters with more equitable hunting opportunities throughout the refuge.

- Establish hunter spacing limits
  - Reduce hunter competition and improve hunting quality

Map 4-8. Waterfowl Hunting Opportunities



- 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 will provide greater opportunity for hunters

- Expand hunting opportunities from 1,722 acres to 3,432 acres or 40 percent of the refuge to include new hunting opportunities in Unit I and III. We must follow the guidelines of the 40 percent rule. All areas approved for purchase by the Migratory Bird Conservation Commission prior to 1978 are inviolate sanctuaries and thus subject to the 40 percent limitation, meaning only 40 percent 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 with the following restrictions:

    - Hunting will be on a first-come, first-served basis that includes jump shooting (except for lottery hunts and disabled hunts).

    - In all waterfowl hunting areas, hunting is permitted four days per week until 3pm during the state waterfowl hunting seasons (except everyday during the snow goose conservation order).

    - Check-in and check-out by hunters will not be required for any waterfowl hunt.

- Phase-out permanent waterfowl hunting blinds over a 5-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 and disabled waterfowl hunt area).

  - Hunters will be required to hunt from hunting blind site areas in the lottery waterfowl hunt area and disabled 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 system.

- Enhance hunting opportunities for individuals with disabilities, particularly for non-ambulatory wheelchair users.

  - Reestablish areas for nonambulatory wheelchair hunters permanently in a designated area in Unit IV.

  - One disabled, wheelchair accessible, and camouflaged waterfowl hunting blind is available.

- Provide lottery hunts in the lottery waterfowl hunt area and disabled waterfowl hunt area.

  - Through a preseason lottery drawing, hunters must choose their hunt dates and blind site locations from among the designated blind locations.

- Only the first two days of each of the state's seasonal hunting splits for waterfowl will be included in the preseason drawing for the disabled waterfowl area and will be first-come, first-serve thereafter.

- Within 5 years of CCP signing, we will open boat ramp access at Foord's Landing 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 hunts, resident Canada goose season, and snow goose season (early and 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.

  - Institute lethal snow goose control and 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-served basis everyday of the season during legal shooting hours.

    - The light goose conservation order is an action implemented under the final environmental impact statement on the management of light geese (USFWS 2007a) 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.

    - Hunting is not permitted in upland areas.

  - The youth hunts will occur in all designated hunting areas on a first-come, first-served basis.

  - In the lottery hunt area and disabled waterfowl hunt area, snow geese may only be taken 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 4 p.m.

Objective 5.1c Upland Game and 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, and woodcock).

Rationale

In addition to the information presented under objective 5.1, upland game and webless migratory bird hunting will remain the same at 1,995 acres. However, the dove hunting acres will be decreased by 110 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 4-9 depicts upland game and webless migratory bird hunting opportunities and infrastructure.

Strategies
In addition to objective 5.1 strategies:

- Continue upland game and webless migratory bird hunting opportunities on 1,995 acres (110 of the total acres will not be open to dove hunting). See objective 5.1b for explanation of 40 percent migratory bird hunting rule.
  - The refuge has adopted State hunting regulations and seasons for the upland game hunting area with the following restrictions:
    - Provide new hunting opportunities for red fox.
      - Hunting of red fox is permitted only when concurrently hunting deer and is only permitted in areas open to deer hunting.
      - Chase hunting is prohibited.
      - Rimfire or centerfire rifles are prohibited.
    - Dove hunting is open in the upland game hunting area except the designated area north of Prime Hook Beach Road.
    - Squirrel hunting is prohibited due to presence of the endangered Delmarva fox squirrel on the refuge.
    - Hunters will not be required to report their harvest data to the refuge.
    - Hunting will be on a first-come, first-served basis. Check-in and check-out by hunters will not be required for any upland game and webless migratory bird hunt.
      - Hunters must be out of the hunting areas one-half hour after legal shooting hours.

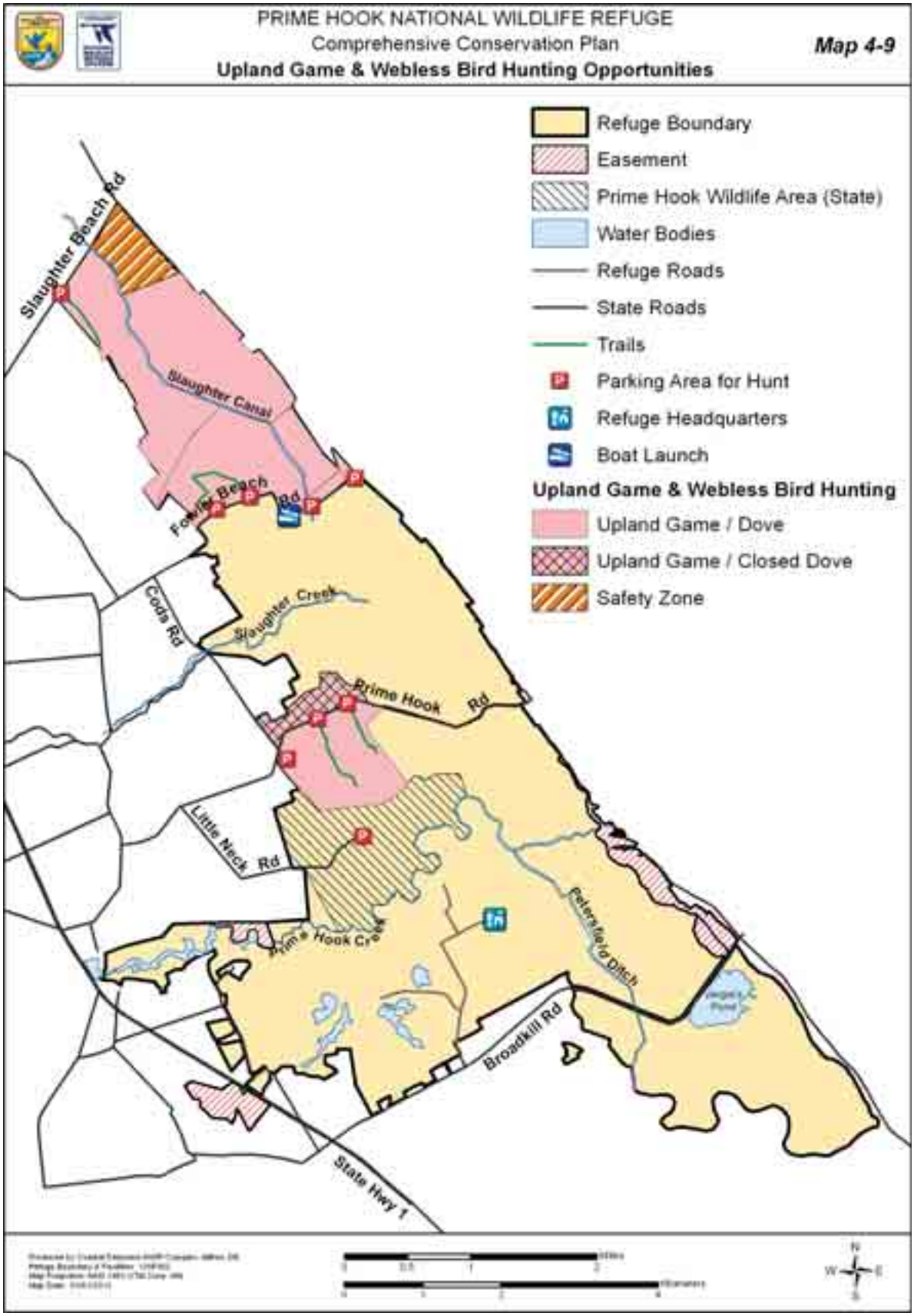
Objective 5.1d Wild Turkey Hunting

Provide high-quality hunting opportunities for turkey.

Rationale
Wild turkey is a resident game species that is managed by DNREC's Division of Fish and Wildlife. Prime Hook NWR falls within Zone 9 of DNREC's Wild Turkey Management Regions. Zone 9, which includes the state-owned Prime Hook Wildlife Area that is adjacent to the refuge, is currently open during the spring turkey hunting season. To ensure a sustainable harvest of the state's turkey population, DNREC biologists track their health, distribution and reproductive success. Current efforts include a volunteer-based survey used to generate an index of annual turkey productivity and recruitment, monitoring turkey harvest and hunter efforts, tracking turkeys with radio transmitters to evaluate their reproductive ecology, habitat use, and survival, and evaluating the genetic diversity of turkeys.

We will provide new opportunities for hunting wild turkey on 3,729 acres for a limited number of hunters. 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, the opportunity was discontinued. In recent years, hunter and staff

Map 4-9. Upland Game and Webless Bird Hunting Opportunities



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, or impacts to natural resources. Map 4-10 depicts turkey hunting opportunities and infrastructure.

Strategies
In addition to objective 5.1 strategies:

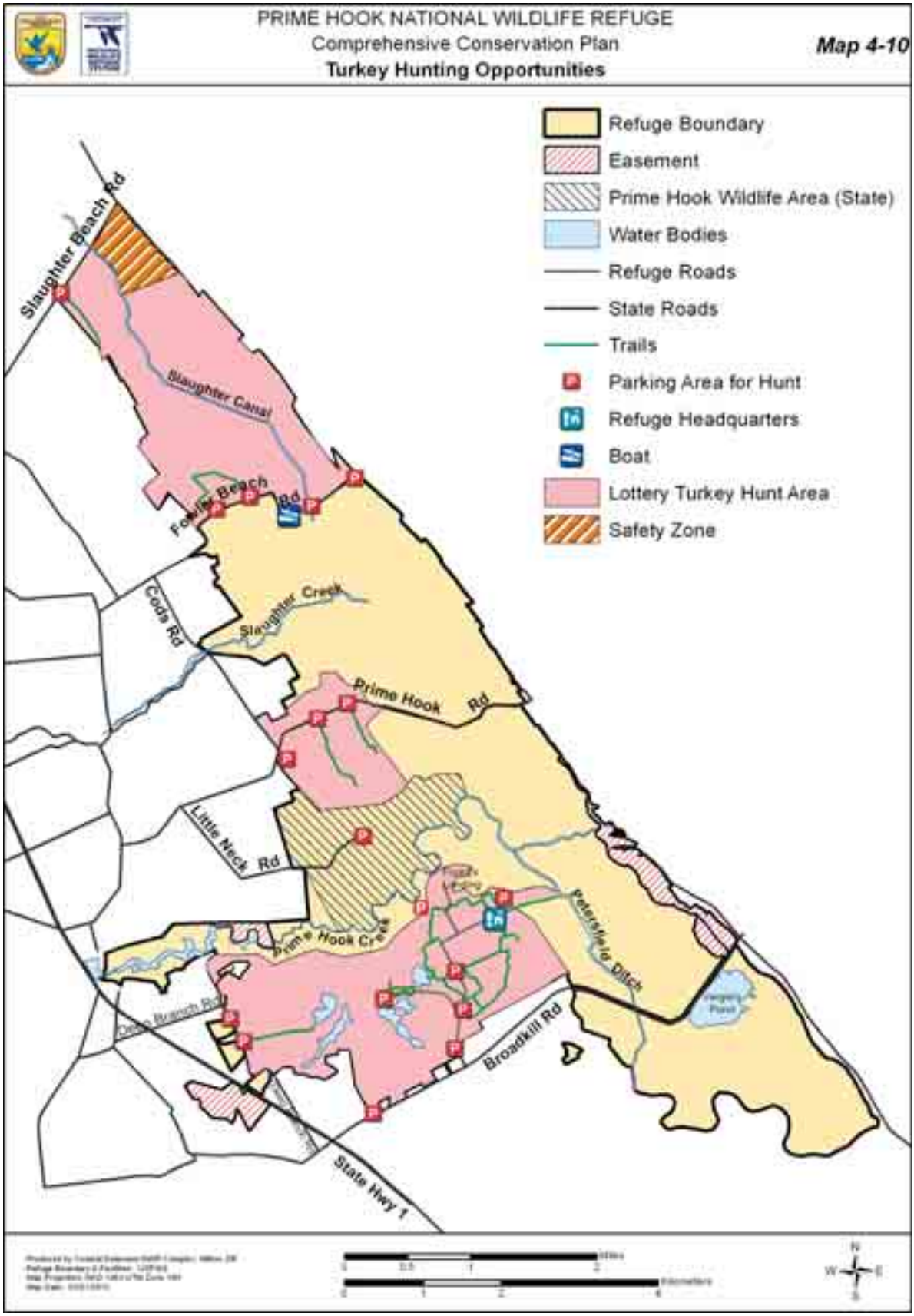
- Collaborate with the Delaware Division of Fish and Wildlife to evaluate the status of the wild turkey population on the refuge. Hunting will be permitted if State and refuge personnel determine that the turkey population in the area is sufficient to support hunting on the refuge.
  - Consult with the 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 to a limited number of hunters (no more than five) 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 may be administered by the Delaware Division of Fish and Wildlife and if so, application and permit fees may be waived.
  - Conduct a preseason lottery drawing. No daily standby drawings will be conducted.
  - During hunts, all public access will be closed in designated hunt areas during legal hunting hours.
  - Participate in the statewide youth/non-ambulatory disabled turkey hunt.
  - The number of permitted hunters may be adjusted (increased or decreased) based on changes in turkey population data.
  - Enhanced opportunities for scouting will be allowed during designated dates and times.

Objective 5.2 Wildlife Observation and Photography

Provide high-quality wildlife observation and photography opportunities.

Rationale
Wildlife observation constitutes the majority of the use on the refuge throughout the year, with refuge staff estimating that 90 percent of visitors engage in this activity. Wildlife observation is the primary reason both visitor and community residents visit the refuge, as indicated by the survey conducted on behalf of the Service (Sexton et al. 2007). The survey also found that being in a natural, undeveloped area and experiencing a serene environment are equally important to the refuge experience as are the trails that afford this opportunity (Sexton et al. 2007). Both visitors and community residents (consumptive and non-consumptive users) appear satisfied with the level of services or features currently offered by the refuge; however, a number of respondents indicated that they would like to see increases or improvements in wildlife viewing opportunities, environmental education, interpretive exhibits, and hiking or nature trails (Sexton et al. 2007).

Map 4-10. Turkey Hunting Opportunities



To improve the refuge's wildlife observation and photography program, we evaluated wildlife observation and photography on the refuge, incorporated the opinions of birders, nature photographers, hikers, etc., 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 preferences and opportunities for wildlife observation and photography, strive to meet the guiding principles for a quality refuge wildlife observation and photography program identified in Service policy 605 FW 4 and 5. They also support the Refuge System Improvement Act of 1997, which identifies wildlife observation and photography as priority wildlife-dependent recreational opportunities that should be offered on refuges when deemed to be compatible.

Maintaining quality infrastructure and providing new facilities will enhance visitor opportunities to view the relationships among resource management, wildlife, habitat, and people. Opportunities for wildlife observation and photography have been expanded to include seven new trails totaling 3.7 miles throughout the refuge in all four management units on existing maintained trails or interior refuge roads, bringing the total number of trails to 14 and 9.9 miles. Other expanded opportunities include the developing interpretive material highlighting wildlife viewing and photography areas along adjacent State roads, improvements to roadside viewing areas along Prime Hook Beach Road and Broadkill Beach Road, constructing a photography blind along a restored wetland area, and enhancing opportunities for disabled individuals.

We will impose limited seasonal closures in areas of the refuge that provide opportunities for wildlife observation and photography. One new closure will be the closure of the eastern portion of Prime Hook Creek from September 1 through March 15. We will continue to allow year-round access to the western 4 miles of Prime Hook Creek for visitors engaged in uses such as wildlife observation, wildlife photography, and fishing Additional seasonal closures may apply until the second Saturday in May for hunting during the snow goose conservation order or turkey hunting.

At first glance, these seasonal closures give the appearance that opportunities for wildlife observation and photography are being significantly reduced or totally eliminated for over eight months during the proposed expanded hunting activities. To the contrary, the majority of the refuge will remain open to wildlife observation and other non-consumptive uses and provide more opportunities and open areas than under current management. The headquarters area remains available 363 days a year for non-consumptive uses, but portions may be closed for turkey hunting. All other areas except for the Deep Branch Trail, Fowler Beach Road trail (southside), and Prime Hook Creek are open on every Sunday during the hunting seasons. The Deep Branch Trail, the Fowler Beach Road trail (southside), and Prime Hook Creek are open with seasonal closures of every day from September 1 through March 15 and if necessary during the snow goose conservation order or turkey hunting seasons. If and when the photography blind is available on the southside of Fowler Beach Road, this portion of the trail will be open year-round and open every Sunday during the hunting season. The majority of the hunting will occur during the main hunting season, which typically runs for five months from September through January, with additional hunting opportunities for rabbit through the end of February. The actual season length, including starting and ending dates, will vary annually, and the actual number of huntable days will vary annually as well. For example, the Federal framework only permits a maximum of 60 days hunted during the waterfowl season, but because of additional restrictions imposed by the refuge (e.g., only allowing waterfowl hunting 4 days a week rather than 6 days a week), the regular duck season on the refuge will actually be approximately 40 days, and only to 3 p.m. on those days. Hunting during the snow goose conservation order, which will occur for 2 ½ months from late January through mid-April, will take place mostly in the wetland areas, leaving the upland areas open to other uses. This hunt is not

anticipated to bring large numbers of hunters, but is beneficial to the species and other wildlife due to overpopulation. With five or fewer turkey hunting permits issued in April and May, a vast majority of the refuge will still remain open to wildlife observation and other non-consumptive uses.

During public involvement for the CCP, some questioned why hunters are often allowed to go into some areas that the non-consumptive public is not allowed. The time of year, the numbers of people, and the opportunities afforded at other areas, and how these relate to habitat and wildlife, all go into our consideration. Since the number of hunters is significantly smaller than the number of people who observe wildlife at the refuge, the amount of people on the area is easier to plan, control and monitor. The relatively smaller number of hunters also do not have the same trampling effects on vegetation, especially from September through January, than the unregulated general public could create. As far as clearing new areas for wildlife viewing, we feel as though removing habitat for the sole purpose of increasing wildlife viewing opportunities conflicts with the Service mission and refuge's purposes because the reduction of habitat may decrease the biological diversity and the integrity of the area. Removing habitat fragments the landscape and may reduce the potential viewing of many species that are area-dependent or have specific habitat requirements. We also feel that the refuge has sufficient parking areas, hardtop roads, foot trails, and observation towers available for physical and visual access to wildlife. Refuge staff will continue to evaluate the wildlife observation and photography program on an annual basis and modify it, as warranted, given new biological or visitor data. This plan reflects a balanced and measured increase in facilities and opportunities for wildlife observation and photography, while continuing to meet fish and wildlife protection and management responsibilities. Map 4-6 depicts wildlife observation and photography opportunities and infrastructure.

Strategies

- Continue to provide wildlife observation and photography opportunities.
  - Refuge headquarters area
- Maintain 6 miles of hiking trails that include the Blue Goose Trail, Photography Blind Trail, Dike Trail, Black Farm Trail, Pine Grove Trail, and Boardwalk Trail.
- Maintain the photography blind on the Photography Blind Trail and observation platform (wheelchair accessible) on the Dike Trail.
- Provide canoeing and kayaking access on Turkle and Fleetwood Ponds.
- Maintain the visitor contact station at refuge headquarters and allow the sale of refuge approved items by the Friends of Prime Hook through a signed memorandum of agreement.
- Area open year-round except when closed for deer hunts.
  - Prime Hook Creek (includes mainstem of creek and Headquarters Canal)
- Maintain the 7-mile Canoe Trail and associated boat ramps for canoeing and kayaking.
  - Slaughter Canal
- Provide opportunities along the canal from Fowler Beach Road to Slaughter Beach Road. Access is by boat only.
  - Fowler Beach

- Continue to permit use by the general public on beach except during seasonal closures.
  - Prime Hook Beach Road and Broadkill Beach Road
- Maintain and enhance existing roadside pull-offs.
- Area is open year-round.
  - Water control structures at Petersfield Ditch, Slaughter Canal, and Cods Road are open year-round.
- Expand or enhance wildlife observation and photography opportunities by creating seven new trails totaling 3.7 miles using existing and already maintained trail and road networks. The total number of refuge trails becomes 14 with 9.9 miles.
  - Except as noted below, access to all areas is provided everyday throughout the year from one-half hour before sunrise to one-half hour after sunset. Seasonal restrictions in areas where hunting occurs will allow access on every Sunday from September 1 through the deer and waterfowl hunting seasons, which typically end in February. Additional seasonal closures may apply through the second Saturday in May for hunting during the snow goose conservation order or turkey hunting. Due to the low number of permitted turkey hunters afield and that snow goose hunters will be hunting in wetland areas, a vast majority of the refuge will still remain open to wildlife observation and other non-consumptive uses.
    - Unit I—Slaughter Beach Road (Slaughter Woods) Trail (NEW)
      - Create a one to two space parking lot and use the existing interior road as the trail. The location of the existing parking lot will not be used for this trail because it creates safety issues by requiring visitors to walk along the roadside.
      - Opportunities available year-round but only open every Sunday during the hunting season.
      - Unit I—Slaughter Canal (existing, but previously promoted for only fishing).
      - Opportunities available year round but only open every Sunday during the hunting season.
    - Unit I—Willow Oak Trail (NEW)
      - Located north of Fowler Beach Road, access will be provided using the existing trail network.
      - Opportunities available year round but only open every Sunday during the hunting season.
    - Units I and II—Fowler Beach (existing)
      - Open year-round with seasonal closures of designated beach dunes and overwash areas from March 1 through September 1.
      - Adaptive management is necessary if Fowler Beach Road, from Slaughter Canal to its terminus at the Delaware Bay, is abandoned

by DelDOT and donated to the Service. If, upon DelDOTs removal of the existing layer of asphalt overlying unconsolidated fill, the walking trail will serve its purpose of public use until marsh vegetation and hydrologic function reclaim the trail and the formally bisected habitat (Units I and II) function as one unit. When conditions are deemed unsafe, access will not be permitted to Fowler Beach for public use opportunities such as wildlife observation, wildlife photography, and fishing.

- Unit II—Fowlers South Trail (NEW)
  - Use existing interior road to provide access
  - Provide parking area at existing gate on north side of Fowler Road
  - Explore the possibility of providing access to seasonal wetland (if developed) with a wheelchair-accessible photography blind
  - Open with a seasonal closure of every day from September 1 through March 15 and if necessary during the during the snow goose conservation order or turkey hunting seasons.
  - If and when the photography blind is available, the portion of this trail from the trailhead to the photography blind will be open year round and open every Sunday during the hunting season.
- Unit III—Prime Hook South Trails (NEW)
  - Use existing parking lots and interior roads to provide access
  - Increase nesting boxes for tree swallows and bluebirds through volunteer support where the public may observe wildlife activity
  - Opportunities available year round but only open every Sunday during the hunting season
- Unit III—Deep Branch Road (Goose Pond) Trails (NEW)
  - Using the existing hunting parking areas and interior road to provide access
  - Open with a seasonal closure of every day from September 1 through March 15 and if necessary during the snow goose conservation order or turkey hunting seasons.
- Unit III—Refuge headquarters area (existing with NEW trail)
  - Improve the trail base for the dike portion of the Blue Goose Trail
  - Create the Broadkill Dike Trail (NEW)
  - Open a portion of the existing interior road near the deer check station building to provide additional parking and wildlife observation opportunity.
  - Open 363 days a year (closed for two deer hunts) and portions may be closed for turkey hunts.

- Unit III—Prime Hook Creek (includes mainstem of creek & Headquarters Canal; existing)
  - Open with a seasonal closure of Eastern Prime Hook Creek (from Foord's Landing to headquarters 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.
- Unit IV—South of Broadkill Beach Road (NEW; existing but not currently open)
  - Reevaluate the trail and observation platform overlooking Vergie's Pond
  - Option 1: Keep the existing trail and create a parking lot at the existing trail head.
  - Option 2: Abandon and remove the existing walkway. Reroute the trail to the east and construct a smaller, less intrusive boardwalk and trail to the firebreak and existing tower and a three to five space parking lot on the existing high ground.
  - Open with a seasonal closure from the Monday before Thanksgiving through March 15 and if necessary during the during the snow goose conservation order hunting season.
- All Units—Interpretive auto tour route
  - Create an interpretive brochure outlining the wildlife viewing areas, trails, pull-offs, etc., that can be accessed from public roads and highways
  - Investigate the potential to use advanced technology (radio, compact disc, cell phones, or downloadable programming) to provide visitors with interpretive material about the refuge related to wildlife observation and photography.
  - Open year-round.

- Improve access at boat launching areas.
  - Upgrade boat ramp access on Fowler Beach Road for access to Slaughter Canal
  - Designate Slaughter Canal a no wake zone.
  - 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 Foord's Landing for access to Prime Hook Creek
    - Provide visitor opportunities to canoe or fish for 3 miles in a loop, eliminating the need for two vehicles due to close proximity of the launch area at the refuge office.
- Eliminate boat launching fees at all refuge boat ramps.
  - Maintenance to boat ramps and parking areas will be funded through deferred maintenance projects

- Within 5 years of the CCP approval, develop a visitor services plan for the refuge.
- Add a new full-time law enforcement officer to enforce regulations.
- Enforce general regulations for wildlife observation and photography.
  - No refuge-specific permits are required.
  - Visitors must stay on the designated trail routes.
  - Bicycling is allowed only on roads open to public vehicular traffic.
  - The visitor contact station is open weekdays from 7:30 a.m. to 4 p.m. and seasonally on weekends.

Objective 5.3 Recreational Fresh and Saltwater Fishing and Crabbing

Provide high-quality fishing and crabbing opportunities.

Rationale

Fishing and crabbing on the Delmarva Peninsula are traditional outdoor pastimes and are deeply rooted in our American and Delaware heritage. Fishing accounts for 10 percent of the total visitation to the refuge (or nearly 10,000 annual visitors). Fishing has and will continue to be an integral component of the public use program at the refuge.

The opinions by the visiting public and community landowners were surveyed in 2004 and 2005 by USGS on behalf of the refuge (Sexton et al. 2007). About 20 percent of visitor respondents indicated that they fished on the refuge and had been fishing there an average of 11 years. When asked about the importance of fishing activities, all of the responses rated it as moderately important, and most anglers (89 percent) feel the refuge provides a quality fishing experience. Fishing on Prime Hook Creek was slightly more important than fishing at the water control structures and at Fleetwood and Turkle Ponds. Very few comments regarding improvements were made. A few respondents mentioned water levels, better access to some fishing areas, and providing catch-and-release fishing areas.

To improve the refuge's recreational fishing and crabbing program, we evaluated fishing on the refuge, incorporated the opinions of anglers and crabbers, 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 fishing preferences and opportunities, strive to meet the guiding principles for a quality refuge fishing program identified in Service policy 605 FW 3. They also support the Refuge System Improvement Act of 1997, which identifies fishing as one of the priority wildlife-dependent recreational opportunities that should be offered on refuges when deemed to be compatible.

Increasing fishing opportunities on the refuge will serve the demand for more fishing opportunities in Sussex County. Improved habitat quality resulting from proposed habitat restorations on the refuge will likely result in improving water quality and increasing some fish populations. This could positively affect the fishing experience and fishing success.

Bank and boat fishing opportunities have been expanded, where possible, to include additional areas for fresh and saltwater fishing. Some of the program changes include allowing saltwater fishing at Fowler Beach during nighttime hours, eliminating boat launching fees at all refuge boat ramps, opening Goose and Flaxhole Ponds as primitive fishing area (boat only access, manual propulsion only, boats must be ported in), and implementing seasonal closures to protect wildlife and reduce user conflicts.

A fishery assessment conducted at Prime Hook NWR in 1994 (USFWS 1994) recommended that consideration be given to opening Flaxhole Pond due to the healthy and desirable sport fishery in the pond at that time. Access to these ponds was noted in the refuge's 1986 fishing plan as an obstacle to providing this use for visitors. However, the refuge has since acquired land that will provide that access.

To minimize fishing mortality and increase the quality of fishing, we propose to adopt catch-and-release regulations, including the mandatory use of barbless hooks, for Turkle Pond, Fleetwood Pond, Goose Pond, Flaxhole Pond, and Prime Hook Creek west of Foord's Landing.

We have proposed seasonal closures in new and existing areas that will provide opportunities for fishing; these are discussed in detail in the strategies below. One new closure is the closure of the eastern portion of Prime Hook Creek from September 1 through March 15. Additional seasonal closures may apply until the second Saturday in May for hunting during the snow goose conservation order or turkey hunting.

The refuge proposes to allow fishing and crabbing at the pulloffs along Prime Hook Road due to increased visitor demand in this area and existing pulloffs already provide safe parking areas for wildlife observers and photographers. Access is restricted to only the pulloff area to provide safety for visitors and to avoid traffic issues. The refuge will consider fishing and crabbing along Broadkill Road and Fowler Beach Road in the future if there is a demand and if visitor safety and adequate parking can be guaranteed. Adequate parking and visitor safety along State-maintained roads has historically been an issue. Crabbing decreased significantly from 3,644 visits in 1976 to 880 visits in 1977 due to new regulations making state highway bridges into refuge waterways off limits in an effort to increase pedestrian safety along these roads.

The refuge will continue to partner with local bass fishing clubs to promote fishing to youngsters, provide opportunities for disabled anglers, conduct fishery assessment surveys in refuge waters, and make management recommendations.

The implementation of the refuge fishing program is consistent with State regulations and additional refuge regulations stipulated in 50 CFR. We will continue to evaluate the program on an annual basis and modify it, as warranted, given new biological or visitor data. This plan further develops an appreciation for fish and wildlife and expands public fishing opportunities. Map 4-6 depicts recreational fishing and crabbing opportunities and infrastructure.

Strategies

- Continue to provide fishing and crabbing opportunities in accordance with the State of Delaware fishing, crabbing, and boating regulations and seasons to include the following areas:
  - Slaughter Canal between Fowler Beach Road and Slaughter Beach Road (boat access only)
  - Slaughter Creek at Cods Road and water control structures at Petersfield Ditch and Slaughter Canal (shore access only; boats are not allowed at Slaughter Creek and Petersfield Ditch) open year-round
  - Prime Hook Creek (boat access only; includes mainstem of creek and Headquarters Canal)
  - Turkle and Fleetwood Ponds in headquarters area (boat and shore access): open year-round except when closed for deer hunts

- Fowler Beach (surf fishing from shore only)

- Open Slaughter Canal between Fowler Beach Road and Slaughter Beach Road year round and only on Sundays from September 1 through the deer and waterfowl hunting seasons, which typically end in February. Additional seasonal closures may apply through the second Saturday in May for hunting during the snow goose conservation order or turkey hunting.

- Close Prime Hook Creek (mainstem of the creek and Headquarters Canal) to anglers during the following:

  - Eastern Prime Hook Creek (from Foord's Landing to headquarters 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 or turkey hunting.

- Expand fresh and saltwater fishing and crabbing opportunities to include the following areas:

  - Open Fowler Beach (shore only) to night fishing by permit only

  - Open Goose and Flaxhole Pond

    - Designate this new area as a primitive fishing area.

    - Provide access by boat only; manual propulsion only; float tubes allowed.

    - Anglers must use the existing parking area and walk and carry in boat.

    - Closed every day from September 1 through March 15 to avoid conflicts with deer hunting and minimize disturbance to waterfowl. Additional seasonal closures may apply through the second Saturday in May for hunting during the snow goose conservation order or turkey hunting.

    - Area will remain closed until fishery and contamination surveys are completed and management recommendations are made (see objective 3.2 of habitat management objectives).

  - Open Prime Hook Beach Road to fishing and crabbing

    - Parking only allowed on existing pulloffs and access is restricted to the pulloff area to provide safety for visitors and to avoid traffic issues.

    - The refuge will consider fishing and crabbing along Broadkill Road and Fowler Beach Road in the future if there is a demand and if visitor safety and adequate parking can be guaranteed.

  - Adopt catch-and-release regulations, including the mandatory use of barbless hooks, for Turkle Pond, Fleetwood Pond, Goose Pond, Flaxhole Pond, and Prime Hook Creek west of Foord's Landing.

    - Regulations, such as catch-and-release and the use of barbless hooks, may be modified if fishery surveys and analysis indicate that other management options are needed to sustain healthy fish populations such as creel or size limits.

- Conduct refuge fishery inventories every 5 years to assess fishery health and water quality of aquatic habitats; documented information should consist of 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, etc.).

- Eliminate boat launching fees at all refuge boat ramps.
  - Maintenance to boat ramps and parking areas will be funded through deferred maintenance projects.
- Do not allow recreational gill-netting, commercial fishing, food fishing with equipment other than hook and line on the refuge, or crabbing using pots or trot lines.
  - The use of gill netting by commercial or recreational fishermen has occurred in the tidal waterways of Slaughter Canal for over 30 years by a small number of fishermen. These activities, whether commercial or recreational, are not consistent with goals and objectives in any refuge management plan, conflict with rod and reel recreational fishermen and wildlife observers using canoes or kayaks, and has the potential to harm non-targeted fisheries through incidental by-catch. Fishing for bait fish is permitted for recreational uses only, subject to regulations stated in Title 7 (Conservation) of the Delaware State Code.
  - Crabbing will only be permitted using hand lines, collapsible traps, crab nets, or hoop crab nets. Collapsible traps must be fished from the shore only and the owner must be present. Other types of crabbing equipment are prohibited. The use of crab pots could conflict with 16USC668dd, 50CFR 27.93, abandonment of property, on a national wildlife refuge, if left unattended, and the use of trot lines would cause conflicts with other recreational activities, particularly on Slaughter Canal.
- Increase or enhance disabled fishing opportunities, particularly for non-ambulatory wheelchair users, at the wheelchair-accessible fishing pier on Fleetwood Pond.
- 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 the western end of Prime Hook Creek.
  - Within 5 years of the plan, open a boat ramp at Foord's Landing for access to Prime Hook Creek.
  - Designate Slaughter Canal as a no wake zone.
- Provide information about fish consumption advisories and water level management on refuge waterways at the refuge office, refuge kiosks, and on the refuge's Web site.
- Harvest information is not required.
- Restrict bank fishing (where permitted) to designated areas off of State-maintained highways at Petersfield Ditch, Slaughter Creek, and Slaughter Canal.
- No check-in/out required.

- Within 5 years of the CCP approval, develop an updated fishing plan for the refuge.
- General regulations for recreational fishing and crabbing
  - No refuge-specific permits are required, except for night fishing at Fowler Beach.
  - Catch and release regulations apply, including mandatory use of barbless hooks, for Turkle Pond, Fleetwood Pond, Goose Pond, Flaxhole Pond, and Prime Hook Creek.
  - Boats must be ported in by foot from the parking areas to Goose and Flaxhole Ponds.
  - Boat motor restrictions.
- Manual propulsion only on Goose and Flaxhole Ponds
  - Crabbing will be conducted using only hand lines, collapsible traps, crab nets, or hoop crab nets. Collapsible traps must be fished from the shore only and the owner must be present. All other types of crabbing equipment are prohibited.

Objective 5.4 Environmental Education and Interpretation

Provide high-quality environmental education and interpretation opportunities.

Rationale

Interpreting the resources and challenges of the refuge to the general public and incorporating these topics into school curricula are important ways to influence the future well-being of the refuge and the Delmarva Peninsula. Only through understanding and appreciation will people be moved to personal and collective action to ensure a healthy refuge for the future. Interpretation and environmental education are also key to changing attitudes and behavior, which affect the refuge through off-refuge land-use decisions and on-refuge conduct and use.

The refuge provides onsite and offsite environmental education and interpretive programs to visitors of all ages and abilities. Programs include structured educational field programs tied to national and State education standards, guided interpretive canoe and hiking trips, special events, lecture programs, self-guided interpretive hiking trails, interpretive signs and displays, the visitor contact station/Friends Group sales outlet, refuge Web site, and refuge brochures. The refuge also conducts interpretive programs to local civic organizations and displays refuge information at numerous offsite events. We estimate that our environmental education and interpretation programs reach over 5,400 people a year. Refuge volunteers and Friends Group members play a considerable role in the success of these programs, which would not be possible without their assistance. Interpretive refuge themes focus on the awareness and importance of the conservation of waterfowl and other migratory birds, the endangered Delmarva fox squirrel and other threatened or endangered species, and their habitats.

To improve environmental education and interpretation on the refuge, we evaluated these programs, incorporated the opinions of visitors and community residents, 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 preferences and opportunities for environmental education and interpretation, strive to meet the guiding principles for a quality refuge environmental and interpretive program identified in Service policy 605 FW 6 and 7.

Expanded and enhanced opportunities in environmental education and interpretation will be accomplished through developing and implementing more interpretive guided walks (fishing, birding, nature), interpretive auto tour and hiking routes using advanced technology (radio, compact disc, cell phones, or downloadable programming), and a new public use map and regulations tear sheet, in addition to the revitalizing of the waterfowl festival in October, and continuing existing programs. The refuge also proposes to expand the visitor contact station/refuge office building. This expansion will provide offices for staff, volunteers, and the Friends Group, feature a larger auditorium, and provide storage for biological and public use programs.

This objective reflects an increase in interpretation and environmental education capability and programs. It also reflects the basic needs for a refuge to provide the necessary facilities to inform and educate visitors and help them make the most of their refuge visit. Since environmental education is curriculum-based and labor-intensive, initial efforts will be limited with existing staff, but will increase if and when staff are added.

Refuge staff will continue to evaluate the environmental education and interpretation programs on an annual basis and modify them, as warranted, given new biological or visitor data. This plan reflects a balanced and measured increase in facilities and opportunities for environmental education and interpretation, while continuing to meet fish and wildlife protection and management responsibilities. Map 4-6 depicts facilities and infrastructure used to support environmental education and interpretation.

Strategies

- Conduct environmental education and interpretive programs in the following areas of the refuge: Headquarters Area including but not limited to hiking and canoeing trails, visitor contact station, Turkle and Fleetwood Ponds; Fowler Beach; and at roadside pull-offs along Prime Hook and Broadkill Beach Roads.

- Continue to facilitate educator-led environmental education programs that focus on refuge key resources and messages for local schools, scout troops, and other organized education-oriented groups.

  - Integrate existing Service national education programs into the refuge's education program. In particular, consider the Shorebirds Sister Schools program, especially in combination with the Delaware Aquatic Resources Center's Green Eggs and Sand program. Other programs to consider include Hands on the Land and the Nature of Learning.

  - Continue to partner with local educational institutions, refuge volunteers, Friends of Prime Hook, and other partners to plan, develop, and implement environmental education programs. This network will act as supporters of the refuge, advocates for environmental education, and as a liaison to the community.

  - Continue to respond to requests for onsite and offsite environmental education and interpretive programs when staffing and funding allows.

- Continue to enhance detailed environmental education and interpretive programs for the refuge.

- Continue to provide interpretive materials and programs explaining the historic, cultural, and natural resources of the refuge to gain public awareness and understanding of their value.

  - Develop a tear sheet with public use regulations and a map that includes fishing information.

- Develop a hunting brochure containing regulations and associated maps, which will be available at the refuge office or on the refuge's Web site.
- Develop a new general refuge brochure.
- Develop an annual schedule of interpretive activities.
- Provide regularly guided field trips for nature, birding, fishing, photography, etc.
- Continue "An Evening at the Hook" monthly lecture series.
- Continue partnership with Friends of Prime Hook in hosting the Vandegrift memorial lecture series and annual nature photography contest and exhibition.
- Continue to provide self-guided interpretive facilities and materials, including signs, maps, kiosks, etc., for the Blue Goose Trail, Photography Blind Trail, Dike Trail, Black Farm Trail, Pine Grove Trail, Boardwalk Trail, Canoe Trail, and the trail and observation platform off Route 16 near Vergie's Pond.
- Continue to provide information to the public through the refuge's website.
- Continue to partner with Delaware Department of Transportation for maintenance of directional highway signage for the refuge.
- Continue to maintain a universally accessible full-service visitor contact station with a sales outlet operated by the Friends of Prime Hook. The visitor contact station will continue to include interpretive displays and various mounted species of animals found on the refuge and will be staffed mainly through volunteer support.
- Participate in national interpretive events such as National Fishing Week and International Migratory Bird Day.

- Continue partnership with Milton Chamber of Commerce in hosting the Horseshoe Crab-Shorebird Festival in May.
- Continue partnership with Lower Sussex Bassmasters to host an annual youth fishing tournament in Milton to celebrate National Fishing Week and promote fishing to youngsters.
- Conduct routine condition reviews of interpretive signs and information kiosks, and complete maintenance and sign replacement as needed.
- Enhance and continue to partner with local educational institutions, refuge volunteers, Friends of Prime Hook, and other partners to plan, develop, and implement environmental education programs that focus on refuge key resources and messages for local schools, scout troops, and other organized education-oriented groups. This network will act as supporters of the refuge, advocates for environmental education, and a liaison to the community.
  - Develop a partnership with a local school district or non-governmental organization to provide funding (full- or part-time) for an onsite education specialist to coordinate the development and implementation of curriculum based environmental education programs.
  - Evaluate the potential for adult educational partnerships through universities or programs such as Elder Hostel.

- Conduct environmental education and interpretive programs in newly opened areas outlined in objective 5.2.
- Offer curriculum-based programs developed by NASP to encourage family participation in archery shooting.
- Develop detailed environmental education and interpretive programs for the refuge that tiers to the visitor services plan.
- Increase and enhance interpretive materials and programs explaining the historic, cultural, and natural resources of the refuge to gain public awareness and understanding of their value.
  - Develop interpretive auto tour and hiking routes using advanced technology (radio, compact disc, cell phone, or downloadable programming).
  - Provide interpretive facilities and materials for newly opened areas outlined in objective 5.2.
  - Increase interpretive programs by providing more regularly guided field trips for nature, birding, fishing, photography, etc.
  - Implement a volunteer master naturalist program.
  - Develop new interpretive panels and maps for information kiosks near the refuge office and along State roads.
  - Revitalize the waterfowl festival, or similar event, celebrating National Wildlife Refuge Week in October only if additional staff is available.
  - Explore other partnerships to develop programs for various age groups.
- Expand the existing visitor contact station/refuge office building to provide offices for staff, volunteers, and the Friends Group, feature a larger auditorium, and provide storage for biological and public use materials.

Sea Level Rise and Climate Change Strategies:

- In conjunction with conservation partners, develop useful and accessible information resources to help Americans fully appreciate the significant implications of sea level rise and climate change on refuge species and their habitats, and to engage these constituencies in seeking solutions.
- Incorporate climate change and sea level rise information and messages into interpretive sign panels, brochures, Web sites, and environmental education programs.
- Hire a temporary staffing position to assist in these outreach efforts.

Objective 5.5 Other Recreational Use

Provide opportunities for the public to use and enjoy the refuge for traditional and appropriate non-wildlife-dependent recreation that is compatible with the purposes for which the refuge was established and the mission of the Refuge System.

Rationale

Public entry and use regulations serve to protect fish, wildlife, plants, and habitat. Public use regulations were last reviewed and amended in 1993. However, the resources and public use of the refuge are dynamic, and periodic review will ensure that regulations are needed, clear, and effective. In addition, new regulations may be required to safeguard resources or address new or emerging problems recognized by managers and law enforcement officers. An annual review will provide a more systematic process than in the past.

Some uses are not dependent on the presence of fish and wildlife; however, these activities are allowed to continue at designated locations in a manner that will give maximum consideration to the fish and wildlife purpose of the refuge. We estimate that approximately 2,000 visitors a year participate in one of these uses and are not counted in the numbers itemized under the six priority wildlife-dependent public uses described above.

Non-priority recreational uses that the refuge manager proposes as compatible on this refuge, with stipulations, are detailed in appendix E.

Strategies

- Refer to prohibited non-priority uses that are discussed earlier in the Appropriateness and Compatibility Determinations section.
- Allow the following non-priority uses that were found to be compatible on the refuge: research, mosquito control, and public leases of the Federal Aviation Administration tower.
  - Canoeing (includes boat and kayaking), walking, hiking, and jogging are allowed uses. These uses were considered as a means of access under the compatibility determinations.
- Allow commercially guided tours for wildlife observation (including commercially guided tours for continuing education). Adhere to Commercial Wildlife Observation Guide Program Stipulations found in appendix E and to information found in Specialized Uses in the section titled, Actions Common to All Alternatives.
  - Will require a special use permit and appropriate fee and minimal disturbance to wildlife resources and their habitat.
  - Will be covered by compatibility determinations for their respective uses (wildlife observation, wildlife photography, etc.)
- Provide the public and State of Delaware ample opportunity to review and comment on any new or substantially changed regulation.
- Use national guidance and *Federal Register* process for codifying any changes and make them a part of the CFR governing national wildlife refuges.
- Post pertinent regulations at boat landings and other public use areas, such as trailheads, informational kiosks, and the visitor contact station.
- Be proactive with law enforcement to inform and educate the public on refuge regulations and seek their compliance.
- Allow commercial photography.
  - Guidance in 43 CFR Part 5 will be followed for fees related to commercial filming and still photography.
- Prohibit commercial fishing, commercial trapping of muskrat, raccoon, etc., turtle trapping, picnicking, 5K road race, beekeeping, waterfowl retrieval permits, dog walking, roller blading, competitions or organized group events, and non-competitive organized events.

GOAL 6. Outreach and Community Partnerships

Collaborate with the local community and partners to complement habitat and visitor service programs on the refuge and the surrounding landscape.

Objective 6.1 Community Outreach

Increase community outreach by conducting up to 15 outreach programs or events[1] each year, and initiate up to 10 news articles to increase community understanding and appreciation of the refuge's significance to natural resource conservation and its contribution to the Refuge System, and to garner additional support for refuge programs.

Rationale

From the results of a refuge visitor and community survey conducted in 2004 and 2005 by USGS (Sexton et al. 2007), nearly a quarter of the community members and refuge visitors are unsure about their level of trust in decisions that the Service makes about managing the refuge. The community surrounding the refuge is aware of and engaged in natural resources decision-making in both passive activities, such as signing a petition, and active activities, such as joining a special interest group or attending a public meeting. It is important, if we are to be a valued part of the communities we serve, that we communicate often with our local citizens. News articles and personal appearances inform our neighbors about what we are doing and why, which we hope will lead to increased understanding, appreciation, and support of our programs. Feedback we receive from these outreach efforts allows us to better understand issues that are important in our communities, and how our management may affect them. A planning process such as development of the CCP is an opportunity to build relationships and improve trust not only with visitors and community residents with whom the refuge has established relationships, but also with those who are less familiar with the refuge or have not engaged in the process due to lack of trust in the agency or uncertainty of their role in the process.

Strategies

- Continue to conduct outreach in conjunction with refuge interpretive programs highlighted under objective 5.4.
- Continue to work within community forums such as the Milton, Milford, and Lewes Area Chambers of Commerce; Southern Delaware Tourism; town meetings; State Fish and Wildlife Advisory Council meetings; and other venues.
  - Continue to co-host or partner with local Chambers of Commerce and the Friends of Prime Hook NWR to conduct the following annual community events: horseshoe crab-shorebird festival in May, youth fishing tournament in June, nature photography contest in October, and the Vandegrift memorial series in summer/fall. While the main venues for some of these programs are in town, onsite programs are included when staffing and funding are available.
- Continue to issue news releases on significant accomplishments and to promote special events and announce major initiatives.
- Continue to maintain the refuge's Web site and post information on refuge kiosks.
- Continue to honor requests for speaking engagements by local community and civic organizations to inform members about refuge purposes and activities.
- Increase outreach in conjunction with interpretive programs under objective 5.4 by offering additional and more diversified activities, special events, or programs.

[1] *Note:* These events will be both onsite and offsite, and are the same (not additive) as those discussed under objective 5.4.

- Create and improve outreach materials and continue to issue news releases on significant accomplishments, advertise special events, and announce major management initiatives.
  - Update refuge fact sheets.
  - Create media press kit to promote events scheduled on the refuge.
  - Enhance Web page with virtual tours of the refuge and a wildlife webcam.
- Participate in those community service, professional association, and Chamber of Commerce events throughout the Delaware Bay ecosystem that will provide the greatest benefit to achieving goals and objectives and furthering the mission of the Refuge System.
  - Coordinate with the Delaware Division of Fish and Wildlife and other partners to develop outreach materials better explaining the refuge's habitat management and visitor services programs.
- Conduct public meetings, as needed, to facilitate communications and raise awareness and understanding of, and seek support for, refuge management programs.

Climate Change and Sea Level Rise Adaptation Rationale
DNREC conducted a survey to gauge the opinions of Delaware residents on climate change and sea level rise in 2010 and received more than 1,500 responses. The respondents were asked questions to gauge their knowledge, concerns, attitudes, perceptions, and opinions about the issues involving climate change and sea level rise. When asked to rank lists of general and environmental issues, respondents ranked climate change and sea level rise last on both lists (DNREC 2010). The survey indicated that Delawareans were aware of climate change and sea level rise and, while ranking those issues very low, they were concerned with other issues related to climate change and sea level rise, such as water pollution, air quality, and loss of forest habitat (DNREC 2010). The results of the survey illustrate that there is more work to be done to increase awareness of climate change and sea level rise. The refuge will work to better inform the public about climate change and sea level rise and relay how the Service and the refuge plan to address these issues.

The Service proposes as a goal in its draft appendix: 5-Year Action Plan for Implementing the Climate Change Strategic Plan (USFWS 2009b), that "We will engage Service employees, our public and private partners, our key constituencies and stakeholders, and everyday citizens in a new era of collaborative conservation to seek solutions to the impacts of climate change and other 21st century stressors to fish, wildlife, and habitats." Proposed actions include providing Service employees with climate change information, education and training; sharing climate change information, education, and training opportunities with external audiences; and forging alliances and creating forums on climate change to exchange information and knowledge and to influence policy internationally. Our strategies, as outlined in this document support this goal.

Sea Level Rise and Climate Change Strategies
In conjunction with conservation partners, develop useful and accessible information resources to help Americans fully appreciate the significant implications of sea level rise and climate change for refuge species and their habitats, and engage these constituencies in seeking solutions. These strategies are supported by the Service's strategic plan for responding to accelerating climate change objective 6.2.

- Incorporate these messages into interpretive sign panels, brochures, Web sites, and environmental education programs.

- Hire a temporary staffing position to assist in these efforts.

Objective 6.2 Private Landowner Assistance

Work with regional and State partners to develop a common, consistent message.

- Within 5 years of CCP approval, establish a greater role assisting landowners who seek to maintain and improve wildlife habitat on private lands within and adjacent to the refuge boundary.

Rationale

Our *Phragmites* control and education program, in conjunction with the wildland urban interface program, is one example of our successes in working with private landowners. We have partnered with more than 150 private landowners to control hundreds of acres of *Phragmites* on the refuge. We hope to continue this effort over time to keep this invasive plant from increasing its territory, and to use it as a model to assist landowners in controlling other invasive plants on private lands. We believe there are many landowners adjacent to the refuge boundary area who would gladly take on more responsibility to manage their lands to benefit wildlife whether for invasive species control or habitat restoration and enhancement, if they had assistance to get started. We will continue to utilize the Service's wildland urban interface program and seek assistance from the Service's private lands biologist. Additional staffing will expand refuge assistance to private landowners. There are funding sources specifically targeted for improving wildlife habitat on private lands that could be competitively directed to the refuge to implement on-the-ground projects.

Strategies

- Continue our current level of *Phragmites* control and other invasive plant initiatives on private land through programs such as wildland urban interface.
- Continue to provide technical assistance to private landowners on invasive species identification and control, wetland protection, and habitat restoration and management.
- Seek grants and other funding sources to assist private landowners.
- Expand our technical assistance capability to assist private landowners on invasive species identification and control, wetland protection, and habitat restoration and management.

Climate Change and Sea Level Rise Adaptation Rationale

Adaption to climate change and sea level rise requires the refuge to consider lands and waters outside the refuge boundaries. There are several partnership incentive programs that could be used to create collaborative conservation partnerships such as Partners for Fish and Wildlife, safe harbor agreements, habitat conservation plans, Natural Resource Conservation Service incentive programs, etc. These strategies are supported by the Service's strategic plan objective 2.3.

One example of a potential partnership is restoring the natural hydrology to lands that may or currently are impacted by sea level rise. In many cases ditches, some of which were dug more than 50 years ago to drain farmland and control mosquitoes, now serve to transport brackish water inland, a problem that could become increasingly prevalent as sea level rises. Saltwater intrusion into agricultural soils and peat collapse are major consequences of this process. Plugging ditches in selected places to reduce saltwater flow inland could be effective for local stakeholders. Another option is to install new water control structures, such as tide gates, in selected locations (Poulter et al. 2008). This technique is currently being used elsewhere on the Delmarva Peninsula. Plugging ditches will also help restore natural drainage patterns to the marshes.

Sea Level Rise and Climate Change Strategies

- Work with partners to identify how key ecological processes are likely to be affected by climate change

- Determine how management actions might help maintain or restore key ecological processes using the various incentive programs offered Federal and State agencies and other conservation organizations.

Objective 6.3 Regional and Community Partnerships

Within the next 15 years, enhance our existing partnerships, and seek additional, collaborative relationships with Federal, State, and local government agencies and regional and community economic development and conservation organizations to fulfill mutual natural resource conservation mandates and help us meet our wildlife, habitat, and visitor services objectives.

Rationale

Partnerships are essential for this refuge to accomplish natural resource conservation mandates and meet wildlife, habitat, and visitor service objectives. Working in partnership encourages broader cooperation between the Service and local communities, interest groups, and other agencies. The Service can be a resource to the community in providing valuable technical assistance to area conservation groups. Sharing resources where mutually compatible conservation objectives are apparent is cost-effective and in the best interest of the Service, the partner organization, and the public.

We will maintain the existing partnerships identified in chapter 3, while also seeking new ones consistent with refuge goals and objectives. The Delaware Division of Fish and Wildlife, Ducks Unlimited, the Nature Conservancy of Delaware, the Conservation Fund, USGS, Southern Delaware Tourism, local Chambers of Commerce, and many others have been particularly important and valued partners. These relationships are vital to our success in managing all aspects of the refuge—conserving land, managing habitats and protecting species, outreach and education, and providing wildlife-dependent recreation.

We will continue to work cooperatively with the Delaware Division of Fish and Wildlife to develop a management plan for wildlife management and public recreational use of this area and associated waters, including Prime Hook Creek. We will also work with them to complete a memorandum of understanding to coordinate activities within the State boundary.

We will continue to work closely with other offices within the Service on mutually important issues and seek new opportunities to find cooperative solutions to problems that affect the refuge but are beyond the ability of the refuge alone to address. One important example is the management of snow goose populations, which will require cooperation with the Migratory Bird Office, as well as State agencies and private landowners. On this issue, we will work with State and local partners on outreach, and with regional and Migratory Bird Office biologists on monitoring and developing population targets.

Citizen involvement is critical to the well-being of the Refuge System and the natural resources that depend on those lands. When local citizens and other stakeholders of a refuge can see firsthand our conservation work, they become an informed constituency on behalf of conservation.

The Friends of Prime Hook National Wildlife Refuge, Inc. (Friends Group) and refuge volunteers have been extremely helpful in promoting an appreciation of natural and cultural resource conservation and facilitating the implementation of priority refuge projects. The Friends Group is instrumental in conducting outreach about the refuge and its opportunities to the community and in accomplishing many programs through their hard work, dedication, and fundraising efforts. Refuge volunteers are instrumental in refuge management

activities including maintenance, habitat management, visitor services, and outreach programs.

Refuge volunteers and the Friends Group play a vital role in the conservation and management of our natural and cultural resources. The refuge currently has an active volunteer program involving more than 100 citizens. These volunteers contribute 6,000 hours annually, assisting with a full range of administrative, biological monitoring, invasive species control, and visitor services tasks. The nurturing and use of volunteers will continue as a vital component of many of the objectives outlined in the CCP. The Friends of Prime Hook, a citizen-based Friends Group, also raises funds for needed projects, conducts special programs which support the goals of the refuge and the mission of the Refuge System, and works to educate the public. Like volunteers, the Friends Group will play an important role in the strategies to achieve many of the objectives outlined in this document.

Strategies

- Continue to maintain the collaborative relationship with Federal, State, and local governmental agencies to meet natural resource mandates and objectives. Examples include providing office space for USDA Wildlife Services; coordinating the waterfowl hunting program on the adjacent Prime Hook Wildlife Area of the Delaware Division of Fish and Wildlife; and accomplishing refuge projects with the aid of crews from the Delaware Department of Corrections, water level management projects with Ducks Unlimited, land acquisition with The Conservation Fund and The Nature Conservancy of Delaware, and biological and visitor surveys with USGS.

- Work with conservation partners to achieve commons goals; establish memorandums of understanding, memorandums of agreement, and cooperative agreements as appropriate.

- Share resources, equipment, and/or expertise with State and private landowners.

- Continue to support and offer guidance to the Friends of Prime Hook NWR organization.

  - Work with the Friends Group to continue to seek outside support for refuge projects, develop public use programs, coordinate refuge projects, operate the sales outlet, plan and conduct public events, conduct community outreach, promote national Service initiatives as they develop, and respond to public inquiries about the refuge.

- Continue to partner with the Friends of Prime Hook, refuge volunteers, and other partners to assist with maintenance of trails, observation platforms, photography blinds, and benches and to promote opportunities in wildlife observation and photography.

- Continue to partner with the Friends of Prime Hook to host the nature photography contest and exhibition.

  - Continually update the memorandum of agreement between the Friends Group and the Service.

  - Continue to provide a primary liaison between the Friends Group and the Service.

  - Continue to support the Friends Group newsletter, distributed to their membership by regularly providing information, articles, and photos about refuge management and visitor services programs.

  - Continue to work with the Friends Group on a regular basis to seek alternative funding sources and partnerships for various projects to benefit the refuge.

- Continue to offer volunteer opportunities to assist with accomplishing projects in the refuge's biological, maintenance, and visitor services program areas and in carrying out the mission of the Service and Refuge System.

  - Continue to implement volunteer recruitment, training, and appreciation/recognition events.

  - Continue to implement the resident volunteer work-camper program.

  - Continue to maintain and observe tree swallow and bluebird nest boxes for public viewing, pending volunteer support.

  - Continue to provide refuge-sponsored guided birding field trips by volunteers.

- Continue to collaborate with educational institutions to conduct research and investigations seeking answers to important natural resource issues on the refuge and within the Refuge System, and contribute our basic understanding of important natural resource issues worldwide.

- Enhance our existing collaborative relationships, and seek additional ones, to increase the likelihood of meeting natural resource mandates and objectives.

- Participate in regional and local community economic development and conservation partnerships and initiatives.

- Facilitate demonstration areas on the refuge and on other conservation lands that showcase applied management to benefit natural resources.

- Enhance the volunteer program to better assist with accomplishing refuge projects

  - Develop a refuge volunteer plan and handbook that covers volunteer program coordination, training, job descriptions, volunteer policy, recruitment policy, monitoring, evaluation, dispute, and termination policies.

  - Explore the possibility of constructing a bunk house or other similar type housing for interns and volunteers to support the refuge's biological and public use programs.

  - Expand the resident workcamper volunteer program.

Climate Change and Sea Level Rise Adaptation Rationale
The rationale is the same as stated above under objective 6.1.

Sea Level Rise and Climate Change Strategies
- Work with Federal, State, and conservation organizations on land acquisition priorities.

- Enhance existing and develop new partnerships to conduct research related to fish and wildlife adaptation to climate change and sea level rise on the refuge, in neighboring watersheds, and elsewhere in the State of Delaware.

- Within 1 year, establish a cooperative agreement with the Delaware Coastal Program on research and monitoring needs for the refuge.

Table 4-5. Summary of Hunting and Wildlife Observation Opportunities, by Month

This table shows what areas of the refuge are open for hunting and wildlife observation by month. It is color-coded to show the differences among the alternatives in hunting and wildlife observation opportunities. Where overlaps in hunting and wildlife observation occur, the table also describes how conflicts between user groups are minimized. For example, some areas are only open to wildlife observation on Sundays and in other areas only hunted portions are closed to wildlife observation.

CCP – Prime Hook NWR

KEY
H = Hunting Open W = Wildlife Observation/Photography Open

Unit Name	Area	Month											
		Jan[1]	Feb[1]	Mar[1]	Apr[1]	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Unit I	Slaughter Canal Area	H, W*	H, W*	H, W	H[2], W	H[2], W	W	W	W	H, W*	H, W*	H, W*	H, W*
	Slaughter Canal	H, W*	H, W*	H, W	H, W	W	W	W	W	H, W*	H, W*	H, W*	H, W*
	Fowler North Area	H, W*	H, W*	H, W	H[2], W	H[2], W	W	W	W	H, W*	H, W*	H, W*	H, W*
	Fowler Beach	W	W	W[B]	W[B]	W[B]	W[B]	W[B]	W[B]	W	W	W	W
	Roadside Viewing on Slaughter Beach Road & Fowler Beach Road	W	W	W	W	W	W	W	W	W	W	W	W
	Viewing at Water Control Structure at Slaughter Canal	W	W	W	W	W	W	W	W	W	W	W	W

*Open only on Sundays

[1] Wetland areas only open to hunting during the snow goose conservation order from Jan/Feb through mid-April and will involve temporary closures of portions of the hunt area to other users

[2] Turkey hunting for five hunters is available in portions of the 3,700 acre turkey hunt area; only hunted portions will be closed to other visitors

[B] Indicates a seasonal closure of designated beach dunes and overwash areas – access to the intertidal zone is permitted

KEY
H = Hunting Open W = Wildlife Observation/Photography Open

Unit Name	Area	Month											
		Jan[1]	Feb[1]	Mar[1]	Apr[1]	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Unit II	Fowler Beach	W	W	W[B]	W[B]	W[B]	W[B]	W[B]	W[B]	W	W	W	W
	Fowler South Area	H[S1], W**	H[S1], W**	H[S1], W	H, W	W	W	W	W	H, W**	H, W**	H[S1], W**	W**
	Cods Road Area	H	H	H	H	CLOSED	CLOSED	CLOSED	CLOSED	H	H	H	H
	Oak Island	H[S1]	H[S1]	H[S1]	H	CLOSED	CLOSED	CLOSED	CLOSED	H	H	H	CLOSED
	Prime Hook North Area	H	H	H	H[2]	H[2]	CLOSED	CLOSED	CLOSED	H	H	H	H
	Roadside Viewing on Prime Hook Beach Road & Cods Road	W	W	W	W	W	W	W	W	W	W	W	W
	Unit II Marsh (Sanctuary)	CLOSED[S]	CLOSED[S]	CLOSED[S]	CLOSED[S]	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED

*Open only on Sundays

**Upon completion of photography blind, this portion of trail will be open year round and only on Sundays during the hunting season

[1] Wetland areas only open to hunting during the snow goose conservation order from Jan/Feb through mid-April and will involve temporary closures of portions of the hunt area to other users

[2] Turkey hunting for five hunters is available in portions of the 3,700 acre turkey hunt area; only hunted portions will be closed to other visitors

[S] Indicates a sanctuary area unless open for hunting during the snow goose conservation order

[S1] Indicates a sanctuary area from the end of November through March 15 unless open for snow goose conservation order

[B] Indicates a seasonal closure of designated beach dunes and overwash areas – access to the intertidal zone is permitted

KEY
H = Hunting Open W = Wildlife Observation/Photography Open

Unit Name	Area	Month											
		Jan[1]	Feb[1]	Mar[1]	Apr[1]	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Unit III	Prime Hook South Area	H, W*	H, W*	H, W	H[2], W	H[2], W	W	W	W	H, W*	H, W*	H, W*	H, W*
	Prime Hook Creek – East of Foord's Landing	H[S2]	H[S2]	H	H,W	W	W	W	W	H	H	H	H
	Prime Hook Creek – West of Foord's Landing	W	W	W	W	W	W	W	W	W	W	W	W
	Unit III Marsh (North & Mid Sections)	H	H[S2]	H[S2], W	H[S2],W	W	W	W	W	H	H	H	H
	Unit III Marsh (Southern Section = Sanctuary)	CLOSED[S]	CLOSED[S]	CLOSED[S]	CLOSED[S]	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED
	Headquarters Area	H, W[D]	W	W	H[2], W	H[2], W	W	W	W	W	W	H, W[D]	W
	Jefferson Lofland Area (Deep Branch Road Trail)	H, W***	H, W***	W***	H[2], W	H[2], W	W	W	W	H, W***	H, W***	H, W***	H, W***
	Millman Area	H	H	H[2]	H[2]	CLOSED	CLOSED	CLOSED	CLOSED	H	H	H	H
	Viewing at Water Control Structure at Petersfield Ditch	W	W	W	W	W	W	W	W	W	W	W	W
	Roadside Viewing on Prime Hook Beach Road & Broadkill Beach Road	W	W	W	W	W	W	W	W	W	W	W	W

*Open only on Sundays

***Seasonal closures to non-consumptive users from September 1 to March 15 to reduce cumulative disturbance to waterfowl in and adjacent to Goose & Flaxhole Ponds

[1] Wetland areas only open to hunting during the snow goose conservation order from Jan/Feb through mid-April and will involve temporary closures of portions of the hunt area to other users

[2] Turkey hunting for five hunters is available in portions of the 3,700 acre turkey hunt area; only hunted portions will be closed to other visitors

[S] Indicates a sanctuary area unless open for hunting during the snow goose conservation order

[S2] Indicates a sanctuary area from the end of the hunting season through March 15 unless open for snow goose conservation order

W[D] Indicates that the HQ area is only closed to non-consumptive users for a deer hunt for one day during the indicated month

KEY

H = Hunting Open W = Wildlife Observation/Photography Open

Unit Name	Area	Month											
		Jan[1]	Feb[1]	Mar[1]	Apr[1]	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Unit IV	Graves Area	H	H	H	H	CLOSED	CLOSED	CLOSED	CLOSED	H	H	H	H
	Trail on Vergie's Pond	H[S1], W[S1]	H[S1], W[S1]	H[S1], W[S1]	H, W	W	W	W	W	W	W	W[S1]	W[S1]
	Island Farm Area	H[S1]	H[S1]	H[S1]	H	CLOSED	CLOSED	CLOSED	CLOSED	H	H	H	H[S1]
	Southern Section of Unit IV (Sanctuary)	CLOSED[S]	CLOSED[S]	CLOSED[S]	CLOSED[S]	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED
	Roadside Viewing on Broadkill Beach Road	W	W	W	W	W	W	W	W	W	W	W	W

[1] Wetland areas only open to hunting during the snow goose conservation order from Jan/Feb through mid-April and will involve temporary closures of portions of the hunt area to other users

[S1] Indicates a sanctuary area from the end of November through March 15 unless open for hunting during the snow goose conservation order (in the Island Farm Area, applies to all but the designated area for disabled waterfowl hunting)

Chapter 5

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Northern bobwhite

Consultation and Coordination

- Introduction
- Public Involvement Summary
- Public and Partner Involvement
- List of Preparers
- Letters of Concurrence

Introduction

Effective conservation usually begins with effective community involvement. To ensure that our future management of the refuge considers the issues, concerns, and opportunities expressed by the public, we used a variety of public involvement techniques in our planning process. What follows is the chronology of public outreach activities we conducted while preparing the CCP and EIS for Prime Hook NWR.

Public Involvement Summary

We began the CCP process for Prime Hook NWR in 2005. We published our original Notice of Intent in the *Federal Register* on October 17, 2005, stating we intended to prepare a CCP and environmental assessment (EA) for the refuge and announcing a public scoping period. During scoping, we solicited comments on the major issues that the public and others felt we would address in the CCP. We also held several public meetings during the scoping period.

Based on the extent of public comments received and subsequent developments since scoping, we determined that an EIS would be more appropriate than an EA. We felt that an EIS was necessary to ensure that a full and fair discussion of all significant environmental impacts occurs and to inform decision-makers and the public of the reasonable alternatives that would avoid or minimize adverse impacts and enhance the quality of the human environment. We published a second Notice of Intent in the *Federal Register* on May 9, 2011, announcing that we complete an EIS rather than EA. We also announced that we were accepting additional scoping comments through June 23, 2011.

We used the input we received during the scoping periods to prepare the draft CCP/EIS. On May 31, 2012, we published a Notice of Availability in the *Federal Register*. The Notice of Availability announced the availability of the draft CCP/EIS for 60 days public review and comment. We published a second Notice of Availability on August 8, 2012 extending the public comment period through August 27, 2012. During the public comment period, we held six public meetings and one formal hearing, as well as three informal refuge open houses. During the draft CCP/EIS comment period, we received over 100 written comments and 19 oral comments. After compiling all of the responses we received, we wrote responses to all of the substantive comments. We include our responses to those comments as an appendix to the final CCP/EIS. Based on these comments, we made several modifications to alternative B in the final CCP/EIS.

The Service issued a final CCP/EIS for a 30-day review period through a Notice of Availability in the *Federal Register* on December 28, 2012. We received a total of 14 comment letters; however, comments did not raise significant new issues, or result in changes to the analysis, or warrant any further changes to alternative B. All substantive comments were previously addressed in our response to public comments detailed in appendix M of the final CCP/EIS. Three letters of concurrence from other agencies are included in this chapter.

For further information or questions please contact:

Thomas Bonetti, Planning Team Leader
U.S. Fish and Wildlife Service, Region 5
300 Westgate Center Drive
Hadley, 01035-9589 Email: *northeastplanning@fws.gov*

Public and Partner Involvement

Planning Updates, Surveys, and other Newsletters	**September 2004–September 2005**	Distributed 429 visitor surveys and 1,430 community surveys in September 2005 cooperation with USGS.
	June 2005	Distributed newsletter announcing planning efforts for habitat management and hunting, and other issues including wood duck boxes.
	September 2005	Distributed a news release about migratory bird management at the refuge.
	December 2006	Distributed our "Conservation Planning Update" newsletter.
	August 2007	Distributed an updated "Conservation Planning Update" newsletter and completion of Final Report for Visitor and Community Survey Results for Prime Hook NWR by USGS.
	May 2011	Distributed a news release about completing an EIS instead of the originally anticipated EA.
	May 2012	Distributed a news release, *Federal Register* Notice, and newsletter announcing that the draft CCP/EIS was available for public review and comment. These also announced the length of the public comment period, where people could send written comments, and the dates and times of public meetings.
	December 2012	Distributed a news release, *Federal Register* Notice, and newsletter announcing that the final CCP/EIS was available for a 30-day review period.
Public Scoping Meetings—Meeting Our Refuge Neighbors	**July 13, 2005**	(Town Meeting before public scoping meetings began) Number of non-FWS attendants: 130 Location: Milton, DE
	November 8, 2005	Number of non-FWS attendants: 110 (total for all 3 meetings) Location: Milton, DE
	November 9, 2005	Number of non-FWS attendants: 110 (total for all 3 meetings) Location: Dover, DE
	November 10, 2005	Number of non-FWS attendants: 110 (total for all 3 meetings) Location: Lewes, DE
Public Meetings During the Draft CCP/EIS Public Comment Period	**June 5, 2012**	Public meeting focused on habitat management, Milford, DE
	June 7, 2012	Public meeting focused on hunting, Milford, DE
	June 9, 2012	Public meeting focused on habitat management, Milton, DE
	June 12, 2012	Public meeting focused on hunting, Lewes, DE
	June 14, 2012	Public meeting focused on wildlife observation, photography, fishing, environmental education, and interpretation, Milton, DE
	June 19, 2012	Formal public hearing, Lewes, DE
	July 19, 2012	Public meeting, Milford, DE

Meetings with State Partners and Other Conservation Experts

July 18-19, 2006

Outreach activity: Partners Workshop

Purpose: Develop a vision statement and goals for Prime Hook NWR

Number of non-FWS attendants: 14

Audience: Rob Gano, Delaware Division of Fish and Wildlife; Bill McAvoy, Delaware Natural Heritage Program; Glenn Garner, Friends of PHNWR; Otis Clifton, local landowner & farmer; Bill Fintel, local citizen & birder; Glen Wells, refuge cooperative farmer; David Weber, Sussex Bird Club; Joe Farrell, University of Delaware Sea Grant Program; Jim White, Delaware Nature Society; Nick DiPasquale & Mark Martel, Delaware Audubon Society; Jay Walls, Delaware Bassmasters; Jeff Gordon, Delmarva Ornithological Society; Jamie West, refuge hunter; Bill Jones, Jonathan Schafler, Annabella Larsen, George O'Shea, Tom Bonetti, Marci Caplis (moderator), Al Rizzo, USFWS

January 18, 2007

Outreach activity: Technical Workshop

Purpose: Share information and discuss the refuge's most important state and regional contributions to the conservation of federal trust resources within the framework provided by the refuge's establishment purposes, the National Wildlife Refuge System mission and its policies.

Number of non-FWS attendants: 10

Audience: Rob Gano & Bill Meredith, Delaware Division of Fish and Wildlife; Bill McAvoy, Delaware Natural Heritage Program; Joe Farrell, University of Delaware Sea Grant Program; Nick DiPasquale, Delaware Audubon Society/ Duffield Associates; Rachel Dawson, Ducks Unlimited; Jennifer Wheatley, Delaware Division of Soil and Water; Mark Nardi, US Geological Survey, MD-DE-DC; Mick McLaughlin, JCM Environmental Consultants; Cory Whaley, University of Delaware Cooperative Extension Service; Bill Jones, Jonathan Schafler, Annabella Larsen, George O'Shea, Tom Bonetti, Rick McCorkle, & Hal Laskowski, USFWS.

June 19-20, 2007

Outreach activity: Technical Workshop

Purpose: Identify priority resources of concern and develop draft biological objectives for PHNWR

Number of non-FWS attendants: 2

Audience: Rob Gano, Delaware Division of Fish and Wildlife; Robert Coxe, Delaware Natural Heritage Program; Bill Jones, Jonathan Schafler, Annabella Larsen, George O'Shea, Rick McCorkle, Hal Laskowski, Jan Taylor, Terry Villanueva, Ray Brown, Steve Funderburk, Greg Breese, Susan Guiteras, & Oscar Reed, USFWS.

May 7, 2008

Outreach activity: Planning meeting

Purpose: Review background hunting information and prepare hunting objectives and strategies

Number of non-FWS attendants: 3

Audience: Rob Gano, Ken Reynolds, & Pat Emory, Delaware Division of Fish and Wildlife; Bill Jones, Oscar Reed, Michael Stroeh, Tony Leger, Tom Bonetti, USFWS.

July 9, 2008	*Outreach activity:* Technical Workshop *Purpose:* Develop draft public use objectives for PHNWR *Number of non-FWS attendants:* 4 *Audience:* Rob Gano & Ken Reynolds (Wildlife), Craig Shirey (Fisheries), Delaware Division of Fish and Wildlife; Kendall Summers, Delaware Division of Parks & Recreation; Bill Jones, Annabella Larsen, George O'Shea, Susan Guiteras, Tom Bonetti, Julie Study, Tina Watson, Michael Dixon, Michael Stroeh, & Oscar Reed, USFWS.
April 22, 2010	*Outreach activity:* Planning meeting *Purpose:* Review internal draft CCP document and alternatives with Delaware Division of Fish and Wildlife staff *Number of non-FWS attendants:* 15
July 2012	Meeting with Senator Carper, his staff, and Tony Pratt from DNREC to provide an update on the CCP and discuss the draft CCP/EIS.
October 2012	Refuge tour and CCP update with Congressman Carney.

List of Preparers

Core Planning Team

Thomas Bonetti, Senior Refuge Planner and Planning Team Leader
Affiliation: USFWS Region 5 Regional Office
Education: B.S. Biology, M.S. Recreation Administration
Experience: USFWS, Region 5 Refuge Planner, 1998-present
U.S. Army Corps of Engineers, 1992-1998
California Department of Parks and Recreation, 1990-1992

Michael Stroeh, Project Leader
Affiliation: Coastal Delaware Refuge Complex, Bombay and Prime Hook NWRs (has since transferred to another refuge in Region 4)
Education: B.S. Wildlife Biology - University of Wisconsin-Stevens Point
Experience: Managed natural resources and public uses on national wildlife refuges for over 24 years.
Contribution: Participated completely in the planning and writing of CCP.

Oscar Reed, Jr., Deputy Refuge Manager
Affiliation: Coastal Delaware Refuge Complex; Bombay Hook NWR
Education: B.S. Biology
Experience: Natural resource and public use management for 19 years
Contribution: Assisted with CCP.

Art Coppola, Refuge Manager
Affiliation: Prime Hook NWR
Education: B.S. in Natural Resources Management, University of Maryland–College Park, Humboldt State University, California
Experience: Refuge Management 3 years
Contribution: Assisted with CCP.

Susan Guiteras, Wildlife Biologist
Affiliation: Coastal Delaware Refuge Complex
Bombay and Prime Hook NWRs
Education: B.S. Biology, M.S. Wildlife Ecology
Experience: Wildlife Biologist, USFWS, 13 years
Contribution: Participated in the writing of CCP, prepared maps.

Annabella Larsen, Wildlife Biologist
Affiliation: Coastal Delaware National Wildlife Refuge Complex;
Prime Hook NWR
Education: B.S. in Chemistry – Rutgers University 1982; B.S. in Biology – Salisbury State University 1986; B.S. Wildlife Management – Delaware State University – 1993.
Experience: Wildlife Biologist, USFWS, 19 years
Research Biologist – University of Salisbury, Maryland 1986-1988
Research Biologist – Wildlife International, Maryland 1988-1990
Engineering Technician – 1980-1982 Exxon Corporation
Contribution: Helped write all chapters of CCP, HMP, some compatibility determinations.

Daniel Stotts, Wildlife Biologist
Affiliation: Coastal Delaware Refuge Complex; Bombay and Prime Hook NWRs
Education: B.S. in Biology - University of Maryland-College Park
Experience: Wildlife Biologist, USFWS, 30 years
Contribution: Assisted with chapters 2 and 4, HMP, and compatibility determinations.

Bill J. Jones, Visitor Services Manager
Affiliation: Coastal Delaware Refuge Complex; Prime Hook NWR
Education: B.S. and M.S. Fisheries Science and Management
Experience: Visitor Services Manager, USFWS, 12 years
Contribution: Visitor Services section of CCP and compatibility determinations. Prepared public outreach material including Web site updates, CCP newsletter articles, and database.

Assistance from other Service Personnel

Brittany Benson
Meredith Bixby
Brian Braudis
Margaret Engesser
Kathryn Fox
Mike Higgins
Dale Hudson
Louise Kotarba
Jennifer McAndrews
Kate McManus
Laura Mitchell
George O'Shea
Virginia Rettig
Al Rizzo
Jonathan Schafler
Anne Sittauer
Tina Watson

Assistance from Federal, State, Local, and other Partners

Delaware Bay Estuary Project
Delaware Division of Fish and Wildlife
Delaware Division of Soil and Water
Delaware Natural Heritage Program
Delaware Coastal Program
Delaware Division of Parks and Recreation
U.S. Geological Survey
Joyce Lindsay
Betty Kirk

Letters of Concurrence

SAVING DELAWARE HISTORY

State of Delaware
Historical and Cultural Affairs

21 The Green
Dover, DE 19901-3611

Phone: (302) 736.7400 Fax: (302) 739.5660

March 4, 2013 Project 2011.04.25.01

Mr. Thomas Bonetti
Natural Resource Planner
National Wildlife Refuge System
US Fish and Wildlife Service
300 Westgate Center Dr.
Hadley, MA 01035-9589

Project: Comprehensive Conservation Plan and Environmental Impact Statement for Prime Hook National Wildlife Refuge

Dear Mr. Bonetti:

Thank you for providing us with an internal review copy of the Prime Hook National Wildlife Refuge Draft Comprehensive Conservation Plan and Environmental Assessment (CCP/EA). It is our understanding Alternative B has been revised to include a step down Cultural Resource Management Plan that will address the effects of sea level rise on archaeological sites and will ensure our cultural resources are adequately considered in the final CCP. On March 1, Ms. Shelley Small transmitted the rewritten texts of chapters 3 and 4 that formally include the Cultural Resource Management Plan into the CCP.

From our conversation, Alternative B is the only option that contains the Cultural Resource Management Plan, which we advocate. Therefore, we support Alternative B, as it will provide a proactive analysis of long range impacts of sea level rise on salt marsh archaeological sites. In addition, it will employ the Service's regular procedures for ensuring that historical and archaeological sites are considered when ground disturbing projects are being planned in the future.

We look forward to working with you on future undertakings and in development of the cultural resource management plan. If you have any questions, please contact me at craig.lukezic@state.de.us.

Sincerely,

Craig Lukezic
Archaeologist

cc: Gwen Davis, Deputy Director, Delaware State Historic Preservation Office

STATE OF DELAWARE
DEPARTMENT OF NATURAL RESOURCES & ENVIRONMENTAL CONTROL

DELAWARE COASTAL MANAGEMENT PROGRAM

89 KINGS HIGHWAY
DOVER, DELAWARE 19901

Phone: (302) 739- 928
Fax: (302) 739-204

February 15, 2013

Thomas Bonetti
U.S. Fish and Wildlife Service
300 Westgate Center Drive
Hadley, MA 01035

Re: Delaware Coastal Management Federal Consistency Certification
Prime Hook National Wildlife Refuge Comprehensive Conservation Plan

Dear Mr. Bonetti,

The Delaware Coastal Management Program (DCMP) has received and reviewed your consistency determination for the above referenced project. Based upon our review and pursuant to National Oceanic & Atmospheric Administration regulations (15 CFR 930), the DCMP concurs with your consistency determination for the U.S. Fish and Wildlife Service's selected alternative, Alternative B, of the Comprehensive Conservation Plan and Environmental Impact Statement for the Prime Hook National Wildlife Refuge (PHNWR) located in Milton, Delaware.

While Alternative B is consistent with our enforceable policies, there are modifications to the habitat management, hunting program and mosquito control aspects of the plan that the Delaware Department of Natural Resources and Environmental Control would like to have implemented. Detailed comments were submitted by Department Secretary Collin O'Mara on February 4, 2013, and enclosed for your reference.

The DCMP supports the PHNWR's efforts to restore and protect vital habitat along Delaware's bayshore and will continue to provide input as the final marsh restoration plan is developed.

Implementation of the finalized restoration plan will require state permits; this concurrence is conditioned upon the issuance of all required permits and adherence to the restrictions and/or conditions placed on any and allpermits issued to you for this project.

If you have any questions please do not hesitate to contact me or Tricia Arndt of my staff at (302) 739-9283.

Sincerely,

Sarah W. Cooksey, Administrator

Enclosure

cc: File 2013.0030
Collin O'Mara-Secretary

Delaware's good nature depends on you!

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION III
1650 Arch Street
Philadelphia, Pennsylvania 19103-2029

FEB 0 4 2013

Mr. Thomas Bonetti
United States Fish and Wildlife Service
Regional Office
300 Westgate Center Drive
Hadley, MA 01035

Re: Final Prime Hook National Wildlife Refuge Draft Comprehensive Conservation Plan and Environmental Impact Statement, December 2012, CEQ # 20120406

Dear Mr. Bonetti:

In accordance with the National Environmental Policy Act (NEPA), Section 309 of the Clean Air Act and the Council on Environmental Quality regulations implementing NEPA (40 CFR 1500-1508), the United States Environmental Protection Agency (EPA) has reviewed the Prime Hook National Wildlife Refuge's Final Comprehensive Conservation Plan and Environmental Impact Statement (CCP/EIS). In our August 27, 2012 review letter of the Draft CCP/EIS, we rated the environmental impacts of the proposed action as LO (Lack of Objections). Based on our review of the subject document we have no objection to the project.

We recommend that the Fish and Wildlife Service (FWS) continue to work closely with federal, state, and local stakeholders throughout the implementation of this plan and any adaptive management decisions. In addition, the FWS should coordinate closely with the U.S. Army Corps of Engineers and EPA on any Clean Water Act Section 404 permit issues that may arise from proposed impacts to waters of the United States.

As mentioned in our August 2012 comments, regarding pesticide application, all pesticides should be mixed, loaded and applied in accordance with label specifications and all applicators must be certified with the Delaware Department of Agriculture or working under the supervision of a certified applicator.

Thank you for the opportunity to offer these comments. If you have any questions, please do not hesitate to contact Ms. Barbara Okorn, staff contact, at (215) 814-3330.

Sincerely,

Barbara Rudnick
NEPA Team Leader

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Snowy egret

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Horseshoe crab eggs

Glossary and Acronyms

Glossary

40% Migratory Bird Hunting Rule: "If a refuge, or portion thereof, has been designated, acquired, reserved, or set apart as an inviolate sanctuary, we may only allow hunting of migratory game birds on no more than 40 percent of that refuge, or portion, at any one time unless we find that taking of any such species in more than 40 percent of such area would be beneficial to the species (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).

Abiotic: Not biotic; often referring to the nonliving components of the ecosystem such as water, rocks, and mineral soil.

Access: Reasonable availability of and opportunity to participate in quality wildlife-dependent recreation.

Accessibility: The state or quality of being easily approached or entered, particularly as it relates to complying with the Americans with Disabilities Act.

Accessible facilities: Structures accessible for most people with disabilities without assistance; facilities that meet Uniform Federal Accessibility Standards; Americans with Disabilities Act-accessible.

[E.g., parking lots, trails, pathways, ramps, picnic and camping areas, restrooms, boating facilities (docks, piers, gangways), fishing facilities, playgrounds, amphitheaters, exhibits, audiovisual programs, and wayside sites.]

Acetylcholinesterase: An enzyme that breaks down the neurotransmitter acetycholine to choline and acetate. Acetylcholinesterase is secreted by nerve cells at synapses and by muscle cells at neuromuscular junctions. Organophosphorus insecticides act as anti-acetyl cholinesterases by inhibiting the action of cholinesterase thereby causing neurological damage in organisms.

Actinorhizal plants: These plants have the ability to form nitrogen fixing nodules that confers a selective advantage in poor soils. Actinorhizal plants are characterized by their ability to form a symbiosis with the nitrogen fixing actinomycete *Frankia,* an association that leads to the formation of nitrogen-fixing root nodules. Most actinorhizal plant species are tree and scrub species that pioneer or colonize disturbed soils where available nitrogen is scarce. Several native shrubs and trees play this critical role in enriching the soil and enabling the establishment of other native plants in natural ecological succession. An example of an actinorhizal plant on the refuge is sweetgum.

Activity: What visitors do at a national wildlife refuge. The economic benefits to local communities of refuge visitation report (*Banking on Nature*) identifies visitor activities being grouped into hunting, fishing, and non-consumptive uses.

Adaption: Adjustment to environmental conditions.

Adaptive Management: The process of implementing policy decisions as scientifically driven management experiments that test predictions and assumptions in management plans, and using the resulting information to improve the plans.

Adventive: A species native to North America but not to Delaware that is now found growing in Delaware outside of its natural range. Adventive species are not considered to be part of Delaware's native flora and are treated as alien species in statistical summaries. These species are usually introduced by human-caused breakdowns of natural barriers to dispersal. In most cases, adventive species have not yet become widely or well established and may or may not be a threat to indigenous plant communities in Delaware. Adventive species also include plants that have been introduced, or intentionally planted in Delaware and are now escaping and surviving without cultivation.

Aestivation: Also known as "summer sleep" is a state of animal dormancy somewhat similar to hiberation. It takes place during times of extreme heat and dryness. Invertebrates (like crabs and especially many insect species) and vertebrate animals are known to enter this state to avoid damage from high temperatures and the risk of desiccation. Both terrestrial and aquatic animals undergo aestivation (from Latin aestas = summer).

Afforestation: Establishing a forest on land that is not a forest, or has not been a forest for a long time by planting trees or their seeds. The term reforestation refers to the reestablishment of the forest after its removal, or planting more trees in the same place after timber harvest.

Agricultural Land: Non-forested land (now or recently orchards, pastures, or crops)

Alternative: A set of objectives and strategies needed to achieve refuge goals and the desired future condition.

Amphipods: A group of nocturnal macroinvertebrates belonging to the order of Amphipoda and known as scuds, side-swimmers or freshwater shrimp. They range in size from 5 to 20 mm long and are restricted to cool, shallow water marshes and generally are found in permanent wetland habitats. They are important protein food sources for waterfowl.

Anadromous Fish: Fish that spend their adult lives in the sea but swim upriver to fresh water to breed (striped bass, American shad, river herring, and sturgeon).

Annual: A plant that flowers and dies within one year of germination

Appropriate Use: A proposed or existing use on a refuge that meets at least one of the following three conditions:

1. the use is a wildlife-dependent one;
2. the use contributes to fulfilling the refuge purpose(s), the System mission, or goals or objectives described in a refuge management plan approved after October 9, 1997, the date the Refuge System Improvement Act was signed into law; or
3. the use has been determined appropriate as specified in section 1.11 of that act.

Approved Acquisition Boundary: A project boundary that the Director of the Service approves upon completion of the planning and environmental compliance process. An approved acquisition boundary only designates those lands which the Service has authority to acquire or manage through various agreements. The approval of an acquisition boundary does not grant the Service jurisdiction or control over lands within the boundary, and it does not make lands within the refuge boundary part of the Refuge System. Lands do not become part of the System until the Service buys them or they are placed under an agreement that provides for their management as part of the System.

Aquatic: Growing in, living in, or dependent upon water.

Aquifer: An underground layer of permeable rock, sediment (usually sand or gravel), or soil that yields water. The pore spaces in aquifers are filled with water and are interconnected, so that the water flows through them. Aquifers can range from a few square kilometers to thousands of square kilometers in size.

Area of Emphasis: Priority pubic uses (hunting, fishing, environmental education, interpretation, wildlife observation, or photography) on a refuge that will be most effective in providing quality opportunities for visitors on that refuge. Every refuge has two areas of emphasis, which were determined based on careful consideration of natural resources, existing staff, operational funds, and existing and potential facilities.

Area-sensitive Species: Species that require large areas of contiguous habitat.

Assemblage: In conservation biology, a predictable and particular collection of species within a biogeographic unit (ecoregion or specific habitat type).

Atlantic States Marine Fisheries Commission: Atlantic States Marine Fisheries Commission is a compact of the 15 Atlantic states created to "promote the better utilization of the fisheries, marine, shell and anadromous, of the Atlantic seaboard by the development of a joint program for the protection and conservation of such fisheries." The Commission conducts interstate fisheries management by coordinating the conservation and management efforts of 22 Atlantic coastal fish species and species groups—to maintain healthy, self-sustaining populations for all Atlantic coast fish species or successful restoration in progress by the year 2015.

Avian: Of or having to do with birds.

Avian Influenza: Or "bird flu" is a disease caused by a virus that infects birds, including pets, domestic poultry, and wild birds.

Baiting: The direct or indirect placing, exposing, depositing, distributing, or scattering of salt, grain, or other feed that could lure or attract wildlife to, on, or over any areas where hunters are attempting to take them.

Basin: The land surrounding and draining into a water body (cf "watershed").

Benthos: Plants and animals that live on the bottom of aquatic environments.

BCC 2002 = Birds of Conservation Concern: A list develop in 2002 by the Service to adhere to the mandate of the Fish and Wildlife Conservation Act, that instructs the Service to "identify species, subspecies, and populations of all migratory nongame bird that, without additional conservation actions are likely to become candidates for listing under the Endangered Species Act of 1973." The BCC 2002 list identifies both migratory and non-migratory bird species beyond those already designated as federally threatened or endangered, that represent the Services highest conservation priorities requiring proactive conservation action to survive.

Bioconcentration: A process resulting in concentration of persistent, fat-soluble compounds like PCBs, DDT, and methyl mercury in organisms at successively higher trophic levels of a food chain or web.

Biogeography: The scientific study of the geographic distributions of organisms.

Biological diversity or Biodiversity: The variety of life and its processes; it includes the variety of living organisms, the genetic differences among them, the communities and ecosystems in which they occur, and the ecological and evolutionary processes that keep them functioning in a healthy manner, yet ever changing and adapting. An ecosystem has greater biodiversity when it contains more species.

Biological Integrity: Biotic composition, structure, and functioning at genetic, organism, and community levels comparable with historic conditions, including the natural biological processes that genomes, organisms, and communities.

Biological Oxygen Demand (BOD): A chemical procedure for determining how fast biological organisms use up oxygen in a body of water. It is used in water quality management and assessment, ecology and environmental science. BOD is not an accurate quantitative test, although it is often used as an indication of the quality of a water source. It is listed as a conventional pollutant in the U.S. Clean Water Act. BOD measures the rate of oxygen uptake by micro-organisms in a sample of water at a temperature of 20 ^{o}C and over an elapsed period of 5 days in the dark.

Typical BOD values: most pristine rivers will have a BOD below 1 mg/L. Moderately polluted waters will range from 2 to 8 mg/L, while municipal sewage that is treated in a three-stage process would have a BOD ~ 20 mg/L or less.

Biomass: The total mass or amount of living organisms in a particular area or volume

Biota: All of the organisms, including animals, plants, fungi, and micro-organisms, found in a given area.

Biotic Impoverishment: Loss of biota and biotic processes; virtually synonymous with the loss of biodiversity.

Blind Site: A designated area identified by a numbered marker where hunting is permitted; hunters can camouflage themselves in the area's natural vegetation, through the use of boat blinds, or construct temporarily construct ground blinds to reduce the chance of detection by sought after game.

Bog: A wetland type characterized by saturated, acidic soil and peat accumulating due to poorly drained area rich in plant residues, usually surrounded by an area of open water, and having characteristic and diverse flora and fauna.

BP (Before the Present): Pre-contact eras are often given in either calendar years (B.C. and A.D.) or in years "before the present." BP is a notation developed as part of the radiocarbon-dating process and indicates a calibrated point measured from 1950. For example, 4950 BP is approximately the same as 3,000 B.C., while 200 BP is about the same as 1750 A.D. This approximation is necessary because there are correction factors used for BP dates, while there are none for calendar dates.

Brackish: Having a salinity between that of fresh and sea water (saltier than fresh, but not as salty as sea).

Breeding Habitat: Habitat used by migratory birds or other animals during the breeding season.

Buffer Zones: Land bordering and protecting critical habitats or water bodies by reducing runoff and non-point source pollution loading; areas created or sustained to lessen the negative effects of human disturbance on animals, plants, and their habitats. Buffers are usually areas of permanent vegetation adjacent to a wetland of waterway that help prevent sediments and contaminants from entering wetlands and waterways.

Bug: In lay terms the word bug refers to tiny creatures that crawl along, such as insects like spiders and millipedes. But for scientists the word has a much narrower meaning. In the strictest terms bugs are insects that have mouthparts adapted for piercing and sucking. The mouthparts of bugs are contained in a beak-shaped structure. So scientists would classify water boatmen, water striders or a cockroach as a bug but not a beetle. In fact scientists call lice and their relatives **true bugs** in the order HEMIPTERA to distinguish them from what everyone else calls bugs.

Bryophytes: A member of a large group of seedless green plants including the mosses, liverworts, and hornworts. Bryophytes lack the specialized tissue xylem and phloem that circulate water and dissolved nutrients in the vascular plants. Bryophytes generally live on land but are mostly found in moist environments as they have free-swimming sperm that require water for transport. In contrast, the gametophyte (haploid) generation of bryophytes constitutes the larger plant form, while the smaller sporophyte (diploid) generation grows on or within the gametophyte and depends upon it for nutrition.

Candidate Species: Species for which we have sufficient information on file about their biological vulnerability and threats to propose listing them.

Canopy: The layer of foliage formed by the crowns of trees in a stand. For stands with trees of different heights, foresters often distinguish among the upper, middle, and lower canopy layers. These represent foliage on tall, medium, and short trees. The uppermost layers are called the overstory.

Carbon sequestration: A geoengineering technique for the long-term storage of carbon or other forms of carbon, for the mitigation of global warming. Carbon dioxide is usually captured from the atmosphere through biological, chemical or physical processes. It has been proposed as a way to mitigate the accumulation of greenhouse gasses in the atmosphere released by burning fossil fuels. For example, reforestation of croplands has greater potential for carbon sequestration as carbon dioxide is transferred from the air and stored into the new biomass of trees for a longer period of time.

Catadromous fish: Fish that migrate downstream in the direction of the sea, usually to reproduce like the American eel.

C & D Canal: In 1824, the construction of the Chesapeake and Delaware Canal began. The new route shortened the distance between Philadelphia and Baltimore by 300 hundred miles. Completed in 1829, the Canal was 19 miles long (13.6 miles through Delaware), 10 feet deep by 36 feetwide.

Cenozoic: The geological era that began 65 million years ago and extends to the present. It followed the Mesozoic Era and is subdivided into the Tertiary and Quaternary periods. The Cenozoic is also known as the **Age of Mammals** as these animals evolved to become an abundant, diverse and dominant group. Birds and flowering plants also flourished.

Chronic Wasting Disease: A contagious neurological disease affecting deer, elk, and moose. It causes a characteristic spongy degeneration of the brains of infected animals resulting in emaciation, abnormal behavior, loss of bodily functions, and death.

Combined Sewer Overflow: A pipe that during storms, discharges untreated wastewater from a sewer system that carries both sanitary wastewater and stormwater. The overflow occurs because the system does not have the capacity to transport and treat the increased flow caused by stormwater runoff.

Community: All the organisms—plants, animals, and microbes—that live in a particular habitat and affect one another as part of the food web or through their various influences on the physical environment. Communities in nature are convenient groupings of different organisms regularly found in the same place at the same time.

Community Type: A particular assemblage of plants and animals, named for its dominant characteristic.

Compatible Determination: Means a written determination signed and dated by the Refuge Manager and Regional Chief, signifying that a proposed or existing use of a national wildlife refuge is a compatible use or is not a compatible use. The Director makes this delegation through the Regional Director.

Compatible Use: Means a proposed or existing wildlife-dependent use or any other use of a national wildlife refuge that, based on sound professional judgment, will not materially interfere with or detract from the fulfillment of the Refuge System mission or the purpose(s) of the national wildlife refuge.

Comprehensive Conservation Plan: Means a document that describes the desired future conditions of a refuge or planning unit and provides long-range guidance and management direction to achieve the purposes of the refuge; helps fulfill the mission of the Refuge System; maintains and, where appropriate restores the biological integrity, diversity and environmental health of each refuge and the Refuge System; helps achieve the goals of the National Wilderness Preservation System; and meets other mandates.

Conifer: Belonging to the phylum of seed-bearing plants (Coniferophyta) comprising of trees and shrubs that include pines, firs and spruces. Conifers have an extensive fossil record going back to the late Devonian (geological period in the Palaeozoic era dating 408 to 360 million years ago) and are typically evergreen trees inhabiting cool temperate regions with leaves reduced to needles or scales. The wood of conifers, is called **softwood** in contrast to the **hardwood** of angiosperm trees. In tradition systems of classification conifers were classified as the Gymnospermae, but now are divided into separate phyla: Coniferophyta (conifers), Cycadophyta (cycads), Ginkophyta (ginkgo), and Gnetophyta.

Conservation: Means management activities used to sustain and, where appropriate, restore and enhance, health populations of fish, wildlife, and plants utilizing, in accordance with applicable Federal and State laws, methods and procedures associated with modern scientific resource programs. Such methods and procedures include protection, research, census, law enforcement, habitat management, propagation, live trapping and transplantation, and regulated taking as per the provisions of the ESA.

Conservation Agreements: Written agreements among two or more parties for the purpose of ensuring the survival and welfare of unlisted species of fish and wildlife or their habitats or to achieve other specified conservation goals. Participants voluntarily commit to specific actions that will remove or reduce threats to those species.

Conservation Biology: The biological science that studies the dynamics of diversity, scarcity, and extinction. It is a modern applied science for maintaining the earth's biological diversity and is a cross-disciplinary field that applies the principles of ecology, biogeography, population genetics, economics, biology, sociology, and anthropology to the maintenance and restoration of biodiversity. Conservation biology is a "mission-oriented" science and its goal is to conserve natural systems and biological diversity.

Conservation Easement: A legal agreement between a landowner and a land trust (that is, a private, nonprofit conservation organization or government agency) that permanently limits the uses of a property to protect its conservation values.

Consultation: A type of stakeholder involvement in which decision-makers ask stakeholders to comment on proposed decisions or actions.

Consumptive, wildlife-oriented recreation: Hunting and fishing.

Cookie Cutter: A floating machine designed to maintain and cut thick infestation of aquatic weeds and unconsolidated bottom material in marsh ditches by spreading the cut material out over the marsh. It will not cut through consolidated sediment, logs, or stumps.

Cool-Season Grass: Introduced grass for crop and pastureland that grows in spring and fall and is dormant during hot summer months.

Cooperative agreement: A usually long-term habitat protection action, which can be modified by either party, in which no property rights are acquired. Lands under a cooperative agreement do no necessarily become part of the Refuge System.

Corridor: A more or less continuous connection between adjacent and similar habitats; examples in a landscape context include hedgerows, streams, and irrigation ditches.

Critical Habitat: According to Federal law, the ecosystem(s) upon which endangered and threatened species depend.

Cultigen: An organism, especially a cultivated plant, such as the banana, not known to have a wild or uncultivated counterpart.

Cultural Resource Inventory: A professional study to locate and evaluate evidence of cultural resources within a defined geographic area.

[N.b. Various levels of inventories may include background literature searches, comprehensive field examinations to identify all exposed physical manifestations of cultural resources, or sample inventories for projecting site distribution and density over a larger area. Evaluating identified cultural resources to determine their eligibility for the National Register follows the criteria in 36 CFR 60.4 (cf. FWS Manual 614 FW 1.7).]

Cultural Resource Overview: A comprehensive document prepared for a field office that discusses, among other things, project prehistory and cultural history, the nature and extent of known cultural resources, previous research, management objectives, resource management conflicts or issues, and a general statement of how program objectives should be met and conflicts resolved

[An overview should reference or incorporate information from a field offices background or literature search described in section VIII of the Cultural Resource Management Handbook (FWS Manual 614 FW 1.7).]

Cumulative effects: The combined effects of all management and other human activities on a defined area of land, a body of water, or both.

Database: A collection of data arranged for ease and speed of analysis and retrieval, usually computerized

Dbh (diameter at breast height): The diameter of the stem of tree measure at breast height (usually 4.5 feet above the ground). The term is commonly used by foresters to describe tree size.

Deer Hunting Stand: A permanent, elevated structure used in hunting to reduce the chance of detection by deer.

Degradation: The loss of native species and processes due to human activities such that only certain components of the original biodiversity persist, often including significantly altered natural communities.

Designated Wilderness Area: An area designated by Congress as part of the National Wilderness Preservation System [FWS Manual 610 FW 1.5]

Desired Future Condition: The qualities of an ecosystem or its components that an organization seeks to develop through its decisions and actions.

Diadromous Fishes: Fish species that use both marine and freshwater habitats during their life cycle. Species can be **anadromous**, living primarily at seas but migrating to freshwater habitats to spawn, or **catadromous**, living in freshwater creeks, ponds and rivers but migrating out to seas to spawn. The anadromous strategy is far more common and examples of refuge focal management species that are anadromous include alewives, blueback herring and striped bass; while the catadromous strategy is less common but exemplified by American eel.

Diapause: A period of insect inactivity and reduced physiological function induced by environmental factors; occurs often in larval, catepillar, or chrysalis stages.

Digitizing: The process of converting maps into geographically referenced electronic files for a GIS.

Dieldrin: A chlorinated hydrocarbon ($C_{12}H_8Cl_6O$), used as an insecticide and in mothproofing.

Disturbance: A change in envriomental conditions, which interferes with the functioning of a biological system. It is reflected by any relatively discrete event in time that disrupts ecosystem, community, or population structure and changes resources, substrate availability, or the physical environment and biological environment. Disturbance at a variety of spatial and temporal scales is a nuatural, and even essential component of many communities and is a key concept used in restoration ecology.

Disturbance Cycles: Periodic recurrence of particular natural disturbances such as fire or flooding.

Diversity: Ecological measure of the number of species and their relative abundance (evenness) in a community; a low diversity refers to relatively fewer number of species or more even abundance.

Donation: A citizen or group may wish to give land or interests in land to the Service for the benefit of wildlife. Aside from the cost factor, these acquisitions are no different than any other means of land acquisition. Gifts and donations have the same planning requirements as purchases.

Drawdowns: The drainage (dewatering) of a wetland corresponding to regional growing season lengths. In the Mid-Atlantic region the growing season ranges from 160 to 280 days in length. The period of time during which drawdowns occur helps determine soil moisture, vegetative response, and wetland productivity. Slower drawdowns (greater than 30 days) are more desirable for plant production, invertebrate response and wildlife use (see Moist Soil Management).

Duck Hunting Blind: A permanent blind camouflaged with switch grass used in hunting to reduce the chance of detection by waterfowl.

Duff: Decomposed ground forest litter or humus. The forest floor, also called duff, is one of the most distinctive features of a forest ecosystem. It consists of shed vegetative parts such as leaves, branches, bark, stems, etc., existing in various stages of decomposition above the soil surface. Composed not only of inorganic material, it also teems with a wide variety of faun and flora. It is one of the richest components of the forest ecosystem from the standpoint of biodiversity because of large numbers of decomposers and predators ion invertebrates, fungi, algae, bacteria, and archaebacteria (single-celled microorganisms).

Easement: An agreement by which landowners give up or sell one of the rights on their property [landowners may donate rights-of-way across their properties to allow community members access to a river (cf. “conservation easement)].

Ecoregion: A territory defined by a combination of biological, social, and geographic criteria, rather than geopolitical considerations; generally, a system of related, interconnected ecosystems.

Ecosystem: A dynamic complex of plant, animal, fungal, and microorganism communities and their associated nonliving (abiotic) environment interacting as an ecological unit; two primary axioms defining ecosystem structure and function are (1) recycling of essential elements, including biomass in different trophic levels following characteristic spatial and temporal patterns in each ecosystem type, and (2) certain emergent properties of self-regulation and self sustaining elements.

Ecosystem Approach: A strategy or plan to manage ecosystems to provide for all associated organisms, as opposed to a strategy or plan for managing individual species, by considering environmental information based on boundaries of ecosystems like watersheds, rather than on geopolitical boundaries.

Ecosystem Dysfunction: Disruption of functioning of ecological processes in an ecosystem.

Ecosystem Management: Any land-management system that seeks to protect viable populations of all native species, perpetuate natural-disturbance regimes on a regional scale, adopt a planning timeline of centuries, and allow human use at levels that do not result in long-term ecological degradation.

Ecosystem Service: A benefit or service provided free by an ecosystem or by the natural environment, such as clean water, flood mitigation, or groundwater recharge.

Ecotone: A transitional zone between two (or more) ecological communities, as between a forest and wetland or river and its estuary. An ecotone has its own characteristics in addition to sharing certain features of the other communities; also known as edge-effect.

Ecotourism: Visits to an area that maintains and preserves natural resources as a basis for promoting its economic growth and development.

Edaphic: Of or relating to the soil, especially as it affects living organisms. In ecology, **edaphic** refers to plant communities that are distinguished by soil conditions rather than by the climate.

Emergent Wetland: Wetlands dominated by erect, rooted, herbaceous plants.

Endangered Species: A Federal- or State-listed protected species in danger of extinction throughout all or a significant portion of its range.

Endemic: **(n)** A species or race native to a particular place and found only there.
(adj.) Restricted to a specified region or locality.

Environment: The sum total of all biological, chemical, and physical factors to which organisms are exposed. We usually think of the environment as everything that surrounds us: air, soils, ocean, bay, wetlands, grasslands, forests, creeks, streams, ponds, birds, animals, insects, plants, fish, reptiles, amphibians

Environmental Assessment (EA): A public document that discusses the purpose and need for an action, its alternatives, and provides sufficient evidence and analysis of its impacts to determine whether to prepare an environmental impact statement or a finding of no significant impact [40 CFR 1508.9].

Environmental Education: Curriculum-based education aimed at producing a citizenry that is knowledgeable about the biophysical environment and its associated problems, aware of how to help solve those problems, and motivated to work toward solving them.

Environmental Health: Composition, structure, and functioning of soil, water, air, and other abiotic features comparable with historic conditions, including the natural biotic processes that shape the environment.

Environmental Impact Statement (EIS): A detailed, written analysis of the environmental impacts of a proposed action, adverse effects of the project that cannot be avoided, alternative courses of action, short-term uses of the environment versus the maintenance and enhancement of long-term productivity, and any irreversible commitment of resources [40 CFR 1508.11].

Environmental Justice: Refers to inequitable environmental burdens borne by groups such as racial minorities, women, residents of economically disadvantaged areas, or residents of developing nations. Environmental justice proponents generally view the environment as encompassing where we live, work, and play (sometimes “pray” and “learn” are also included) and seek to redress inequitable distributions of environmental burdens (pollution, industrial facilities, crime, etc.) and equitably distribute access to environmental goods such as nutritious food, clean air and water, parks, recreation, health care, education, transportation, etc.

EPT Index: A widely used measure of environmental condition. This simple index is calculated as the number of different kinds of Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies). The EPT Index is useful because most of the species in these three orders of aquatic insects are sensitive to pollution and environmental stress. Of the three sensitive orders, Ephemeroptera and Trichoptera larvae are most useful for biomonitoring pollution and serve as reliable indication that the aquatic environment is healthy.

Ericaceous: Pertaining to a heath, or vegetation characteristics of low fertility, acidic, poorly drained soils, dominated by small leaved shrubs or Ericaceae (heathers and heaths) and Myrtaceae (myrtles).

Estuary: A coastal water body, with tidal mixing, where fresh water from rivers mixes with salt water from the ocean.

Eutrophication: The process during which a water body becomes highly loaded with nutrients, (primarily nitrogen and phosphorous), often causing oxygen depletion from unconsumed algal production.

Exotic: Species that occur in a given place, area, or region as the result of direct or indirect, deliberate or accidental introduction of the species by humans.

Extant: Now living; not destroyed or lost; not extinct.

Extinction: The termination of existence of a lineage of organisms (e.g., a subspecies or species).

Extirpation: Local extinction; a species or subspecies disappearing from a locality or region without becoming extinct throughout its range.

Fauna: All animal life associated with a given habitat, country, area, or period

Federal Lands Recreation Enhancement Act (REA): This Act, Public Law 108-447 (118 Stat. 2809), allows the government to charge a fee for recreational use of public lands managed by the Bureau of Land Management, the Bureau of Reclamation, the Service, the National Park Service, and the Forest Service. The recreation fee program is a program by which fees paid by visitors to certain federal recreation sites are retained by the collecting site and used to improve the quality of the visitor experiences at those sites.

Federal-listed species: A species listed either as endangered, threatened, or a species at risk (formerly, a "candidate species") under the Endangered Species Act of 1973, as amended

Federal Trust Resource: A resource that the Government holds in trust for the people through law or administrative acts. Federal trust resources are nationally and internationally important, like endangered species, migratory birds and fish that regularly move across state lines. They also include cultural resources protected by Federal historic preservation laws, and nationally important or threatened habitats, like wetlands, navigable waters, and public lands like national wildlife refuges.

Federal Trust Species: All species where the Federal government has primary jurisdiction including federally endangered or threatened species, migratory birds, anadromous fish, and certain marine mammals.

Fee-Title Acquisition: The acquisition of most or all of the rights to a tract of land; a total transfer of property rights with the formal conveyance of a title. While a fee-title acquisition involves most rights to a property, certain rights may be reserved or not purchased, including water rights, mineral rights, or use reservation.

Final Demand: The total spending by final consumers on all goods. The amount reported in **Banking with Nature** as the change in spending by final consumers in a given region attributable to refuge visitation. Final demand includes spending by people who earn income from refuge visitors' activities as well as spending by refuge visitors themselves.

Finding of No Significant Impact: Supported by an environmental assessment, a document that briefly presents why a Federal action will have no significant effect on the human environment, and for which an environmental impact statement, therefore, will not be prepared. [40 CFR 1508.13]

Fire Regime: The distinctive frequency, intensity, and spatial distribution of natural fires within a given locality, habitat-type or ecoregion.

Fish Consumption Advisories: A public notice issued by the Delaware Department of Natural Resources and Environmental Control and the Delaware Department of Health and Social Service's Division of Public Health about the presence of chemical toxins in the flesh of finfish and shellfish taken from Delaware waters and the associated health risk to anglers and their families who consume their catch.

Fish Weir: A means of providing safe upstream and downstream passage for migrating fish around a barrier.

Floodplain: Flat or nearly flat lands that may be submerged by floodwaters; a plain built up or in the process of being built up by stream or tidal deposition.

Flora: In botany, flora of a given area refers to all the plant life occurring in a given place or time that is naturally occurring or indigenous (native) plants.

Friends Group: Any formal organization whose mission is to support the goals and purpose of its associated refuge and the National Wildlife Refuge Association overall; "friends" organizations and cooperative and interpretive associations.

Flyway: Any one of several established migration routes of birds.

Focal Species: A species that is indicative of particular conditions in a system (ranging from natural to degraded) and used as a surrogate measure for other species of particular conditions. An element of biodiversity selected as a focus for conservation planning or action. The two principal types of targets in conservancy planning projects are species and ecological communities.

Foraging: Searching for food.

Forbs: Flowering plants (excluding grasses, sedges, and rushes) that do not have a woody stem and die back to the ground at the end of the growing season.

Forest Ecology: The scientific study of the interrelated patterns, process, flora, fauna, and ecosystems of land dominated by trees. The management of forests is silviculture.

Forested Wetlands: Wetlands dominated by trees.

Forest Association: A woodland community described by a group of dominant tree species that also occurs with other tree species.

Founder Effects: Nonselective changes in the genetic makeup of a colonizing population during its establishment by a few founding individuals.

Fragmentation: The disruption of large and contiguous habitats into isolated and small patches. Fragmentation has two negative components for biota: the loss of total habitat area, and the creation of smaller, more isolated patches with no connectivity.

Fiscal Year: October 1 to September 30.

Geographic Information System (GIS): A computerized system to compile, store, analyze and display geographically referenced information.

[E.g., GIS can overlay multiple sets of information on the distribution of a variety of biological and physical features.]

Grassland: A habitat type with landscapes dominated by native grasses and forbs and with biodiversity characterized by species with wide distributions, and plant communities are easily maintained with periodic mowing or burning. In such systems larger vertebrates, birds, invertebrates, reptiles and amphibians make extensive use of these areas which are rare today on the landscape.

Groundwater: Water in the ground that is in the zone of saturation, from which wells and springs and groundwater runoff are supplied.

Guild: A group of organisms, not taxonomically related, but are ecologically similar in characteristics such as food preferences, behavior, or microhabitat requirement, or similar in their ecological role or niche in general.

Habitat: The place or type of site where species and species assemblages are typically found and/or successfully reproduce.

[N.b. An organism's habitat must provide all of the basic requirements for life, and should be free of harmful contaminants.]

Habitat Fragmentation: The breaking up of a specific habitat into smaller, unconnected areas.

[N.b. A habitat area that is too small may not provide enough space to maintain a breeding population of the species in question.]

Hardwood Species: Tree species characterized by broad, flat leaves, as distinguished from coniferous or needle-leaved trees. Oak, cherry, maple, and hickory are examples.

Harvest Information Program: A method by which state wildlife agencies and the Service are developing more reliable estimates of the number of all migratory birds harvested throughout the country. These estimates give biologists the information they need to make sound decisions concerning hunting seasons, bag limits, and population management.

Hemi-marsh: Diverse stands of emergent vegetation intermixed with equal areas of open water. This creates edge within the marsh, providing attractive habitat for waterfowl.

Herptile (plural herptiles): This term is used to encompass both reptiles and amphibians, especially in situations where a member of either group of animals is meant without excluding the other. ***Etymology:*** From *herpetology (the branch of zoology that deals with the study of reptiles and amphibians,* by blending with *reptile.*

Historic Conditions: Composition, structure, and functioning of ecosystems resulting from natural processes that based on sound professional judgment, were present **before** substantial human related changes happened to the landscape. The historic conditions benchmark, for the purposes of restoring biological integrity, diversity and environmental health, is the post-Pleistocene, pre-European time period of 800 AD to 1800 that serves as the **"historic conditions"** benchmark containing a range of historic variability.

Historic Range of Variability : **A** description of the change over time and space in the ecological condition of potential natural vegetation types and the ecological processes that shape those types. Potential natural vegetation types represent native vegetation types and characteristics that would occur when natural disturbance regimes and biological processes occur without human intervention as a reference point to maintain and/or restore biological integrity, diversity, and environmental health.

Holocene: The most recent geological epoch of the Quaternary period, or the end of the Pleistocene up to the present. It follows the final glacial episode of the Pleistocene and is sometimes referred to as the **Postglacial** epoch. The Holocene is the most often used ecosystem reference point when considering historical conditions and ecology and its application to ecosystem restoration. The Holocene comprises the past 10,000 years of the earth's history, or the period following the last glaciation (**the Wisconsinan**) during which the surface of North American took its modern form. The Holocene climatic event marks the last synchronous global disturbance that affected every element of the environment from sea levels to soil-forming processes to the distribution of plants and animals, including humans. The Holocene is when several human cultures began to move away from foraging and harvester-based economies into agriculturally based economies. (Egan and Howell 2001 in ***The Historical Ecology Handbook: A Restorationist's Guide to Reference Ecosystems)***

Hundreds: The term "Hundred" denotes a political sub-division. It is an archaic method of dividing an area into administrative unit. About 1682, each Delaware county was subdivided into "hundreds." It denoted an area in which 100 men resided who could be easily mustered for service to the king. The term therefore designated an area in which 10 families with 10 members resided. "Hundreds" continued to represent an assessment or tax district which became the basis of the electoral districts which were created in Delaware's 1897 constitution. Similar to a township which serves as a county's administrative district in other states, the "hundreds" designation is unique to Delaware.

Hydrology: The scientific study of terrestrial water, in particular inland water before its discharge into the oceans or evaporation into the atmosphere. It includes the study of the occurrence and movement of water and ice on or under the earth's surface and its reactions with the environment and biota. The science has many important applications in flood control, irrigation, domestic and industrial uses, hydroelectric power and natural resource management.

Hyper-eutrophic: A physical, chemical, and biological condition that results after a lake, an estuary, or slow-flowing watercourse receives excessive inputs of plant nutrients (mostly nitrates and phosphates) as a result of erosion and runoff from the surrounding land basin.

Hypogeous: Relating to the germination of a seed in which the cotyledons (embryonic leaves) remain below the surface of the ground.

Impact: (*Banking on Nature* definition): The new economic activity generated in a region as a refuge attracts non-residents to the area, This figure represents economic activity that would be lost if the refuge were not there.

Impoundment: An area of tidal marsh that has been cut off from tidal inundation through the construction of dikes, dams, or water control structures.

Indicator species: A species whose presence, absence, or relative well-being in a given environment is a sign of the overall health of its ecosystem. By monitoring the condition and behavior of an indicator species, scientists are likely to affect other species that are more difficult to study.

Indigenous: Native to a particular area.

Indigenous species: A species that, other than a result as an introduction, historically occurred or currently occurs in a particular ecosystem

Interagency Passport: The Recreation Enhancement Act (REA) established the "America the Beautiful – the National Parks and Federal Recreational Lands Pass" (Interagency Pass Program) to promote consistency among the participating federal agencies and to create a high-quality pass program that is supported by the public and partner organizations. The Interagency Pass Program provides four pass options for the public to use at Federal recreation sites where entrance or standard amenity fees are charged. The four passes that make up the program are:
Interagency Annual – Available to anyone 16 years and older at an annual cost of $80; Interagency Senior – Available to US residents and citizens 62 years old and older at a cost of $10 (lifetime); Interagency Access – free (lifetime) and available to US residents/citizens with a permanent disability; and Interagency Volunteer – Available to anyone who volunteers over 500 hours at one of the participating agencies.

Interjurisdictional Fish: Are those "…populations that two or more states, nations, or Native American tribal governments manage because of their geographic distribution or migratory patterns (710 FW 1.5 H). Examples include anadromous species of river herring, salmon and free-roaming species endemic to large river systems, such as sturgeon and paddlefish. [USWFS Director's Order No. 132, Section 6(C)]

Interpretation: The National Association of Interpreters defines "interpretation" as a communication process that forges emotional and intellectual connections between the interests of the audience and the inherent meanings in the resource.

Interpretive facilities: Structures that provide information about an event, place, or thing by a variety of means, including printed, audiovisual, or multimedia materials.

[E.g., kiosks that offer printed materials and audiovisuals, signs, and trail heads.]

Interpretive Materials: Any tool used to provide or clarify information, explain events or things, or increase awareness and understanding of the events or things.

[E.g., printed materials like brochures, maps or curriculum materials; audio/visual materials like video and audio tapes, films, or slides; and, interactive multimedia materials, CD-ROM or other computer technology.]

Invasive Species: An alien species whose introduction causes or is likely to cause environmental harm or economic losses or harm human health. An invasive species is usually an aggressive plant or animal that colonizes a habitat and displaces native and beneficial species.

Invertebrate: Any animal lacking a backbone or bony segment that encloses the central nerve cord.

Inviolate Sanctuaries for Migratory Birds: A refuge, or portions thereof, acquired or established in one of the following ways:

1. With the approval of the Migratory Bird Conservation Commission for the purpose of an inviolate sanctuary, or for any other management purpose, for migratory birds; or
2. By an instrument or document that states that we are establishing the refuge as an inviolate sanctuary for migratory birds, or for any other management purpose, for migratory birds" under, or to fulfill the purpose of, the Migratory Bird Conservation Act.

Issue: Any unsettled matter that requires a management decision.

[E.g., a Service initiative, an opportunity, a management problem, a threat to the resources of the unit, a conflict in uses, a public concern, or the presence of an undesirable resource condition.]

[N.b. A CCP should document, describe, and analyze issues even if they cannot be resolved during the planning process (FWS Manual 602 FW 1.4).]

Keystone Species: A species that plays a pivotal role in an ecosystem and upon which a large part of the community depends. A keystone species presence within an ecosystem has a disproportionate effect on other organisms within the system. A keystone species is often a dominant predator whose removal allows a prey population to explode and often decrease overall diversity. Other kinds of keystone species such as beavers, that significantly alter the habitat around them, significantly affect large numbers of other organisms (flora and fauna).

Landform: The physical shape of the land reflecting geologic structure and geomorphological processes that have shaped the features of a given land surface.

Landscape: A heterogeneous land area composed of a cluster of interacting ecosystems repeated in similar form throughout; an ecological mosaic of specific ecosystems.

Landscape Management: Management of nature at a landscape scale that strives to maintain functions and processes that characterize landscape features.

Land Trusts: Organizations dedicated to conserving land by purchase, donation, or conservation easement from landowners.

Lottery Hunt: Opportunities to hunt (deer or waterfowl on Prime Hook NWR) in designated areas where permits for individual dates are randomly issued to participants through a drawing

Macroinvertebrates: Invertebrates large enough to be seen with the naked eye like most aquatic insects, snails, amphipods, and chironomids. These larger and more prominent invertebrates are extremely important as food resources for waterfowl and shorebirds and other water birds. Abundance and species composition of macroinvertebrates in freshwater streams and waterways is often measured as an indication of negative impacts and stream and watershed health.

Management: Manipulation of nature for a specific goal.

Marl: A crumbly mixture of clays, calcium and magnesium carbonates, and remnants of shells that forms in both freshwater and marine environments.

Mast: Seeds and fruits produced by trees and shrubs that are eaten by wildlife.

Matrix: The most extensive and most connected habitat type in a landscape, which often plays the dominant role in landscape processes.

Memorandum of Understanding: A document describing a bilateral or multilateral agreement between parties.

Mesic: Relating or adapted to a moderately moist habitat. Mesic soils are sandy-to-clay loams containing moisture-retentive organic matter. Maples, white ash and basswood are mesic plants.

Metapopulation: A set of partially isolated populations belonging to the same species. A metapopulation has several subpopulations linked together by immigration and emigration. The populations are able to exchange individuals and recolonize sites in which the species has recently become extinct. A metapopulation consists of "a population of populations."

Metapopulation dynamics. The processes of recolonization and extinction of subpopulations of a metapopulation. Although individual populations have finite life-spans, the metapopulation as a whole is often stable because immigrants from one population are likely to re-colonize habitat which has been left open by the extinction of another population.

Migratory Birds: Birds that follow a seasonal movement from their breeding grounds to their wintering grounds. Waterfowl, shorebirds, raptors, and songbirds are all migratory birds.

Migratory Nongame Birds of Management Concern: Species of nongame birds that have undergone significant population declines; have small or restricted populations; or are dependent upon rare and vulnerable habitats. Non-game migratory birds protected by the Migratory Bird Treaty Act (MBTA), make up 88 to 96 percent of the bird species on the BCC 2002 lists.

Migration: Regular extensive, seasonal movements of birds between their breeding regions and their wintering regions; to pass usually periodically from one region or climate to another for feeding or breeding.

Minimum viable population: The low end of the viable population range; the smallest isolated population having {x} percent chance of remaining extant for {y} years despite the foreseeable effects of demographic, environmental and genetic random variation and natural catastrophes.

Mitigation: Actions to compensate for the negative effects if a particular action or project.

Moist-Soil Management (MSM): A native wetland plant management system using water level manipulations to create wet/dry cycles in impounded marsh areas that support early successional herbaceous vegetation which produces large quantities of moist-soil annual seeds, tubers, and other plant parts as highly nutritious food sources for waterfowl and other wildlife. MSM uses the draw down of water levels to promote the germination of native plants on exposed mudflats from late winter, early spring and/or late summer months and subsequent re-flooding of the same areas during early fall waterfowl migration periods.

Monitoring: The process of collecting information to track changes of selected parameters over time.

Mosaic: An interconnected patchwork of distinct vegetation types.

Mudflats: Unvegetated areas exposed after drawdown, low tide or natural seasonal drying of wetland areas. Waterfowl, shorebirds, and other birds can forage on invertebrates in these exposed areas.

Mycorrhizal: The symbiotic association of the mycelium of a fungus with the roots of plants, often trees. The fungus assists in the absorption of minerals and water from the soil and defends the roots from nematodes, while the plant roots provide carbohydrates to the fungus.

National Wildlife Refuge System Improvement Act of 1997 (Improvement Act): Sets the mission and the administrative policy for all refuges in the Refuge System; defines a unifying mission for the Refuge System; establishes the legitimacy and appropriateness of the six priority public uses (hunting, fishing, wildlife observation, wildlife photography, environmental education, and interpretation); establishes a formal process for determining appropriateness and compatibility; establish the responsibilities of the Secretary of the Interior for managing and protecting the Refuge System; requires a comprehensive conservation plan for each refuge by the year 2012. This Act amended portions of the Refuge Recreation Act and Refuge System Administration Act of 1966.

National Environmental Policy Act (NEPA): Requires all Federal agencies to examine the environmental impacts of their actions, incorporate environmental information, and use public participation in planning and implementing environmental actions.

National Wildlife Refuge Complex: An internal Service Administrative linking of refuge units closely related by their purposes, goals, ecosystem or geopolitical boundaries. In this case, referring to the Coastal Delaware NWR Complex, which consists of Prime Hook NWR and Bombay Hook NWR.

National Wildlife Refuge System: Means all lands, waters, and interests administrated by the Service as wildlife refuges, wildlife ranges, wildlife management areas, waterfowl production areas, coordination areas, and other areas for the protection and conservation of fish and wildlife including those that are threatened with extinction as determined in writing by Presidential or Secretarial order. The determination by the Director may not be delegated.

National Wildlife Refuge System Mission: Means 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.

Native: 1. (n.) A species that has not been introduced from somewhere else by humans. 2. (adj.) not introduced by humans.

Native Plant: A plant that has grown in the region since the last glaciation, and occurred before European settlement.

Natural Disturbance Events: Recurring perturbations such as fires and floods that occur in ecosystems without human intervention.

Natural Range of Variation: It is recognized that ecosystems are dynamic and complex but ecologists use this term to explain that what they measure or observe within an ecosystem is likely to change over space and time, but within a certain **range of variables** measured, the ecosystem remains basically recognizable. The natural range of variation refers to the changes within ecosystems that are operating without human influence. More recently ecological restorations use the term "historic range of variation" (HRV). HRV is a recognition that ecosystems have a range within which they are self-sustaining and beyond which they move into a state of disequilibrium. Because many of today's ecosystems are in an unsustainable state due to modern interventions into their historic processes, finding ways to look back at the factors that made them sustainable is a logical method to proceed in restoring degraded ecosystems.

Neartic: Relating to the biogeographic subregion that includes Greenland, artic America, and parts of North America north of tropical Mexico.

Neotropical: The new world tropical region from southern Mexico and the West Indies to South America.

Niche: Ecological role of a species in a community.

Non-ambulatory: Not able to walk about.

Non-consumptive, wildlife-oriented recreation: Wildlife observation and photography and environmental education and interpretation.

Nonforested Wetlands: Wetlands dominated by shrubs or emergent vegetation.

Non-native species: See "exotic species."

Non-point source pollution: A diffuse form of water quality degradation in which wastes are not released at one specific, identifiable point but from a number of points that are spread out and difficult to identify or control.

Nonpoint Source: A diffuse form of water quality degradation produced by erosion of land that causes sedimentation of streams, hyper-eutrophication from nutrients and pesticides used in agriculture and silvicultural practices, and by acid rain resulting from burning fuels that contain sulfur.

Nonvascular Plant: Any of various plants (mosses, liverworts and hornworts) that lack vascular tissue; a bryophyte for example.

Notice of Intent: An announcement we publish in the *Federal Register* that we will prepare and review an environmental impact statement [40 CFR 1508.22].

Noxious Weed: A plant species designated by Federal or State law as generally possessing one or more of the following characteristics: aggressive or difficult to manage; parasitic; a carrier or host of serious insect or disease; or nonnative, new, or not common to the United States, according to the Federal Noxious Weed Act (PL 93-639), a noxious weed is one that causes disease or had adverse effects on man or the environment and, therefore, is detrimental to the agriculture and commerce of the United States and to the public health.

Objective: Actions to be accomplished to achieve a desired outcome or goal. Objectives are more specific, and generally more measurable, than goals.

Obligate species: A species that must have access to a particular habitat type to persist.

Observation Platform: An elevated structure in a designated viewing area.

Other Recreational Use: A recreational use of the Refuge System that is not one of the six wildlife-dependent recreational uses and which may only be allowed if both appropriate and compatible.

Palustrine: One of three types of freshwater wetland systems, palustrine wetlands include marshes, bogs, swamps, and small shallow ponds.

Partners for Wildlife Program: A voluntary, cooperative habitat restoration program among the Service, other government agencies, public and private organizations, and private landowners to improve and protect fish and wildlife habitat on private land while leaving it in private ownership.

Partnership: A contract or agreement among two or more individuals, groups of individuals, organizations, or agencies, in which each agrees to furnish a part of the capital or some service in kind (e.g., labor) for a mutually beneficial enterprise.

Party (Hunt) Zone: A designated deer hunting area that allows two to ten hunters to free roam within the area and not be confined to a permanent deer hunting stand. There are four party hunt zones currently at Prime Hook NWR.

Passive Management: Protecting, monitoring key resources and conducting baseline inventories to improve our knowledge of the ecosystem.

Patch: A highly localized unit of population and community.

Passerines: Songbirds.

Pathogens: Biological agents, such as bacteria and viruses, that cause sickness or disease. Common sources in the Delaware Estuary include wastewater treatment plants, combined sewage overflow, and nonpoint source runoff.

Palynology: The study of fossil pollen and spores (pollen analysis) and various other microfossils, such as coccoliths and dinoflagellates. Palynology is used in stratigraphy, palaeoclimatology, and archaeology. Pollen and spores are very resistant to decay and therefore their fossils are readily found in sediments and rocks. Spores and pollen are classified according to shape, form of aperture, and both internal and external details of the exine (outer coat). They are indicative of the nature of the dominant flora, and the climatic conditions of the period in which they lived.

Pedestrian Trails: Areas designated for hiking use only and not opened to other modes of transportation such as biking.

Perennial: Lasting or active through the year or through many years; a plant species that has a life span of more than 2 years

Permanent Disability: A permanent physical, mental, or sensory impairment that substantially limits one or more major life activities, such as caring for oneself, performing manual tasks, walking, seeing, hearing, speaking, breathing, learning, and working. See 7 C.F.R. §15e.103; see also 29 U.S.C. § 705(20).

Pest: Any living organism (plant or animal) that occurs where it is not wanted or that causes damage to crops or humans or other animals.

Phenols: Any class of organic compounds that contain a hydroxyl group (OH) attached to an aromatic (benzene) ring. Phenols are used in industry to make plastics, detergents, pesticides and drugs. Phenols can be poisonous and carcinogenic to living organisms when found at elevated levels in the environment.

Phenology: The scientific study of cyclical biological events, such as flowering, breeding, and migration in relation to climatic conditions. Phenological records of the dates on which seasonal phenomena occur provide important information on how climatic change affects ecosystems over time.

Photography Blind: cf. Observation Platform

Phragmites australis: A common reed grass, generally considered a pest plant, because of its tendency to replace other valuable native vegetation by forming dense monotypic stands.

PhytoPlankton: Microscopic algae that are freely floating in aquatic environments and are important links to fish food chains.

Plant: As defined in the Refuge System Improvement Act, means any member of the plant kingdom in a wild, unconfined state, including any plant community, seed, root, or other part of a plant.

Pleistocene: The span of geological time preceding the Recent epoch, during which continental glaciers advanced and retreated and the human species evolved. The epoch began about 2.5 million years ago and closed with the end of the Ice Age 10,000 years ago.

Point Source: A source of pollution that involves discharge of waste from an identifiable point, such as a smokestack or sewage-treatment outflow pipe.

Population: In biology, any group of organisms belonging to the same species occupying a particular space and time; it incorporates subject areas from ecology, genetics, evolution, demography, behavior, and biostatistics and deals with the fundamental issues of structure and dynamics of biological populations.

Population Monitoring: Assessing the characteristics of populations to ascertain their status and establish trends on their abundance, condition, distribution, and health.

Population Viability: Concept of a "viable" population number that represents a threshold for survival versus extinction.

Population Viability Analysis (PVA): Models and numerical estimation procedures to determine the minimum viable population size or area. A PVA recognizes that extinction is subject to chance events and the likelihood of survival must be evaluated in consideration of a specified time frame to be used in conservation planning for endangered species. A population viability analysis can be effectively used in the recovery process of Endangered and Threatened species by supplying information that promotes proactive actions to enhance species recovery, improve our understanding of critical population processes and increase the predictive capabilities of future PVA models. (Bessinger and Westphal 1998)

Preferred Alternative: This is the alternative determined (by the decision-maker) to best achieve the Refuge purpose, vision, and goals; contributes to the Refuge System mission, addresses the significant issues; and is consistent with principles of sound fish and wildlife management.

Prescribed Fire: The application of fire to wildland fuels, either by natural or intentional ignition to achieve identified land use objectives [FWS Manual 621 FW 1.7].

Prime Hook State Wildlife Management Area: Owned and managed by the Delaware Division of Fish and Wildlife, this 698-acre area borders the Prime Hook NWR on its northern, eastern, and southern boundaries.

Priority Public Use: On national wildlife refuge lands, a compatible wildlife-dependent recreational use involving hunting, fishing, wildlife observation and photography, or environmental education and interpretation.

Private Land: Land owned by a private individual or group or non-government organization.

Proactive Management: Management of nature that seeks to avert a decline in habitat quality or quantity before an event is likely to occur.

Public: Individuals, organizations, and non-government groups; officials of Federal, State, and local government agencies; Native American tribes, and foreign nations—includes anyone outside the core planning team, those who may or may not have indicated an interest in the issues, and those who do or do not realize that our decisions may affect them.

Public Involvement: Offering an opportunity to interested individuals and organizations whom our actions or policies may affect to become informed; soliciting their opinions. We thoroughly study public input, and give it thoughtful consideration in shaping decisions about managing refuges.

Public Land: Land owned by the local, State, or Federal Government.

Public Use: Any use of the Refuge System by the public, including, but not limited to, wildlife-dependent recreation and other appropriate uses.

Purposes of a refuge: Means the purposes specified in or derived from the law, proclamation, executive order, agreement, public land order, or administrative memorandum establishing, authorizing or expanding a national wildlife refuge, unit or subunit.

Quality: Defined by 11 criteria as it relates to wildlife-dependent recreation (605 FW 1-General Guidelines for Wildlife-Dependent Recreation)—1) Promotes safety of participants, other visitors, and facilities; 2) Promotes compliance with applicable laws and regulations and responsible behavior; 3) Minimizes or eliminates conflict with fish and wildlife population or habitat goals or objectives in an approved plan; 4) Minimizes or eliminates conflicts with other compatible wildlife-dependent recreation; 5) Minimizes conflicts with neighboring landowners; 6) Promotes accessibility and availability to a broad spectrum of the American people; 7) Promotes resource stewardship and conservation; 8) Promotes public understanding and increases public appreciation of America's natural resources and our role in managing and conserving these resources; 9) Provides reliable/reasonable opportunities to experience wildlife; 10) Uses facilities that are accessible to people and blend into the natural setting; and 11) Uses visitor satisfaction to help define and evaluate programs.

Quaternary: The second period of the Cenozoic era, which began about 2 million years ago. It is subdivided into two epochs—the Pleistocene and Holocene. The beginning of the Quaternary is usually based on the onset of a worldwide cooling. During this period four principle glacial phases occurred in North America and Europe, in which ice advanced towards the equator, separated by interglacial periods marked by warmer climatic conditions. The last glacial ended about 10,000 years ago. Humans became the dominant terrestrial species during the Quaternary. Among the fauna adapted to the colder conditions of the Pleistocene were the mammoth and the woolly rhinoceros.

Ramsar Convention: A 1973 convention held in Ramsar, Iran which addressed the important of wetlands on an international scale. The main goals of the convention were 1) "to stem the progressive encroachment of and the loss of wetlands now and in the future;" 2) to promote habitats which are of international importance to waterfowl; 3) to coordinate national policies with international action; and 4) to encourage research and management.

Raptors: Birds of prey, such as bald eagles, osprey, northern harriers and peregrine falcons.

Rare Species: Species identified for special management emphasis because of their uncommon occurrence within a particular watershed or ecosystem.

Rare Community Types: Plant community types classified as rare by any state natural heritage program; includes exemplary community types.

Recharge: Means water entering an underground aquifer through faults, fractures, or direct absorption.

Record of Decision: A concise public record of a decision by a Federal agency pursuant to NEPA which includes:
the decision; all the alternatives considered; the environmentally preferable alternative; a summary of monitoring and enforcement, where applicable for any mitigation; and, whether all practical means have been adopted to avoid or minimize environmental harm from the alternative selected (or if not, why not).

Recreation Fee Program: cf. Federal Lands Recreation Enhancement Act

Recreational Visitor Day (RVD): A unit of measure equal to one person spending one full day (8 hours) recreating at a particular site. RVDs allow comparisons between visitors who stay for only short periods of time and those who stay longer.

Refuge Goals: "…descriptive, open-ended, and often broad statements of desired future conditions that convey a purpose but do not define measurable units." *(Writing Refuge Management Goals and Objectives: A Handbook)*

Refuge Purposes: "The terms 'purposes of the refuge' and 'purposes of each refuge' mean the purposes specified in or derived from the law, proclamation, executive order, agreement, public land order, donation document, or administrative memorandum establishing, authorizing, or expanding a refuge, refuge unit, or refuge subunit." (*National Wildlife Refuge System Improvement Act of 1997)*

Refuge Lands: Lands which the Service holds full interest in fee title or partial interest like an easement.

Refuge Management Activity: Means an activity conducted by the Service or a Service-authorized agent to fulfill one or more purposes of the national wildlife refuge, or the National Wildlife Refuge System mission. We do not require a compatibility determination for refuge management activities as defined by the term "refuge management activity" except for "**refuge management economic activities.**" Examples of refuge management activities that do not require a compatibility determination include prescribed burning, water level management, invasive species control; routine scientific monitoring studies, surveys, and censuses; historic preservation activities; law enforcement activities; and maintenance of existing refuge facilities, structures, and improvements. (CD Policy: 603 FW 2.10A)

Refuge Management Economic Activity: Means a refuge management activity on a national wildlife refuge which results in generation of a commodity which is or can be sold for income or revenue or traded for goods and services. Examples include farming, grazing, haying, and trapping.

Refuge Use: Any activity on a refuge, except administrative or law enforcement activity carried out by or under the direction of an authorized Service employee.

Refugium: Area that has escaped from major climatic changes that have occurred within the immediate region and that serves as a refuge for biota that was more widely distributed.

Regular Hunt: Opportunities to hunt on Prime Hook NWR where a one-time annual permit is needed by participants to access designated areas on a first-come, free roam basis

Reintroduction: Placement of an individual, population, or species back into its historic habitat range after it has been extirpated from that habitat.

Resident/Non-Resident: Banking with Nature Definition: = People living more than 30 miles from the refuge are defined as non-residents.

Restoration: Management of a disturbed and/or degraded habitat that results in the recovery of its original features and native plant communities.

Restoration Ecology: The study of renewing degraded, damaged, or destroyed ecosystem function through active human intervention using biological principles and applications in population and community ecology aimed to restore and rehabilitate highly disturbed or degraded ecosystems to their more natural state. There is consensus in the scientific community that the current degradation and destruction of the earth's biota is taking place on a catastrophically short timescale leading to a current extinction rate 1,000 to 10,000 times the normal rate and that habitat loss is the leading cause of both species extinctions and ecosystem dysfunction. Two ways to reverse this trend is conservation of currently viable natural habitats and the restoration of degraded habitats.

Resources of Concern: All plant and/or animal species, species groups, or communities specifically identified in refuge purposes, system mission or international, national, regional and state plans or acts. For example, shorebirds have been identified a resource of concern at Prime Hook NWR as the refuge is a designated site in the Western Hemispheric Shorebird Reserve Network and it will focus on conserving priority shorebird species as identified in the United States Shorebird Conservation Plan, Partners in Flight Plan, the North American Waterfowl Management Plan, the North American Bird Conservation Initiative, the North American Waterbird Conservation Plan, the Delaware Wildlife Management Action Plan and Federal or state threatened and endangered species HMP Policy (620 FW 1.4G). The term **"resources of concern"** and **conservation targets** are used interchangeably in Service policy documents and other literature.

Right-of-Way: **C**overs uses that will encumber real property on refuges by granting a right to use and alter the landscape through construction of a facility such as a road, powerline, pipeline, or building (air navigation facility, radio tower, etc.). Generally, such uses are for a relatively long period of time; i.e., 10 years or longer. [340 FW 3]

Riparian: Referring to the interface between freshwater habitats and the terrestrial landscape.

Riparian Forested Land: Forested along a stream or river.

Riparian Habitat: Habitat along the banks of a stream or river [cf. note above].

Ruderal: Of a plant growing in disturbed soil, and so often in waste near human habitation.

Runoff: Water from rain, melted snow, or agricultural or landscape irrigation that flows over a land surface into a water body.

Sanctuary: A place of refuge and protection.

Scale: In ecology, referring to hierarchical units of measuring or modeling spatial processes, (like dispersal, niche divergence) or temporal processes (like succession, species guild formation); the magnitude of a region or process; refers to both spatial size like a small-scale patch or a large-scale landscape, and a temporal rate like rapid ecological succession or slow evolutionary speciation.

Scoping: The process of obtaining information from the public for input into the planning process.

Seasonal Closures: Areas and/or trails closed for the protection of wildlife based on their annual life cycles and habitat needs or due to conflicts with other uses. Closures are seasonal and are determined by refuge staff.

Section 7: The section of the Endangered Species Act of 1973, as amended, outlines procedures for interagency cooperation to conserve federally listed species and designated critical habitats. Section 7(a)(1) requires Federal agencies to use their authorities to further the conservation of listed species. Section 7(a)(2) requires Federal agencies to consult with the Services to ensure that they are not undertaking, funding, permitting, or authorizing actions likely to jeopardize the continued existence of listed species or destroy or adversely modify designated critical habitat. Other paragraphs of this section establish the requirement to conduct conferences on proposed species; allow applicants to initiate early consultation; require FWS and NMFS to prepare biological opinions and issue incidental take statements. Section 7 also establishes procedures for seeking exemptions from the requirements of section 7(a)(2) from the Endangered Species Committee. [ESA §7]

Section 7 Consultation: The various section 7 processes, including both consultation and conference if proposed species are involved. [50 CFR §402]

Service: cf. U.S. Fish and Wildlife Service

Shorebird: Any of a suborder (*Charadrii*) of birds, such as a plover or a snipe, that frequent the seashore or mud flat areas.

Shrublands: Habitats dominated by various species of shrubs, often with many grasses, forbs and some trees.

Significance: As it relates to the *Banking on Nature* Report, is the total economic activity in a region that is related to a refuge. Significance shows a refuge's role in the regional economy.

Slough: 1) A depression or hollow, usually filled with deep mud or mire (wet, soggy, muddy ground); or 2) a stagnant swamp, marsh, bog or pond as part of a creek or backwater.

Smart Objectives: Specific, measurable, achievable, results-oriented, and time-fixed (*Writing Refuge Management Goals and Objectives: A Handbook).*

Snag (Tree): A partially or fully dead tree that remains standing. Snags provide habitat for a variety of birds and other wildlife.

Sound Professional Judgment: A finding, determination, or decision that is consistent with principles of sound fish and wildlife management and administration, available science and resources, and adherence to the requirements of the Refuge Administration Act and other applicable laws.

Source Population: A population in a high-quality habitat where the birth rate greatly exceeds the death rate and the excess individuals emigrate.

Special Use Permit: The issuance of a permit and collection of fees on lands of the Refuge System is authorized by the Refuge System Administration Act (16 U.S. C. 668dd-ee) as amended, and the Refuge Recreation Act (16 U.S. C. 460k-460k-4). A SUP is issued when the public is engaged in the following activities on a national wildlife refuge outside Alaska (Alaska refuges use a different form): agriculture, commercial activities, research/monitoring (does not include research/monitoring by refuge staff as part of normal duties), commercial filming, commercial visitor services, special events, and any other activity not mentioned above. At minimum, the refuge manager should complete an appropriate use decision or, preferably, a compatibility determination for the activity before issuing the Special Use Permit. The refuge manager determines fees according to existing policies and guidance.

Species: The basic category of biological classification intended to designate a single kind of animal or plant. Any variation among the individuals may be regarded as not affecting the essential sameness which distinguishes them from all other organisms.

Species Assemblage: The combination of certain species that occur together in a specific location with dependent interactions and certain community characteristics.

Species at Risk: A species being considered for Federal listing as threatened or endangered, formerly, a "candidate species."

Species Diversity: A measure of species richness and evenness is often used to quantify species diversity as a numerical comparison between communities. Species diversity increases as the number of species increases and as the number of individuals are more evenly distributed.

Species of Concern: Species not federally listed as threatened or endangered, but about which we and/or our partners are concerned.

Species Richness: The measure of species diversity calculated as the total number of species in a habitat or community whereas evenness is defined as the relative abundance of individuals among the recorded species.

Staging and Loafing: Areas used by waterfowl to rest and increase fat and protein reserves in preparation for migration.

Stand: An area of trees with a common set of conditions (e.g. based on age, density, species composition, or other features) that allow a single management treatment throughout.

State Land: State-owned public land.

State-Listed Species: cf. "Federal-listed species"

Step-Down Management Plan: A plan for dealing with specific refuge management subjects, strategies, and schedules, e.g., cropland, wilderness, and fire [FWS Manual 602 FW 1.4].

Stochastic Processes: Processes with a variable outcome that is random or uncertain. Stochastic processes increase in importance with decreasing or very small population size. Some examples are: **Genetic Uncertainty** ➔ random changes in genetic make-up due to founder effect, genetic drift, or inbreeding which affects fitness; **Environmental Uncertainty** ➔ represents unpredictable changes in factors such as weather, food supply, and populations of competitors, predators, and parasites; **Natural Catastrophes** ➔ represent floods, fires and droughts that occur at random intervals.

Stopover Habitat: Habitat where birds rest and feed during migration

Strategy: A specific action, tool, technique, or combination of actions, tools and techniques used to accomplish a refuge's stated objectives.

Stratigraphy: The scientific study of rock strata, especially the distribution, deposition, correlation and age of sedimentary rocks. It is the branch of geology concerned with the origin, composition, sequence, and correlation of rock strata. It forms the basis of historical geology and has also found practical application in mineral exploration, especially that of petroleum.

Structural Diversity: Diversity in a community that results from having many horizontal or vertical physical elements (like layers or tiers of a canopy, or varying heights and densities of forbs and grasses in an early successional "old field") An increase in laying, tiering, or plant heights and densities leads to an increase in structural diversity.

Structure: The various horizontal and vertical physical elements of a vegetation community.

Succession: The more or less predictable change in the composition of communities following a natural or human disturbance. It marks the regular patterns in how plants and other organisms take each other's place or how they "succeed" each other. First comes pioneer species---fast growing, fast-spreading plants adapted to harsher environmental conditions, like sweetgums pioneering poor soils with depleted fertility from intensive agricultural use. In time pioneers build up nitrogen in the soil and provide shade and wind protection for other species to colonize and eventually reverting to mixed hardwood or coniferous stand of trees. There are no absolute rules about succession. It can take a few years or centuries and has no fixed final state.

Successional Management: Form of management, using habitat management techniques like controlled burning or water level control in marshes that manipulates the successional processes of a community to maintain early stages of plant communities to meet specific wildlife or habitat management objectives, or allowing native communities to revert to later successional stages of development at their own pace.

Successional Meadows: A large treeless area that is dominated by grasses and small woody and non-woody plants.

Surface Water: All waters whose surface is naturally exposed to the atmosphere, or wells or other collectors, directly influenced by surface water.

Sustainable Development: The attempts to meet economic objectives in ways that do not degrade the underlying environmental support system. From a conservation biology perspective it implies that "human activities are conducted in a manner that respects the intrinsic value of the natural world, the role of the natural world in human well-being, and the needs for humans to live on the income from nature's capital rather than the capital itself."

Synergistic: Producing or capable of producing synergy, or the interaction of two or more agents or forces so that their combined effect is greater than the sum of their individual effects.

Tax Ditch: A tax ditch is a governmental subdivision in the state of Delaware. It is a watershed-based organization formed by a prescribed legal process in Superior Court. The organization is comprised by all landowners (called "taxables") of a particular watershed and was primarily devised to drain wetland areas for farming.

Terrestrial: Living on land.

Territory: An area over which an animal or group of animals establishes jurisdiction.

Tertiary Period: The first period of the Cenozoic Era, beginning with the end of the Mesozoic Era (Age of Reptiles) 63 to 65 million years ago and closing with the start of the Pleistocene epoch about 2.5 million years ago; succeeded by the Quaternary period (Pleistocene plus Recent epochs).

Threatened Species: A Federal-listed, protected species that is likely to become an endangered species in all or a significant portion of its range.

Tiering: Incorporating by reference the general discussions of broad topics in environmental impact statements into narrower statements of environmental analysis by focusing on specific issues.

Tilth: A measure of the health of soil. Good tilth is a term referring to soil that has the proper structure, and nutrients to grow healthy plants. Soil in good tilth is loamy, nutrient rich soil that can also be said to be friable because optimal soil conditions is represented by a mixture of sand, clay, and organic matter that prevents severe compaction.

Translocation: **(See Reintroduction)**—Management technique often used in mitigation for endangered species protection whereby an individual, population, or species is removed from its habitat to be established in another area of similar or identical habitat.

Tributary: A creek, stream or river that flows into a larger, creek or stream, feeding it water.

Trophic: The functional classification of organisms in an ecological community based on feeding relationships; the first level includes green plants; the second trophic level includes herbivores; and so on.

Trust Resource: cf. Federal trust resource.

Trust Species: cf. Federal trust species.

Turbidity: Refers to the extent to which light penetrates a body of water. Turbid waters are those that do not generally support net growth of photosynthetic organisms.

Umbrella Species: Species that require large areas to maintain viable populations and by which protection of their habitat may safeguard the habitat and populations of many other more restricted and less wide ranging species.

Understory: The lower layer of vegetation in a stand, which may include short trees, shrubs, and herbaceous plants.

Unfragmented Habitat: Large, unbroken blocks of a particular type of habitat.

Upland: Dry ground (i.e., other than wetlands).

Upwelling: A process whereby nutrient-rich waters from the ocean depths rise to the surface; it commonly occurs along the continental coastlines.

U.S. Fish and Wildlife Service: (Service, USFWS, FWS) The principal federal agency responsible for conserving, protecting, and enhancing fish and wildlife and their habitats for the continuing benefit of the American people. The Service manages the 93-million-acre National Wildlife Refuge System comprised of more than 530 national wildlife refuges and thousands of waterfowl production areas. It also operates 65 national fish hatcheries and 78 ecological service field stations, the agency enforces federal wildlife laws, manages migratory bird populations, restores national 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 aid program that distributes millions of dollars in excise taxes on fishing and hunting equipment to state wildlife agencies.

U.S. Geological Survey (USGS): A Federal agency whose mission is to provide reliable scientific information to describe and understand the earth; minimize loss of life and property from natural disasters; manage water, biological, energy, and mineral resources; and enhance and protect our quality of life.

Validation Monitoring: Scientific testing of the validity of the models and assumptions upon which a monitoring program is based.

Vascular: Any of various plants that have vascular tissues xylem and phloem. The vascular plants include all seed-bearing plants (gymnosperms and angiosperms) and the pteridophytes (includes ferns, lycophytes, and horsetails).

Vernal Pool: Depressions holding water for a temporary period in the spring, and in which various amphibians are highly dependent on for breeding (lays eggs); these depressions often harbor very unique flora and fauna.

Vision Statement: A concise statement of what a management unit could achieve in the next 10 to 15 years.

Visitors: A visitor is someone who comes to the refuge and participates in one or more of the activities available at the refuge.

Visitor Services: Any program provided by the Service that is specifically or predominately designed for the participation or benefit of visitors.

Visitor Services Review: An evaluation of a refuge's visitor services program to support the CCP process. The review offers suggestions on addressing issues and opportunities, provides recommendations to assist the station in the development of the site's visitor services program, and provides the refuge staff with a fresh look at the refuge and the programs they manage everyday.

Visits (Visitation): A visit is not the same as a visitor. One visitor could be responsible for several visits on a refuge. For example, if a family of four went fishing in the morning and then hiked a nature trail in the afternoon, they would have contributed eight activity visits but only four visitors.

Vulnerable species: Species that are sensitive to human activity because of their life history, appearance, reputation, edibility, location, or other factors.

Wading Birds: Any of many long-legged birds that wade in water in search of food.

Watershed: A geographic area in which water, sediments, and dissolved materials drain to a common water body. A watershed includes both the land and the body of water into which the land drains.

Water Control Structure: A device installed to help control water levels and provide an appropriate outlet for discharging water, that can include stoplogs, flaplog, weirs, checkdams, and inline control structures.

Water Level Management: It is the active management of water elevation within a wetland to mimic natural seasonal hydrology patterns that are attractive to waterfowl and other wetland-dependent wildlife. These manipulations of water levels in the refuge's moist soil and impoundment management units are used to create a mudflat-type environment to attract shorebirds, to concentrate fish for wading birds to feed upon, to stimulate annual vegetation as a food source for waterfowl, and to reduce the number of plants that are low in nutrition for wildlife.

Water Quality Standards: State regulations which outline permissible levels of individual pollutants in specific bodies of water.

Warm-Season Grass: Native prairie grass that grows the most during summer, when cool-season grasses are dormant.

Waterfowl: A category of birds that includes ducks, geese, and swans.

Watershed: The geographic area within which water drains into a particular river, stream, or body of water; land and the body of water into which land drains.

Well Protected: In CCP analysis, a rare species or community type is considered well protected if 75 percent or more of its occurrence sites are on dedicated open space or protected habitat.

Wetlands: Lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water. These areas are inundated or saturated by surface water or groundwater at a frequency and duration sufficient to support a prevalence of vegetation typically adapted to life in saturated soil conditions. "Wetlands are lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water."—Cowardin et al 1979

Wet Meadows: Meadows located in moist, low-lying areas, often dominated by large colonies of native grasses, forbs and wildflowers. Often they are created by beaver dams or exposed pond bottoms. Saltmarsh meadows are subject to daily coastal tides.

Wilderness: cf. "Designated wilderness area."

Wildfire: A free-burning fire requiring a suppression response; all fire other than prescribed fire that occurs on wildlands [FWS Manual 621 FW 1.7].

Wildland Fire: Every wildland fire is either a wildfire or a prescribed fire [FWS Manual 621 FW 1.3].

Wildland Urban Interface: Roughly defined as the zone where natural areas and development meet.

Wildlife: The terms "fish," "wildlife," and "fish and wildlife" mean any wild member of the animal kingdom, whether alive or dead, and regardless of whether it was bred, hatched, or born in cavity, including its parts, products, eggs, or offspring.

Wildlife-Dependent Recreational Use: A use of a national wildlife refuge involving hunting, fishing, wildlife observation and photography, or environmental education and interpretation (National Wildlife Refuge System Administration Act of 1966).

Wildlife Management: Manipulating wildlife populations, either directly by regulating the numbers, ages, and sex ratios harvested, or indirectly by providing favorable habitat conditions and alleviating limiting factors.

Wildlife-Oriented Recreation: Recreational activities in which wildlife is the focus of the experience.

["The terms 'wildlife-dependent recreation' and 'wildlife-dependent recreational use' mean a use of a refuge involving hunting, fishing, wildlife observation and photography, or environmental education and interpretation."—National Wildlife Refuge System Improvement Act of 1997]

Xeric: Characterized by, relating to, or requiring only a small amount of moisture.

Acronyms

Acronym	Full Name
ACJV	Atlantic Coast Joint Venture
ALAD	Amino levulinic acid dehydratase
APHIS	Animal and Plant Health Inspection Service
BCC	Birds of Conservation Concern
BCR	Bird Conservation Region
BIDEH	Biological Integrity, Diversity, and Environmental Health
CCP	Comprehensive Conservation Plan
CFR	Code of Federal Regulations
CWD	Chronic Wasting Disease
DELDOT	Delaware Department of Transportation
DMCS	Delaware Mosquito Control Section
DNHP	Delaware Natural Heritage Program
DNREC	Delaware Department of Natural Resources & Environmental Control
EA	Environmental Assessment
EIS	Environmental Impact Statement
EPA	Environmental Protection Agency
ESA	Endangered Species Act
GIS	Geographical Information Systems
GPS	Global Positioning System
HMP	Habitat Management Plan
IPCC	Intergovernmental Panel on Climate Change
MDN-GAP	Maryland, Delaware, New Jersey Gap Analysis Program
NAAQS	National Ambient Air Quality Standard
NABCI	North American Bird Conservation Initiative
NASP	National Archery in the Schools Program
NAWMP	North American Waterfowl Management Plan
NEPA	National Environmental Policy Act
NOAA	National Oceanic and Atmospheric Administration
NVCS	National Vegetation Classification System

Acronym	Full Name
NWR	National Wildlife Refuge
NWRS	National Wildlife Refuge System
OMWM	Open Marsh Water Management
PARC	Partners in Amphibian and Reptile Conservation
PIF	Partners in Flight
RONS	Refuge Operation Needs System
SAMMS	Service Asset Maintenance Management System
SHC	Strategic Habitat Conservation
SLAMM	Sea Level Rise Affecting Marsh Model
TMDL	Total Maximum Daily Load
U.S.	United States
USDA	United States Department of Agriculture
USGS	United States Geological Survey
WMA	Wildlife Management Area

Appendix A

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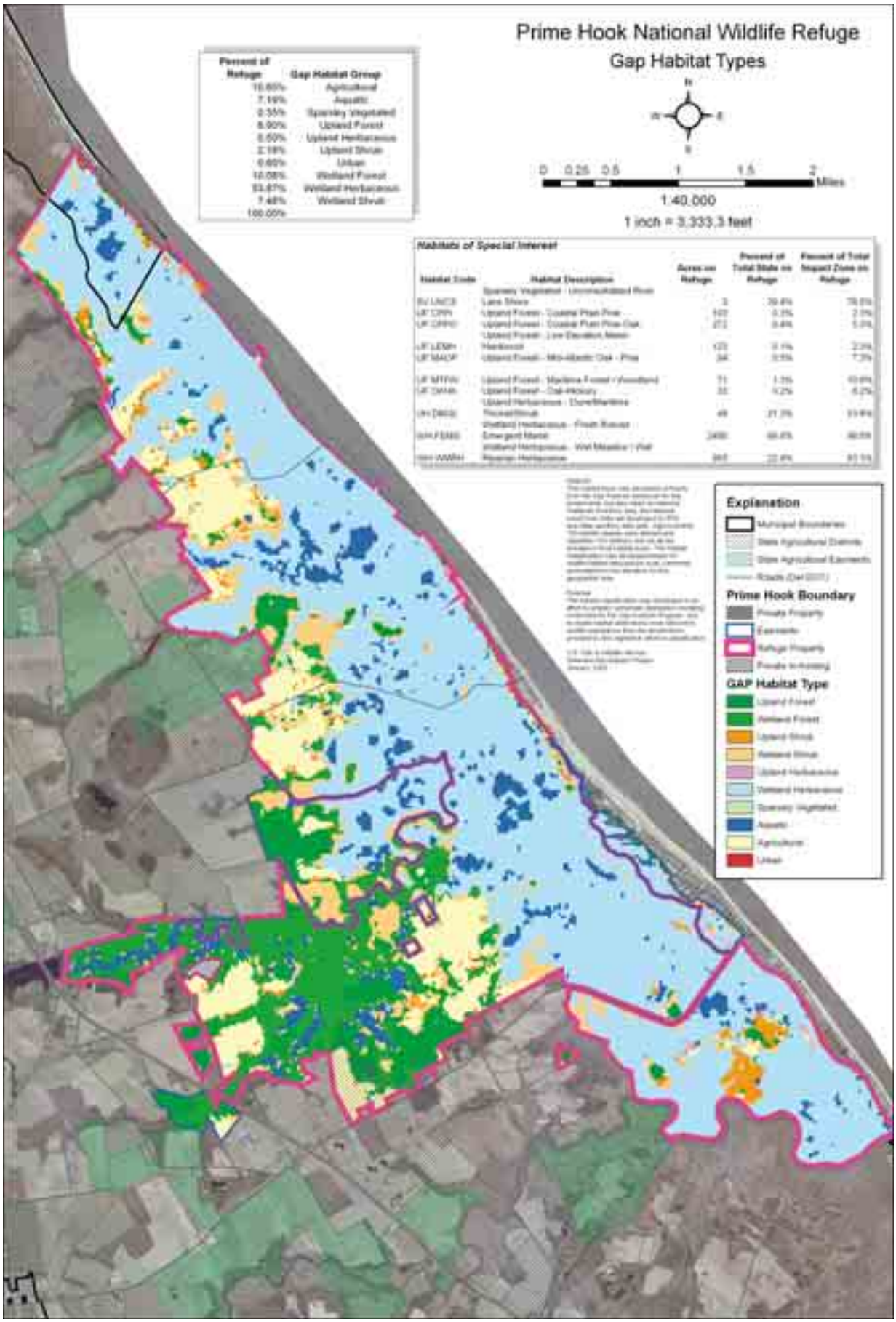
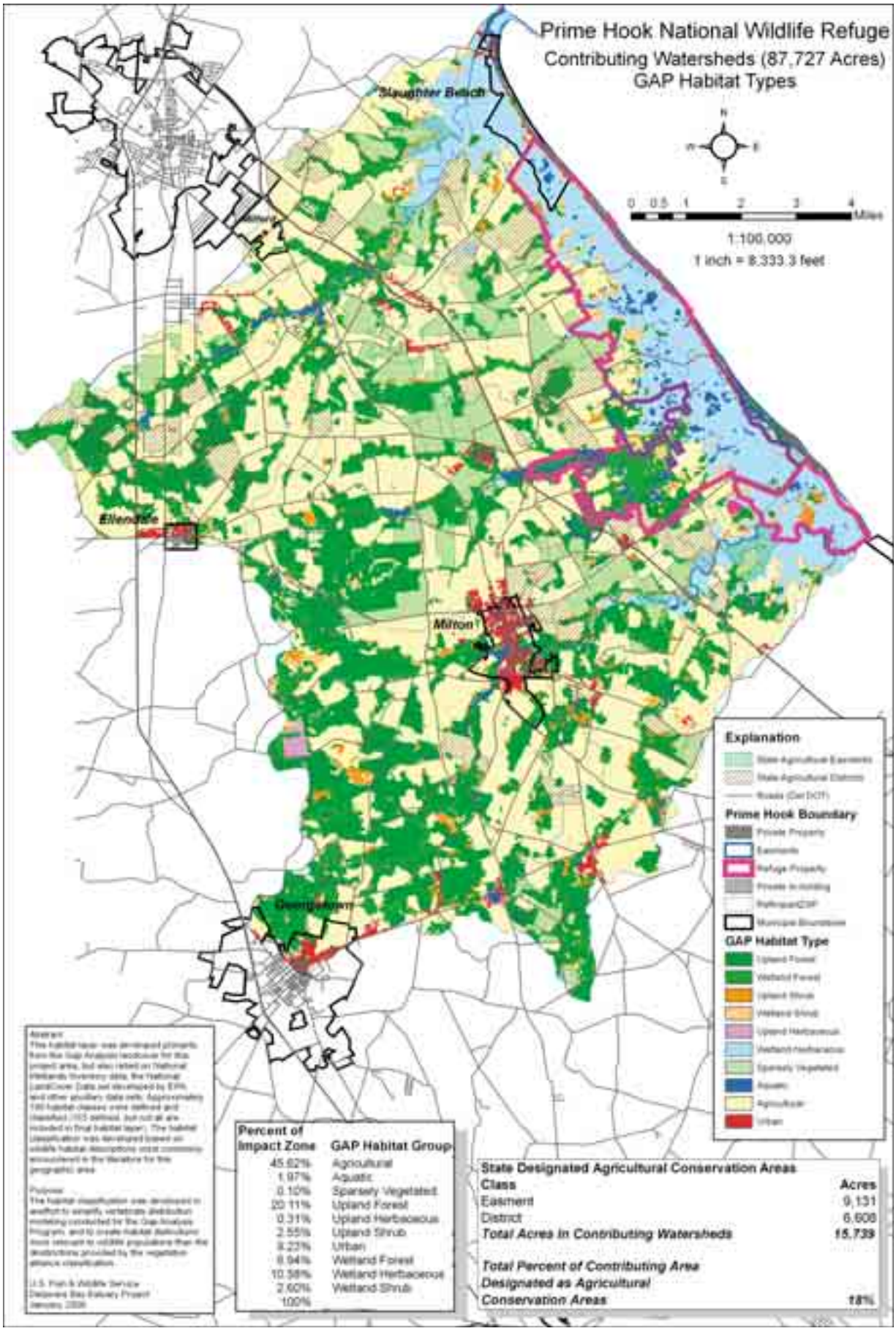
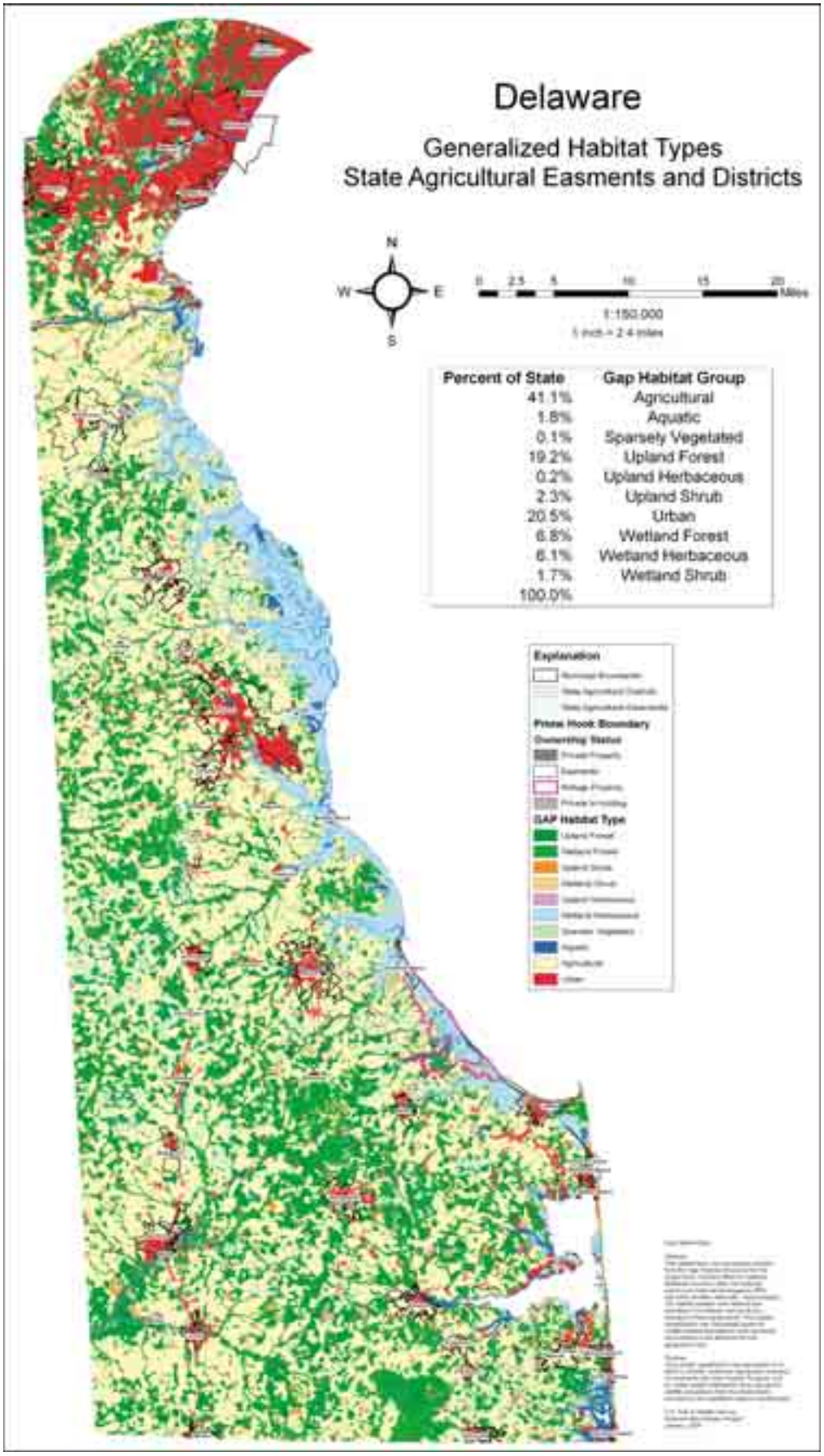
Greater yellowlegs on the refuge

Gap Habitat Maps


Prime Hook National Wildlife Refuge
Gap Habitat Types
Percent of Refuge
Gap Habitat Group
10.85% Agricultural
7.19% Aquatic
0.55% Sparsely Vegetated
8.90% Upland Forest
0.50% Upland Herbaceous
2.18% Upland Shrub
0.85% Urban
10.08% Wetland Forest
53.87% Wetland Herbaceous
7.48% Wetland Shrub
100.00%
N
W
E
S
0 0.25 0.5 1 1.5 2 Miles
1:40,000
1 inch = 3,333.3 feet
Habitats of Special Interest
Habitat Code
Habitat Description
Acres on Refuge
Percent of Total State on Refuge
Percent of Total Impact Zone on Refuge
Explanation
Municipal Boundaries
State Agricultural Districts
State Agricultural Easements
Roads (Del 2007)
Prime Hook Boundary
Private Property
Easements
Refuge Property
Private In-Holding
GAP Habitat Type
Upland Forest
Wetland Forest
Upland Shrub
Wetland Shrub
Upland Herbaceous
Wetland Herbaceous
Sparsely Vegetated
Aquatic
Agriculture
Urban


Prime Hook National Wildlife Refuge
Contributing Watersheds (87,727 Acres)
GAP Habitat Types
Slaughter Beach
Ellendale
Milton
Georgetown
0 0.5 1 2 3 4 Miles
1:100,000
1 inch = 8,333.3 feet
Explanation
Prime Hook Boundary
GAP Habitat Type
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
8.23% 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
Prime Hook Boundary
Ownership Status
GAP Habitat Type

Appendix B

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Rough green snake

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.

<u>North American Waterfowl Management Plan (NAWMP) & Atlantic Coast Joint Venture (ACJV)</u>
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.

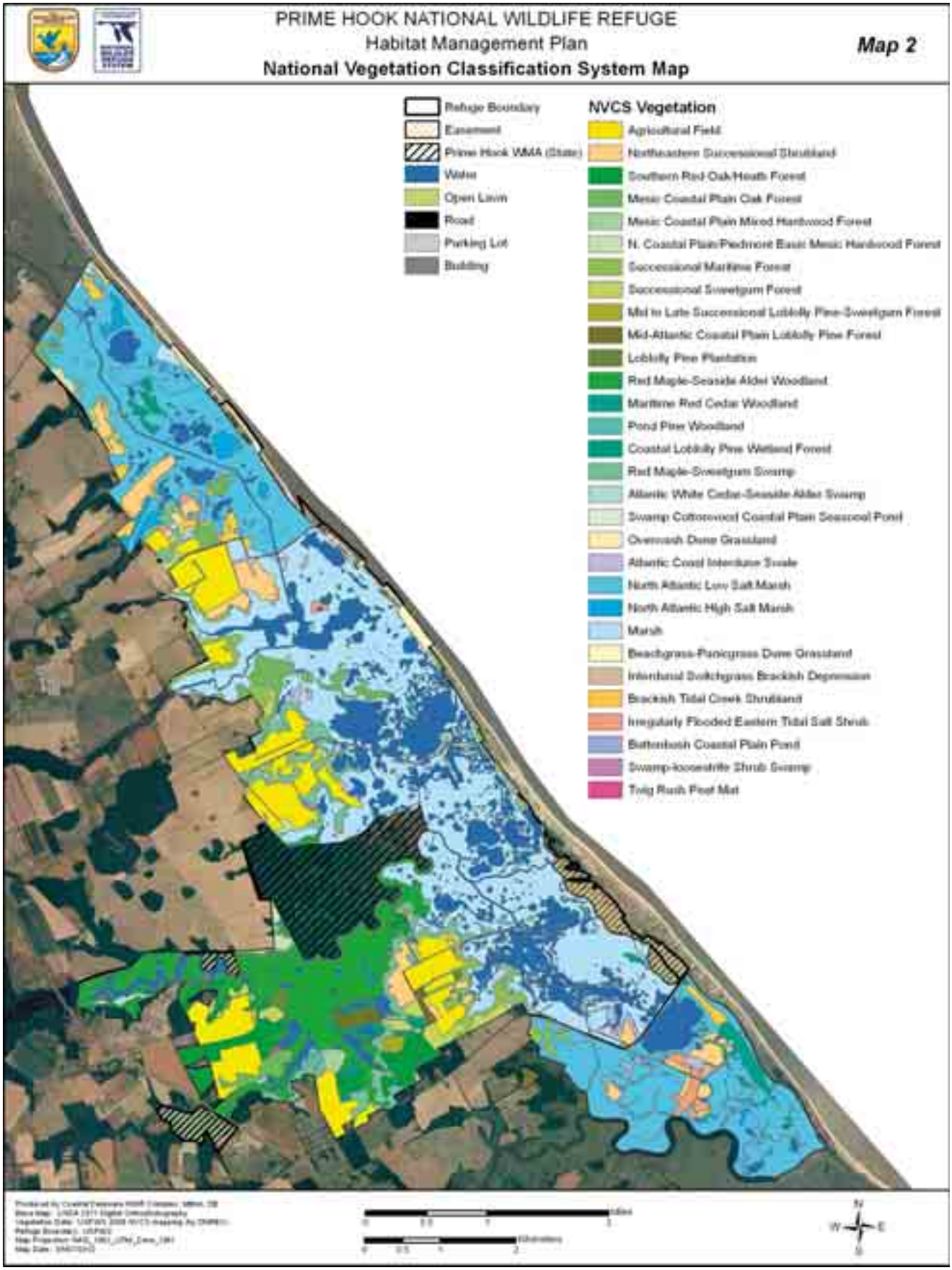
Natural habitats are dominated by emergent wetlands interspersed with swamp and upland forests representative of the Delmarva Coastal Plain ecosystem. Eighty percent of PHNWR's vegetation cover types are influenced by tidal and freshwater creek drainages that discharge into the Delaware Bay with associated 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:

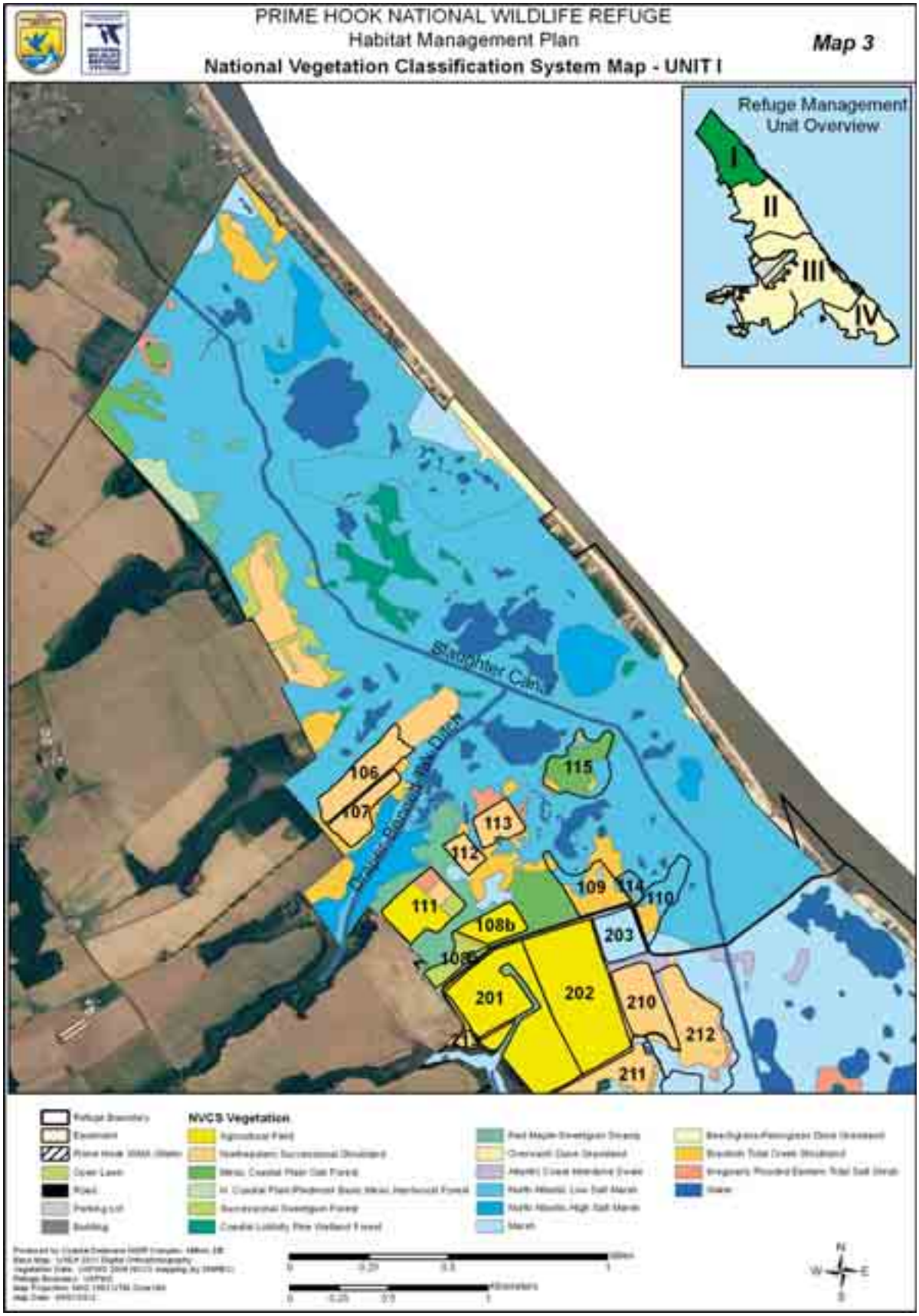
1) The Great Marsh (1,000 acres of salt marsh, owned by the town of Lewes) located just south of the Refuge,
2) Milford Neck WMA (5,459 acres), 3 miles north of the refuge above Mispillion Inlet;
3) Ted Harvey Conservation Area (2,661 acres), 9 miles north of the refuge above Bower's Beach;
4) Little 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

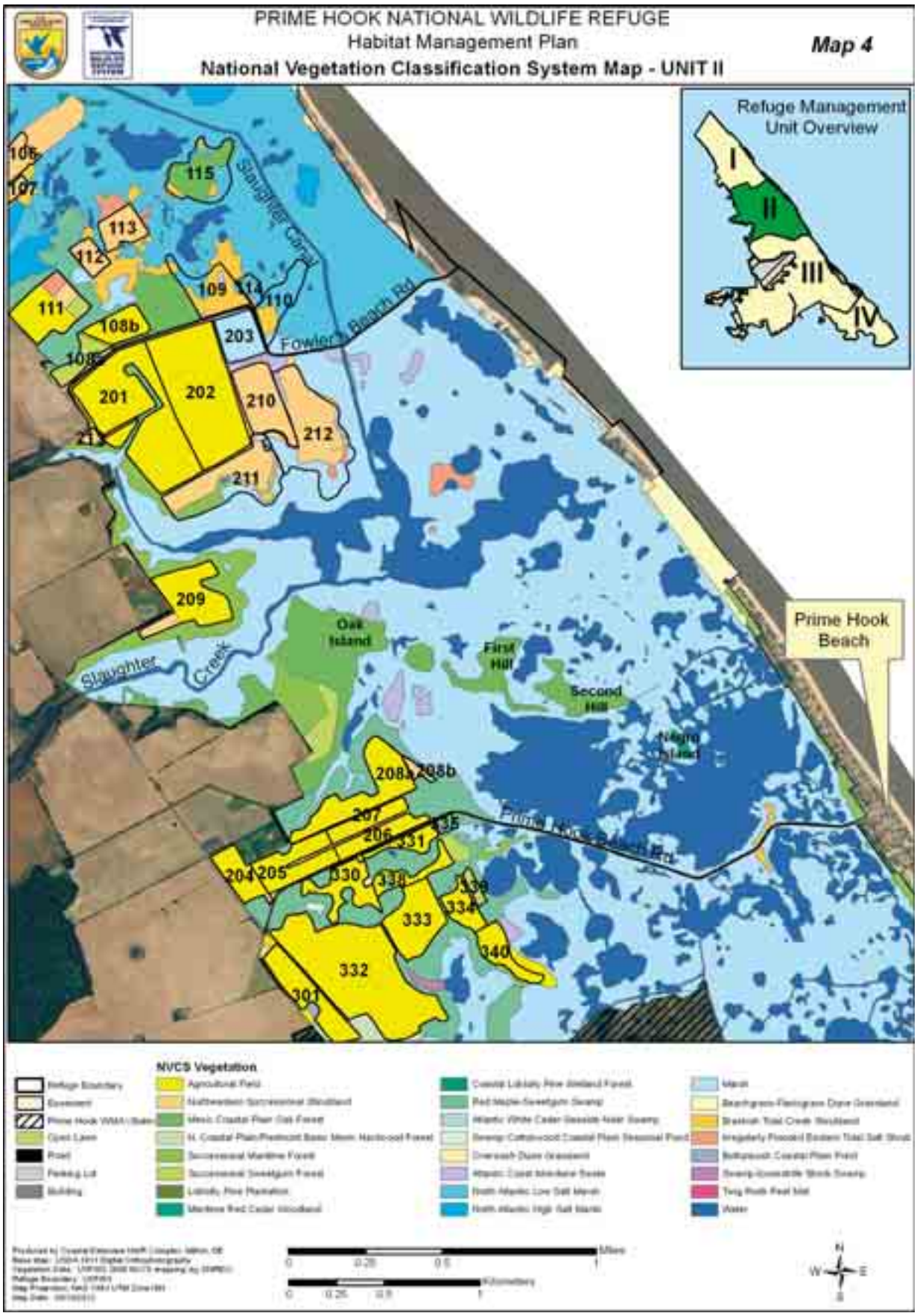
Map 2. National Vegetation Classification System Map - Overview (2006)



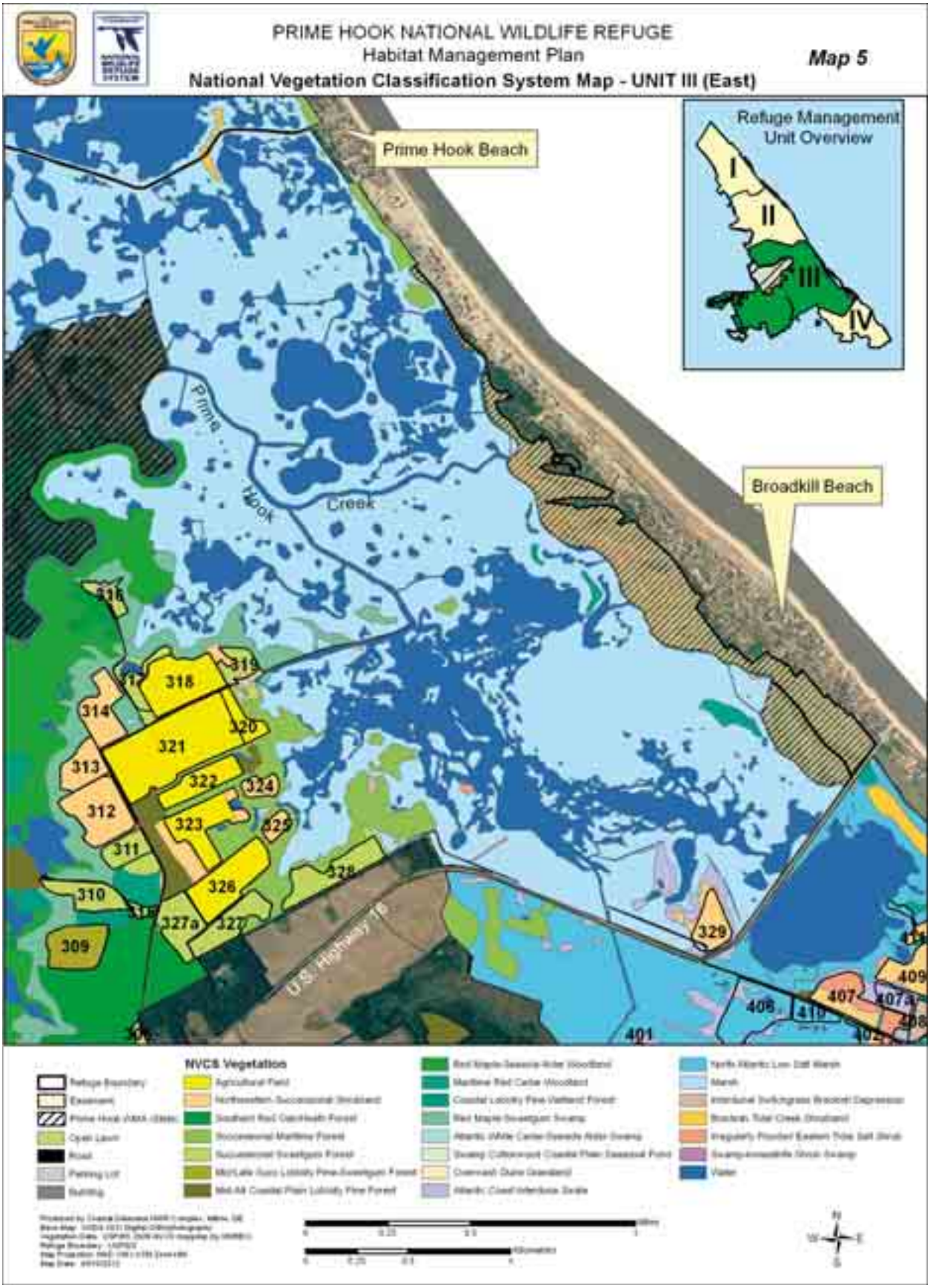
Map 3. National Vegetation Classification System Map - Unit I



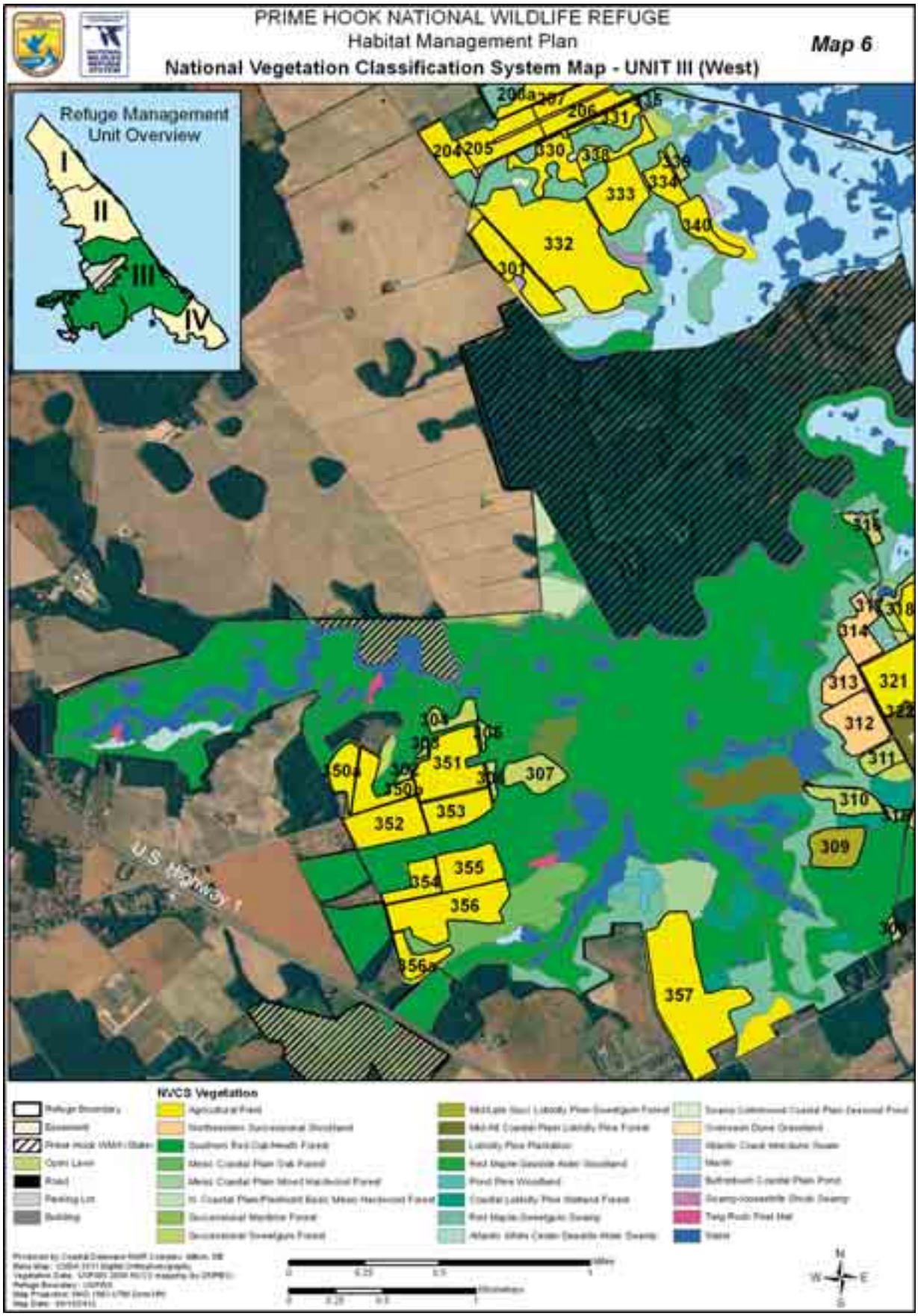
Map 4. National Vegetation Classification System Map - Unit II



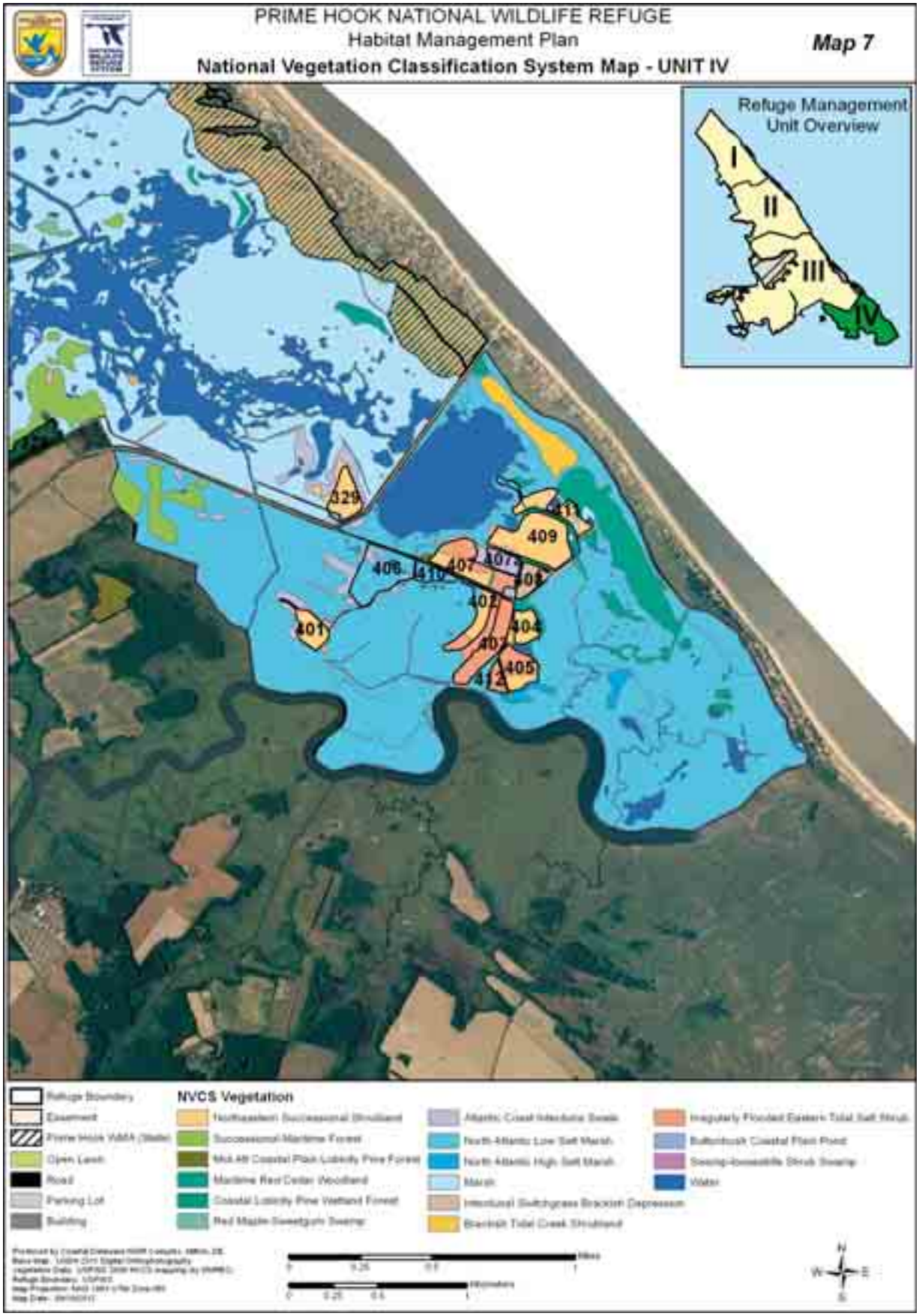
Map 5. National Vegetation Classification System Map - Unit III (East)



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 were mapped on PHNWR by the Delaware Natural Heritage Program (DNHP) in 2005 and 2006. It should be noted that, as a result of the recent shoreline changes in Unit II (overwashes, inlets), these vegetation communities have been 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. However, the vegetation map is still useful for much of the refuge uplands, and serves as a baseline summary of vegetation conditions. At the time of the mapping, 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). As of the preparation of this HMP, the vegetation map for the refuge is being updated by DNHP to reflect the changes in recent years, which will serve as a new baseline to track vegetation community changes as a result of future management and restoration.

Table 6. Habitat Types by Acres and NVCS Common Names on PHNWR in 2005-2006

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

HABITAT TYPE	ACRES	NVCS Association Common Names
Successional Sweetgum Forest	180	Sweetgum, Loblolly Pine, Red Maple
Coastal Loblolly Pine Forest	51	Loblolly Pine, Wax-myrtle, Royal Fern
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 habitat conditions and species composition at that time. 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

HABITAT (Refuge Unit)	SCIENTIFIC NAME (substrate)	TYPE
Twig Rush Peat Mat (Unit III)	*Sphagnum fimbriatum*	peat moss
	S. recurvum	peat moss
	S. perichaetile	peat moss
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.

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 a managed 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 through a relatively minor dune repair, 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.

Priority I Habitats	Associated Priority Focal Species
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;
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.

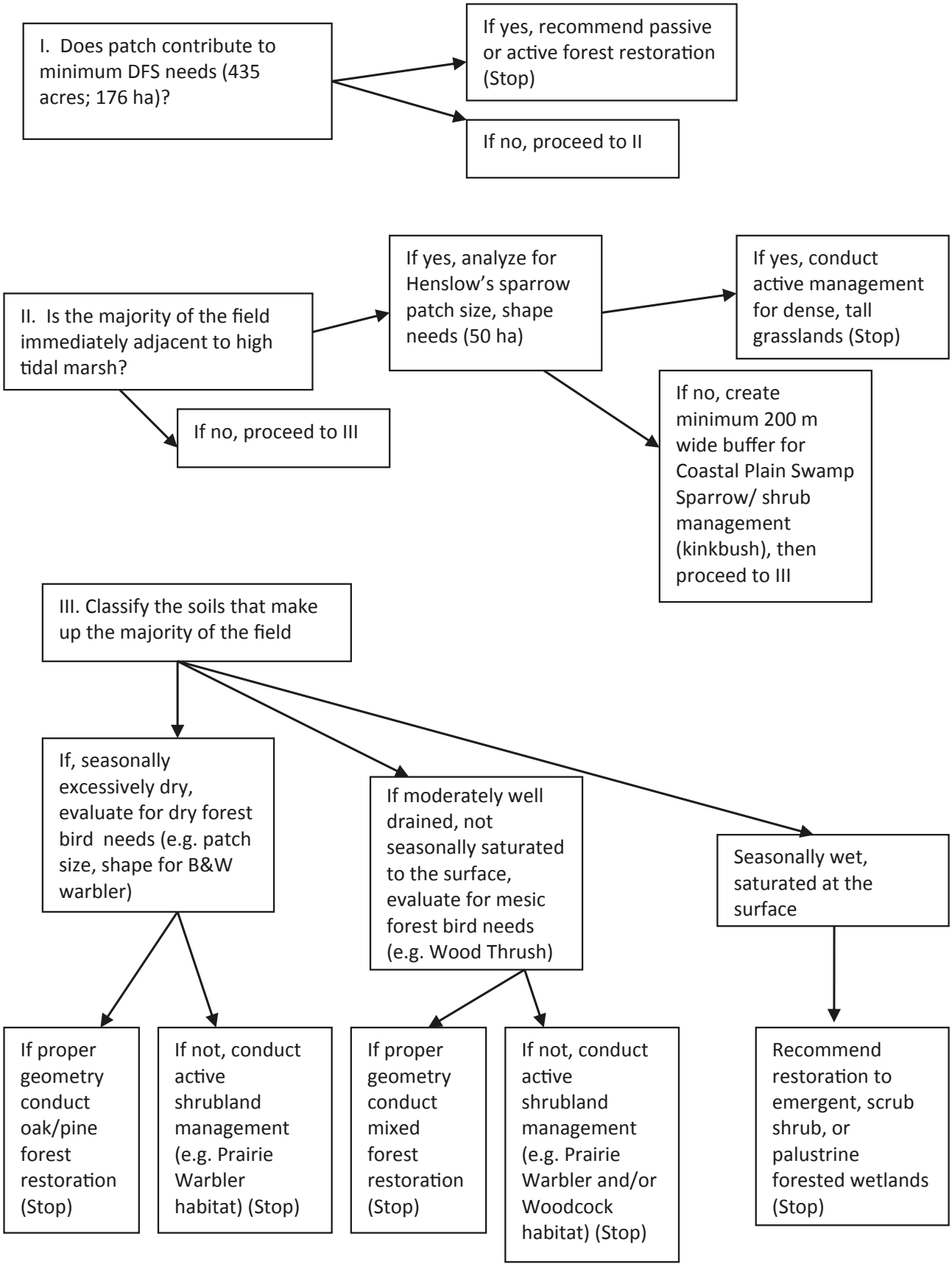
3.5 Conflicting Habitat Needs

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.

Natural barrier beach island habitats and associated species are also threatened by a number of human 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 (≥ 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.

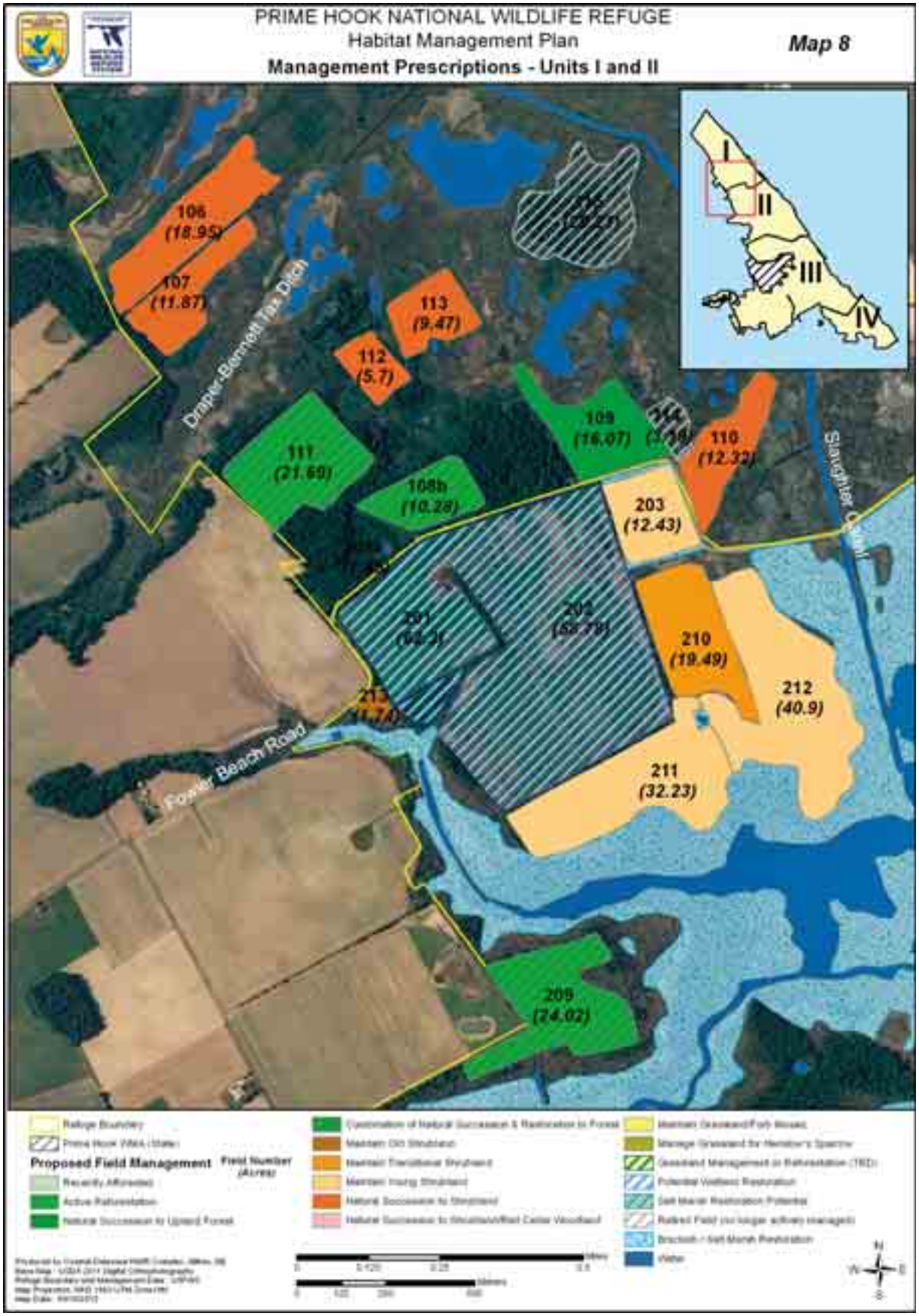
The natural world contains a myriad of extremely complex and dynamic systems. As land stewards and habitat managers, we can never completely understand every aspect of these continually changing systems, but must be ready to react to its ever-changing geophysical, ecological, social, and political factors 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.

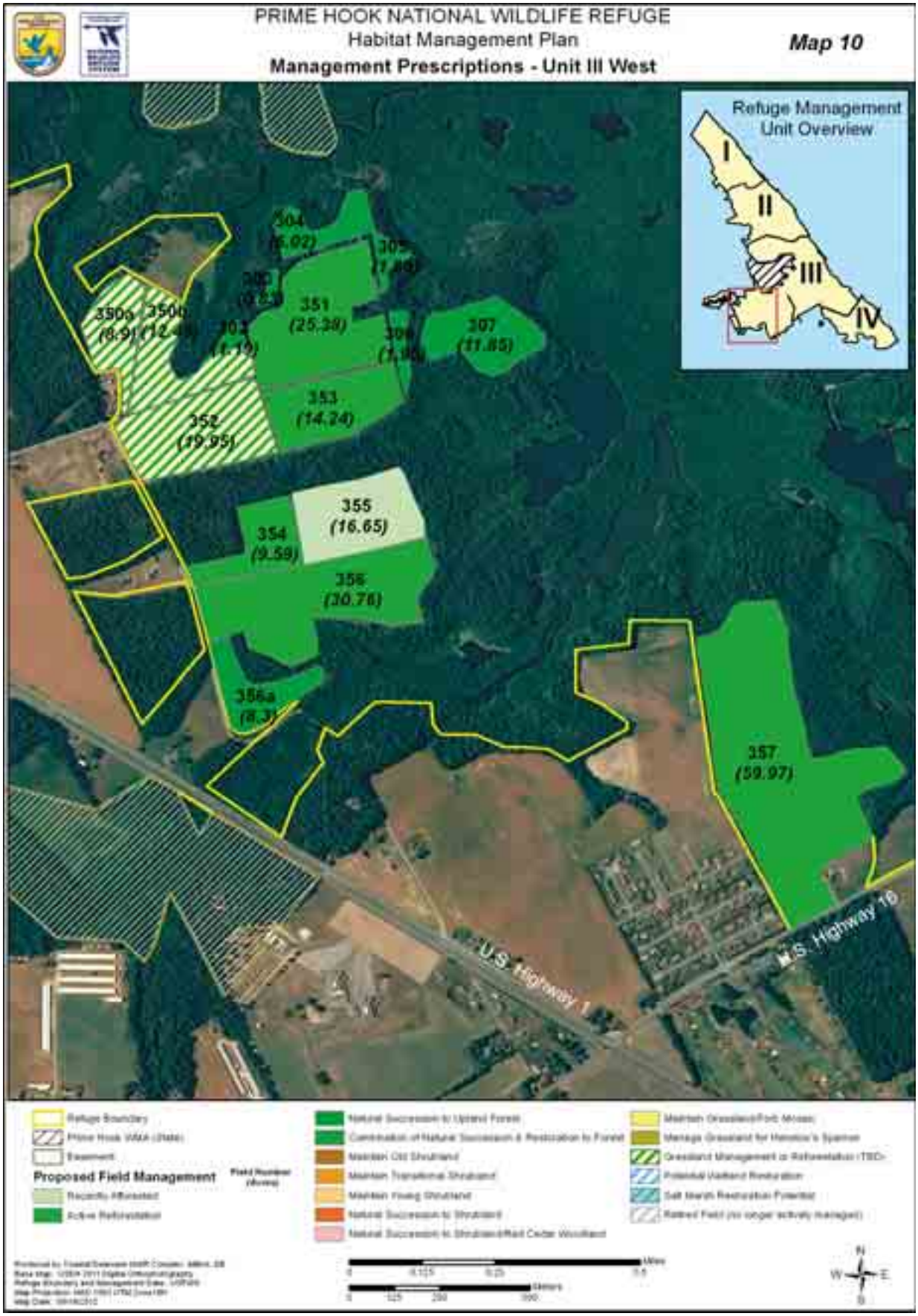
See HMP Chapter 2 Section 2.2 for a description of NVCS Natural and Anthropogenic Vegetative Community Types represented within each Refuge Management Unit (HMP Maps 2–7). Where appropriate, Natural Plant Communities have been summarized by Refuge Management Unit for each Objective in Section 5.3 below. 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

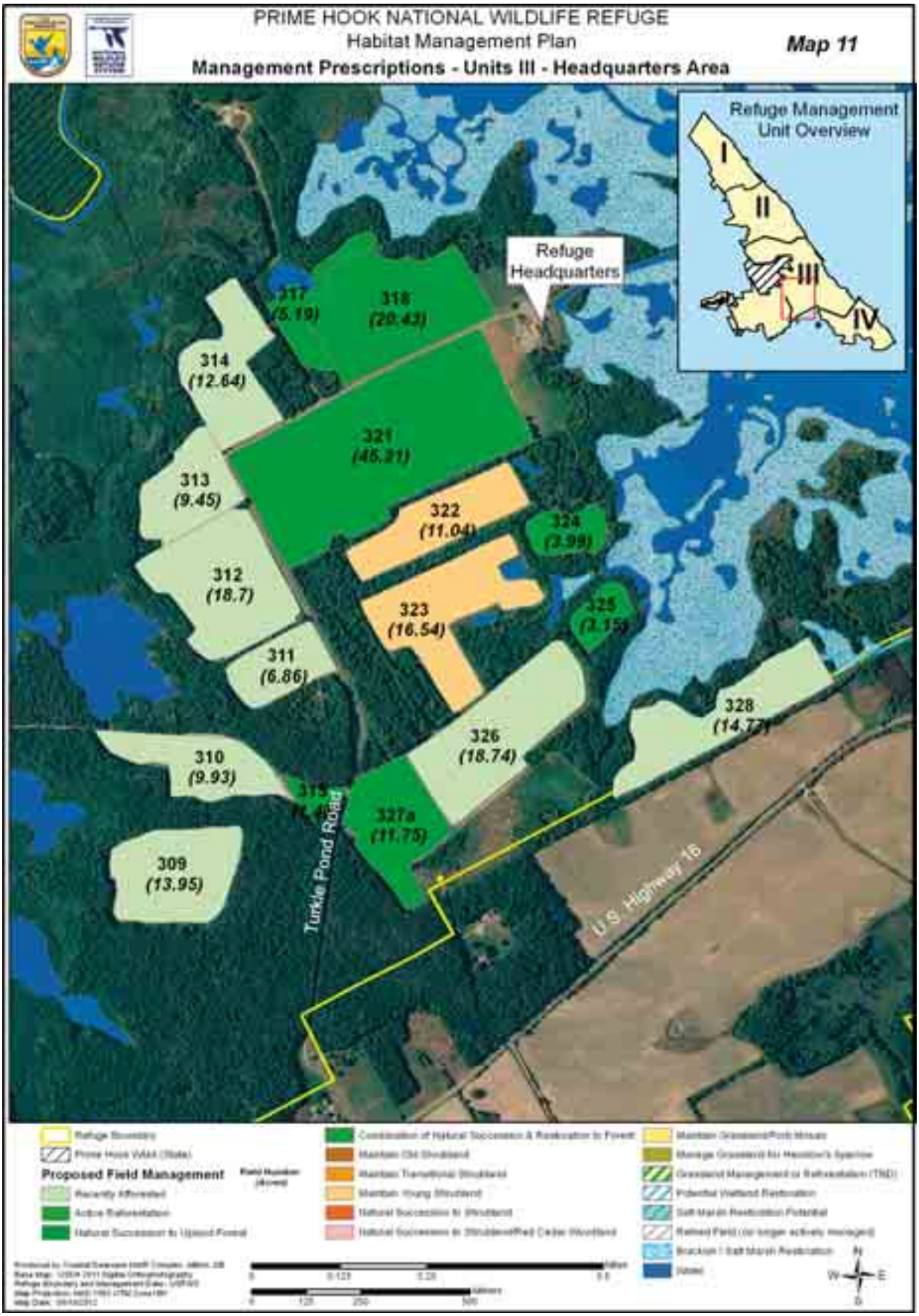


Map 9. Management Prescriptions - Units II & III

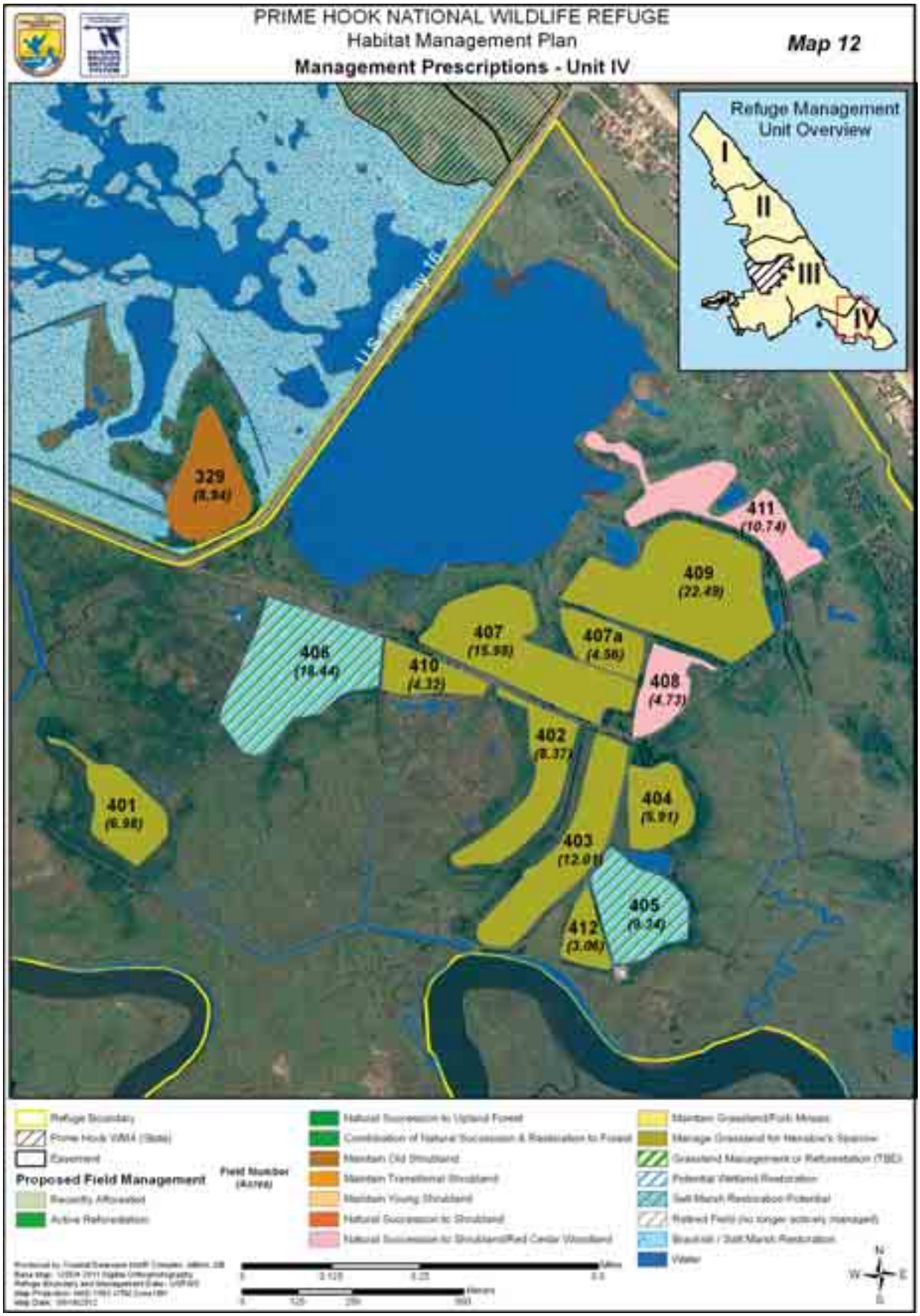
Map 10. Management Prescriptions - Unit III (West)



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 Unit I marsh to keep pace with sea level rise.
- 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, use of wave attenuating devices or restoration techniques, planting of desirable species, or a host of other strategies. (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 Programs and a private contractor, continue development of a model to predict the hydrodynamic response of the wetland complex under a variety of different potential restoration scenarios, such as: closed inlets, opened inlets, one inlet opening in response to a storm event, purposeful inlet 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, non-profit organizations, engineering firms, academic 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 and implementation to describe the process and techniques under consideration and provide the opportunity for public input.
- Within 1-3 years, implement short-term restoration strategies, even as large-scale and long-term restoration plans are developed. These strategies may include some or all of the following:

  - Continue development of a hydrological model, as described above, to evaluate long-term restoration options.
  - Partner with the PDE to plan and implement appropriate application of living shoreline techniques (e.g., coconut logs, Christmas tree fences, oyster shell breakwaters) within the Unit II interior along public roads and neighboring private property 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.
  - Further evaluate the potential applicability and installation of engineered wave dissipation devices, such as pyramid-shaped or spherical concrete structures designed explicitly for moderate or high-energy settings. Examples include GeoTubes, Wave Attenuation Devices, Beach Prisms, Artificial Reefs.
- Within 15 years, implement a comprehensive 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:
  - 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 and DNREC 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. DNREC maintains control over the placement of state resource sediment for beneficial use projects throughout the state.
  - 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;
  - If predicted from hydrodynamic modeling analysis to be beneficial for marsh restoration, work with DelDOT on the abandonment and appropriately-timed 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. DelDOT has sole authority over decisions regarding Fowler Beach Road.
  - 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 to ensure that improvements to Prime Hook Rd. will permit optimal management and/or restoration of Unit III, based on the outcome of modeling analysis. DelDOT has sole authority over decisions to alter Prime Hook Beach Road.

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 and underwater sonar technology to monitor elevation throughout the wetland complex, which is less precise than SET measurements, but can be conducted on a broader geographic scale.
- As deemed necessary, 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 and other suitable monitoring programs 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.
- 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

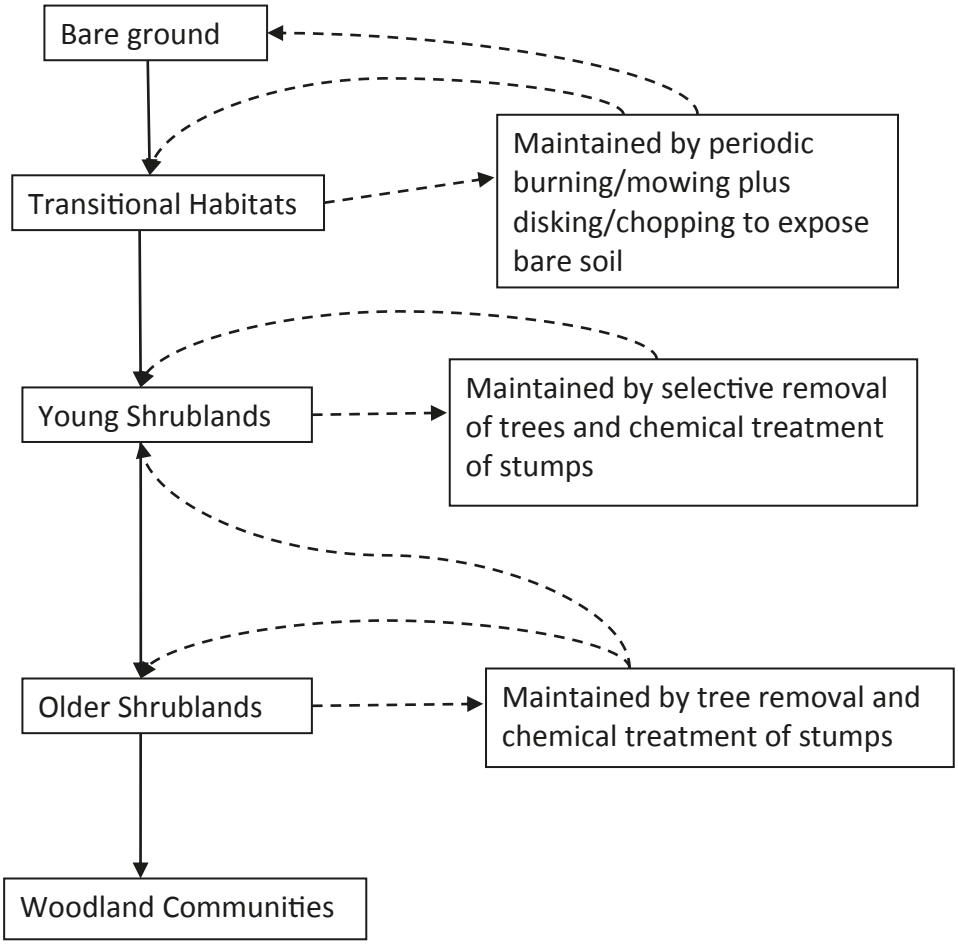
Habitat Management Prescriptions for all Units (HMP Maps 8-11				
Manage as Young Shrubland	**III**	322	Agricultural Field	11
		323	Agricultural Field	16.5
Maintain Old Shrubland	**II**	213	Northeastern Successional Shrubland	2
Manage as Old Shrubland	**III**	329	Northeastern Successional Shrubland	8.9
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.

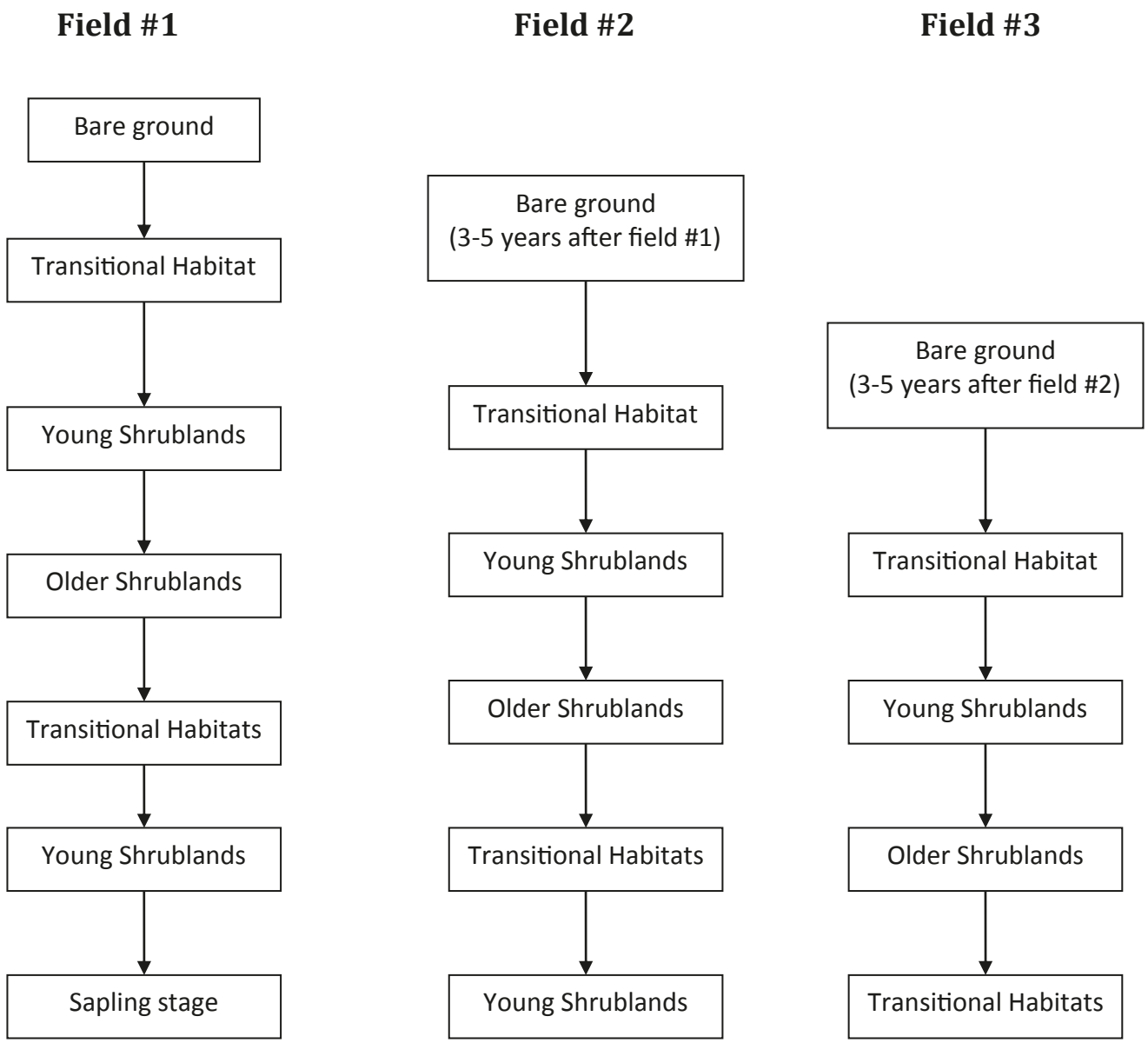
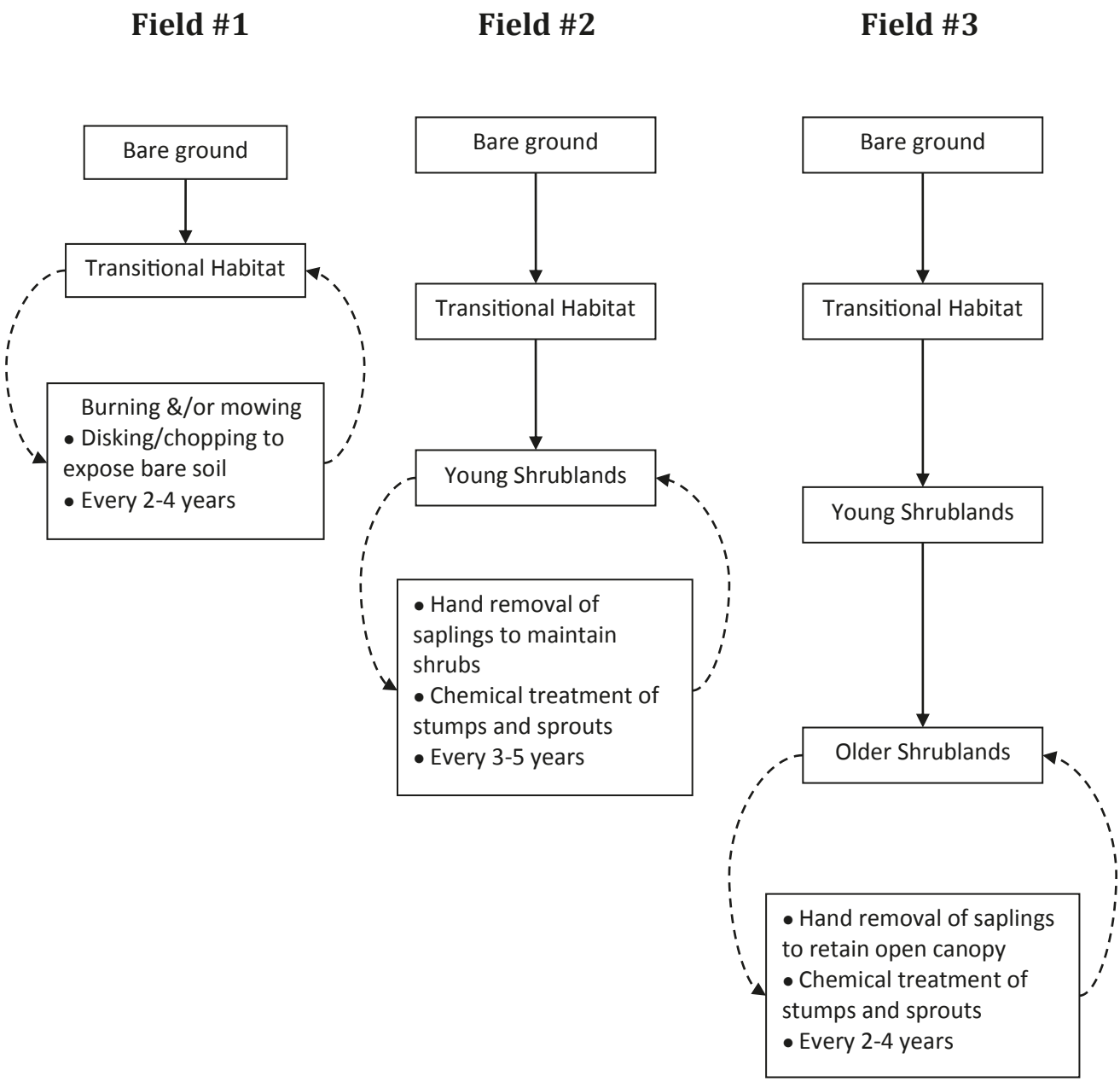


Figure 2. "Repeated Management" approach for establishing and maintaining successional shrubland communities in Prime Hook National Wildlife Refuge.



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 MANAGEMENT

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 MANAGEMENT

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

Final Hunting Management Plan

FINAL
HUNTING MANAGEMENT PLAN
Prime Hook National Wildlife Refuge
October 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 (Map 1). 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 10,144 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 wetlands, 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.

Map 1. Overview and Vicinity Map

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 10,144 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, and 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, and 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 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. 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 open for hunting in this plan will not be adversely affected, 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 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, Broadkill Beach Road, and Slaughter Beach Road.

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 are permitted for deer and 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 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 Unit III. 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.

Salt marsh habitats were found to be the most resistant to human trampling when compared to other habitats such as a natural dune, a man-made dune, and man-made coastal grasslands (Anderson 1995). This study analyzed the vegetation of five paths (one in each of the habitats) created and sustained by human trampling and reported that trampling of vegetation (estimated to be 1,815-3,630 passages per year) can be considered as very light. Even though it created paths and reduced vegetation cover and species diversity, the paths still retained a persistent vegetation (Anderson 1995). Even using inflated and unlikely estimates of free roam use in refuge salt marsh habitats for deer and waterfowl hunting, the impact from the trampling of vegetation would be considered very light and consistent with the findings reported in Anderson (1995).

The phasing out and elimination of all of the refuge's 115 deer hunting stands and waterfowl hunting blinds will also 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 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).

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. Monitoring will continue in Turkle Pond to determine if there is an impact on the eagle nest on Horse Island, which is currently abandoned.

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.

Public use and access is recognized as important, but 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. Bregnballe et. al (2003) also reported that to ensure high species diversity, a waterbird reserve should include a non-shooting refuge that encompasses adjoining shooting marshland. Reducing hunting to a few hours on shooting days may be used to mitigate hunting disturbance in zones surrounding shooting-free refuges.

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 3,185 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 Unit II (~1,800 acres), the southern half of Unit III (~390 acres), and in Unit IV (~995 acres). The northern portion of Unit IV, which contains a trail and observation platform, will be closed from the Monday before Thanksgiving to March 15 to also minimize disturbance to wildlife in this area. The southern portion of Unit IV will not be open to any public use. Waterfowl hunting will stop at 3pm in all hunting areas and will be limited to four days per week to reduce disturbance to waterfowl feeding patterns, which in turn will result in high quality hunting experiences. Disturbance is also decreased by closing the Oak Island Area in Unit II, the area south of Fowler Beach Road in Unit II, and disabled deer hunting area in Unit IV in late November to hunting and by closing the Deep Branch Trail to non-consumptive users from September 1 through March 15. 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).

The term "sanctuary", as used in the context of the CCP, indicates an area free from hunting and other uses. A key feature of a sanctuary is to make it large enough that intrusions on it's borders do not unduly disturb the normal lifecycle functions, e.g. feeding, resting, preening, courtship or cause the birds to take flight. The Service believes the areas designated for sanctuary are sufficiently large to reduce the detrimental affects of all forms of disturbance, including those resulting from hunting activity.

Sanctuaries also allow birds to have adequate escape distances (ED), which are defined as the shortest distance at which they flush or otherwise move away from the approaching person or other disturbing stimulus. Many factors influence EDs such as hunting, flock size, hunger, migratory motivation, etc. Laursen et. al (2005) suggested providing a mean ED of the largest ED of a bird species plus one to two standard deviations to calculate the size of the core area or buffer zone. In their study, the largest ED was 1000 meters for wigeon (other species included mallard, etal, pintail, waders, and gulls) and would be approximately 1700 meters with two standard deviations. Based on this information, refuge sanctuary areas can accommodate the ED's of most species.

Disturbance to waterfowl in or adjacent to the refuge is not a new phenomenon. The Service agrees, in part, there is virtually no area of the refuge that is not susceptible to auditory and visual disturbance. The refuge is relatively narrow and is crossed by several county roads. Some days auto traffic on Route 1 can be clearly heard a couple miles to the west, aircraft fly overhead, patrons of the refuge drive the county roads, birders walk the trails, refuge staff run tractors and airboats as part of their management

program, residents drive to and from the neighboring communities to the east, beach enthusiasts travel to the public beaches, kayakers paddle the creek, crabbers park along the roads, neighbors hunt right up to the refuge border, and refuge hunters occasionally fire guns. Unfortunately, this is the nature of NWRs in the heavily populated eastern US. Most NWRs on the east coast do not harbor qualities that we generally think of as constituting "wilderness", eg. quiet, or solitude. Under an official wilderness designation, refuge staff would not be permitted the use of many of the standard management tools used on PHNWR. Even so, hunting is in fact permitted on areas designated as wilderness.

More specifically, hunting on adjacent private property causes disturbance to waterfowl every year in the following areas: Unit 1 along the western boundary, Unit 2 along Cods Road and Fowlers Beach Road, Unit 3 along the southeastern portion near Broadkill Beach, along Prime Hook Creek, and in the state managed Prime Hook Wildlife Area, and Unit 4 along the Broadkill River, Petersfield Ditch, and in salt marshes on the western boundary. Hunting has been open in all four units of the refuge and Unit 1 has been hunted for years by free-roaming hunters seeking deer and upland game in refuge saltmarshes. Despite disturbance of waterfowl from vehicular traffic, refuge staff observe visitors year after year viewing and photographing waterfowl within 20 yards of vehicle even during the hunting season. Adding additional sanctuary areas on the refuge will only increase areas of respite for waterfowl and other wildlife and further enhance opportunities to enjoy them by refuge visitors.

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 October 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., U.S. 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 2011, the average annual waterfowl harvest at the refuge is 2.5 percent of Delaware's total waterfowl harvest (Table 1.1). Furthermore, in 2011, the refuge's harvest of ducks was only 2.3 percent of Delaware's total duck harvest, 0.06 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. 2012). Also in 2011, the refuge's harvest of geese (Canada and snow geese combined) was only 0.75 percent of Delaware's total goose harvest, 0.02 percent of the Atlantic Flyway's goose harvest, and less than 0.01 percent of the entire United States' goose harvest (Table 1.2; Raftovich et al. 2012).

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 2011, 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 2011-2012 hunting season, the refuge harvested between 0.58 percent and 1.61 percent of the State's estimated monthly duck population and between 0.02 percent and 0.03 percent of the State's estimated monthly goose population (Table 1.3; October and November statewide waterfowl survey information was unavailable). Refuge hunters harvested between 1.60 percent and 7.04 percent of the refuge's estimated monthly duck population and between 0.04 percent and 0.08 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

Year	Statewide Waterfowl Harvest*	Refuge Waterfowl Harvest	Refuge Waterfowl Survey**	Refuge Hunter Visits
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
2010	84,130	1,604	58,960	874
2011	56,370	1,050	138,894	908

* Statewide waterfowl harvest data from: http://www.flyways.us/regulations-and-harvest/harvest-trends; accessed October 2012.

** 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. Some monthly surveys were incomplete in 2007, 2010, and 2011, which may not have reflected the peak (http://www.fw.delaware.gov/Hunting/Pages/Waterfowl%20Surveys.aspx; accessed October 2012).

Table 1.2. Comparison of waterfowl harvest at Prime Hook NWR to State, Flyway, and United States harvest in the 2011 hunting season.

Waterfowl Harvest Area	Ducks	Geese
Prime Hook NWR	934	116
Delaware*	41,000	15,400
Atlantic Flyway*	1,672,900	580,400
United States*	15,931,200	2,879,900

*Harvest estimates from (Raftovich et al. 2012)

Table 1.3. Comparison of duck and goose (Canada & snow geese) harvest at Prime Hook NWR to State waterfowl surveys during the 2011-2012 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 2011	219	6,236	Data Unavailable	11	16,823	Data Unavailable
November 2011	126	7,857	Data Unavailable	12	15,540	Data Unavailable
December 2011	217	8,707	37,185	45	99,869	174,992
January 2012	372	5,287	23,053	48	133,634	199,204

* 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%20 Surveys.aspx;* accessed October 2012).

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 2011, refuge hunters harvested between 0.03 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
2010	15	No	n/a	n/a	52,451
2011	60	No	n/a	n/a	103,301

* 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. Some monthly surveys were incomplete in 2007, 2010, and 2011, which may not have reflected the peak *(http://www.fw.delaware.gov/Hunting/Pages/Waterfowl%20 Surveys.aspx;* accessed October 2012).

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. Deer hunters have been free roam hunting in Unit I of the refuge for years and upland game hunters free roam hunt in areas in Unit I, Unit II, and Unit III. Free roam hunting of deer was permitted in all deer hunting areas between 9am and 3pm up until the 2002-2003 hunting season, but was prohibited due to complaints of unethical hunting behaviour such as harvesting deer from the stands of other hunters. 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 hunting areas and is expected to be negligible (refer to impacts to waterfowl for more information). 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 with greater access and also increase the potential for waterfowl disturbance. These disturbances are mitigated by creating sanctuary areas where no waterfowl hunting occurs.

Prior to the conservation order taking affect in late January, all snow goose hunting on-refuge will be isolated to the same areas/blinds and refuge specific hunting dates as other waterfowl hunting. A continuous period (except Sundays) from January 28 – April 13(for 2012-2013 hunting season) will be open for hunting snow geese during the Conservation Order which will open all emergent wetlands on-refuge to snow goose hunting only, once all other waterfowl seasons have closed. Snow geese present a fairly unique issue, finding themselves on the Service's Migratory Bird Program focal species list for actually being over abundant. It is the desire of the USFWS, Canadian Wildlife Service and all Provinces and States to drastically reduce the size of the current continental populations of light (snow) geese, primarily because of the dramatic damage excessive numbers of snow geese have inflicted on very fragile arctic breeding grounds, areas that are important to other breeding migratory species, as well. Seasons, bag limits and methods of take have been liberalized for the purpose. Opening all available habitats on the refuge from January 28 – April 13 is specifically designed to reduce damage sustained from overbrowsing of refuge saltmarshes.

Unfortunately, the Service projects, based upon documented history of similar hunts on-refuge, that very few hunters will take advantage of the snow goose hunting opportunity. The hunting season starts October 1, several weeks before any number of birds arrive on Delmarva, and while many hunters are more interested in deer hunting instead. Snow geese are difficult to hunt and there may be an incidental few killed during the regular duck and migratory Canada Goose season.

Over the period 2001 – 2006, when the refuge was open to late season snow goose hunting, 100 hunters harvested 96 snow geese over a shortened season extending from late January to mid-March and averaged 16.0 birds per year. The hunter success rate averaged 0.96 birds per hunt. Because of the difficulty of hunting snow geese, hunting parties were likely composed of a minimum of two hunters. Thus a maximum of 50 total parties hunted over a combined total of approximately 216 days available over the 6 year period with each party potentially having several thousand acres upon which to hunt. 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 5-8). The Service projects negligible impacts to other refuge resources from snow goose hunting.

In addition, non-refuge areas in Delaware will also be open to snow goose hunting during the same period. It appears anecdotally that the limited few hunters that attempt snow goose hunting during the late season are likely to do so from agricultural fields, alleviating most waterfowl hunting pressure on Delaware's tidal marshes and impoundments.

Waterfowl hunting in Unit I salt marshes have the potential to increase adverse impacts and disturbance on refuge wintering American black ducks. Since black ducks are a focal species of conservation concern, monitoring and evaluation of impacts of increased recreational use of salt marsh habitats will be required to identify and respond to unacceptable impacts. Unit IV salt marshes will continue to be a sanctuary area.

The American Black Duck was selected as a" focal" or indicator species by the refuge because of its listing on Federal and State conservation lists, but more importantly for its close association with native saltmarsh. Targeting conservation actions to a few focal species, specifically in habitat management

objectives, is made with the assumption that hundreds of other fish, wildlife and native plant species will benefit.

From the larger Service perspective, the USFWS, Migratory Bird Program, has generated its own list of Birds of Management Concern and "Focal" Species. The Birds of Management Concern is a list of species, subspecies, populations or geographic segments of populations that warrant management or conservation attention. Birds of Management Concern are drawn from the list of species afforded protection under the Migratory Bird Treaty Act (50 CFR Part 10) and therefore fall under Federal jurisdiction. To be of management concern, a bird must be a high priority gamebird, on the Birds of Conservation Concern 2008 list, a federal threatened or endangered species listed in the U.S. (T/E), or overly abundant (OA) leading to management conflicts. Full species are considered of management concern throughout their U.S. range (including Caribbean and Pacific islands) unless specific subspecies populations, or geographic units (e.g., U.S. Fish and Wildlife Service Regions or Bird Conservation Regions) are designated.

The Migratory Bird Program's "focal" species or "focal" populations are covered under the Migratory Bird Treaty Act, are a subset of the Birds of Management Concern, and are those the program believes need additional investment of resources to address pertinent conservation or management issues. Also included in the list are species occurring in the U.S. that are listed under the Endangered Species Act (ESA) or are on the Bird of Conservation Concern (BCC) 2008 list but are not protected under the Migratory Bird Treaty Act (MBTA).

Within the Migratory Bird Program's list of "focal" species, not to be confused with the PHNWR specific list generated by the refuge for this CCP, are some species of game birds, including the American Black Duck. The Migratory Bird Treaty Act, grants the Secretary of the Interior the authority to establish hunting seasons for any of the migratory game bird species. For waterfowl management specifically, the US and Canada are divided into four flyways; the Atlantic, Mississippi, Central, and Pacific. In the US, the Flyway Councils, consisting of representatives from state and provincial game-management agencies, recommend regulations to the U.S. Fish and Wildlife Service (Service) for waterfowl and for most migratory, shore and upland game birds.

The Councils are advised by flyway technical committees consisting of state and provincial biologists. These technical committees evaluate species and population status, harvest, and hunter-participation data during the development of the Council recommendations.

The Service's Office of Migratory Bird Management (MBMO), with advice from biologists in the Service's Regional Offices, evaluates the Council recommendations, considering species status and biology, cumulative effects of regulations, and existing regulatory policy, and makes recommendations to the Service's Regulations Committee to set hunting seasons for migratory birds that ensure healthy game populations in years to come and fair distribution of hunting opportunities throughout the migration routes.

The Service Regulations Committee considers both the Council and MBMO recommendations, then forwards its recommendations for annual regulations to the Service Director.

Once regulatory proposals are approved, they are published in the *Federal Register* for public comment. After the comment period, final regulations are developed, which are then signed by the Assistant Secretary of the Interior for Fish, Wildlife, and Parks. From this federal framework, individual States

may select hunting seasons and bag limits. Once the States have adopted their respective seasons and bag limits, individual refuges may choose to adopt State regulations in-whole, or the refuge may choose additional refuge specific regulations.

In an effort to reduce undesirable impacts on refuge resources and management programs, PHNWR has adopted more restrictive regulations than those adopted by either the Service's MBMO or the State of Delaware. These regulations include area closures (sanctuaries), hunting 4 of 7 days/week instead of 6 of 7, and ending the hunt day at 3:00 PM instead of sunset.

As indicated above, black ducks and black duck hunting are managed on a state, flyway and continental scale. The process of setting hunting regulations is a deliberative one, based on substantial data. Regulations are set with the full knowledge and desire that a proportion of the population will be removed by hunters, whether on or off of NWRs. Within the northeastern US and eastern Canada particularly, the black duck is considered a valuable recreational and economic resource. The apparent 50% decline in black duck numbers over the last half of the last century, has raised concern for the long-term sustainability of a currently viable, albeit reduced, population. Thus, the American Black Duck has received the designation of "focal" species by the Service's Migratory Bird Program for some reasons other than those presented by PHNWR .

Under both the Administration Act, as amended, and 43 CFR 24, the Director as the Secretary of the Interior's designee will ensure that Refuge System regulations permitting hunting and fishing are, to the extent practicable, consistent with State laws, regulations, and management plans (605 FW 2). The Service and the State of Delaware consider the black duck population capable of sustaining harvest; so PHNWR will comply with State seasons and bag limits.

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 3,729 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
2010	4	0	1	3	108	129
2011	9	0	1	0	76	100

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

For migratory birds such as mourning dove, an estimated 14,700 birds were harvested in Delaware during the 2011 season (Table 1.6; Raftovich et al. 2012) when only nine 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 2011 hunting season.

Harvest Area	Dove	Woodcock	Snipe
Prime Hook NWR	9	1	0
Delaware*	14,700	500	500
Eastern Management Unit*	6,666,900	77,000	57,500
United States*	16,580,900	308,700	136,300

*Harvest estimates from (Raftovich et al. 2012); Estimates for snipe are from the Atlantic Flyway

The refuge proposes to open 3,729 acres for wild turkey hunting. This additional acreage includes many of the areas open for deer hunting. Turkey hunting was permitted on the refuge in Unit I west of Slaughter Canal from 1993 up until 1998. Turkey is a resident game species that is managed by DNREC's Division of Fish and Wildlife. The refuge falls within Zone 9 of DNREC's Wild Turkey Management Regions and the refuge will work closely with DNREC to evaluate the status of the turkey population and its hunting potential. Zone 9, which includes the state-owned Prime Hook Wildlife Area that is adjacent to the refuge, is currently open during the spring turkey hunting season. To ensure a sustainable harvest of the state's turkey population, DNREC biologists track their health, distribution and reproductive success. Current efforts include a volunteer-based survey used to generate an index of annual turkey productivity and recruitment, monitoring turkey harvest and hunter efforts, tracking turkeys with radio transmitters to evaluate their reproductive ecology, habitat use, and survival, and evaluating the genetic diversity of turkeys. The number of permitted hunters, which will be no more than five, may be adjusted (increased or decreased) based on changes in turkey population data.

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 3,185 acres would be protected from hunting activities and other public use that cause disturbances to secretive marsh and waterbirds. Furthermore, the refuge has limited the number of hunting days and has restricted hunting hours. Disturbance is also decreased by closing the Oak Island Area in Unit II, the area south of Fowler Beach Road in Unit II, and disabled deer hunting area in Unit IV in late November to hunting and by closing the Deep Branch Trail to non-consumptive users from September 1 through March 15.

Impacts on Fisheries

Impacts to fisheries from visitors engaged in hunting are expected to be temporary and negligible. Anticipated increases in hunting 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 0.5 percent to 1.5 percent of Delaware's total deer harvest each year. The current harvest level of deer on the refuge (66) has a negligible impact on the Statewide deer population, which was last estimated at 31,071 deer in 2009 (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)***

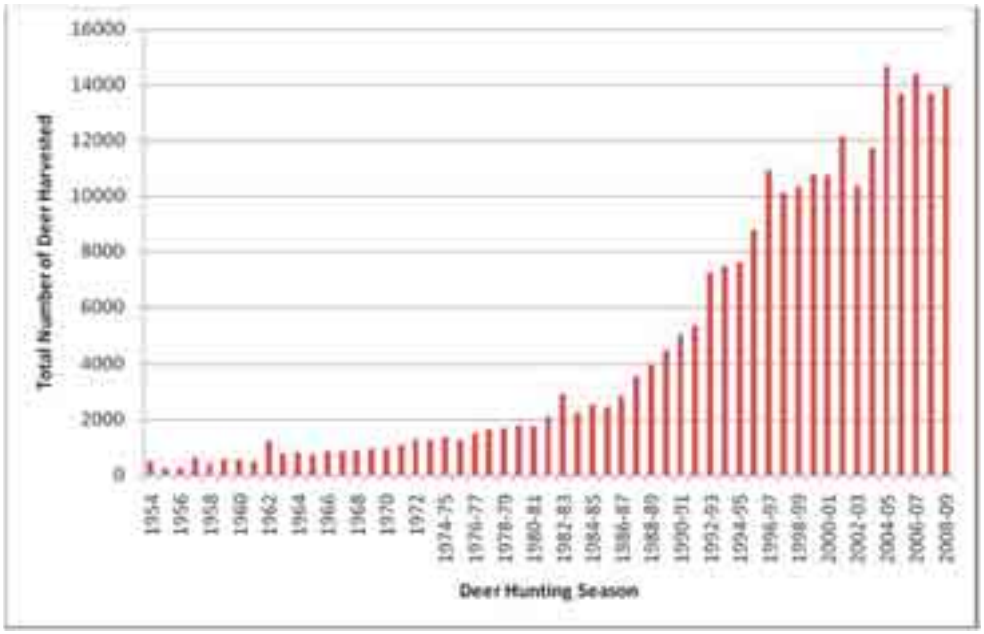


Table 1.8. Number of deer harvested and hunter visits on Prime Hook NWR compared to statewide harvest (Source: DNREC 2010b, refuge harvest data; http://www.dnrec.state.de.us/fw/deer.pdf)

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
2010	14,183	114	549
2011	13,559	66	513

*Data from DNREC (2010b).

Table 1.9. Cumulative impacts of existing deer hunting on Prime Hook NWR/State Deer Management Zone 9 (2011-2012 data) compared to Statewide Harvest.

Hunt Location & Type	Harvest
Prime Hook NWR	66
State Deer Management Zone 9	852
Statewide Harvest (all 17 Deer Management Zones)	13,559

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 2009) 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 in the next 15 years. 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, and turkey provides an administratively simple program that balances other public use activities. The program supports Presidential Executive Order #13443: 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.

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. Short-term, moderate adverse impacts are expected for non-consumptive users due to the seasonal closures that are highlighted below:

1. Deep Branch Road Trail (includes Goose and Flaxhole Ponds; Unit III), Eastern Prime Hook Creek (from Foord's Landing to headquarter ramp) (Unit III), and hiking trail on Fowler Beach Road (southside of Unit II): 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 or turkey hunting. If and when the photography blind is available on the southside of Fowler Beach Road, this portion of the trail will be open year round and open every Sunday during the hunting season.

2. Headquarters area (includes Turkle and Fleetwood Ponds) (Unit III): Closed only for a maximum of two days for deer hunts and portions may be closed for turkey hunts.

3. Island Farm Area in 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.

4. Hiking trails on Fowler Beach Road (Unit I), Prime Hook Road (Unit III), and Slaughter Beach Road and Slaughter Canal (Unit I): Open only on Sundays from September 1 through the deer and waterfowl hunting seasons, which typically end in February. Additional seasonal closures may apply through the second Saturday in May for hunting during the snow goose conservation order or turkey hunting.

Negative reactions by some visitors may be caused by 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 and turkey hunts. The closure of the eastern end of Prime Hook Creek in September is only one month earlier than current management. In fact, for the last few years, the eastern end has been closed in early September for safety reasons due to the opening of the early teal hunting season on the adjacent state-owned Prime Hook Wildlife Area. The deer hunts in the refuge headquarters are the same as current management and only portions of this area will be closed for one-half day for turkey hunting. Seasonal closures for hunting occur during the fall and winter months, which is typically a slower period of use due to weather conditions. Law Enforcement Officers would enforce these and other current refuge regulations, where appropriate, and would seek the assistance and cooperation of Delaware Division of Fish and Wildlife in enforcing common regulations to provide a safe environment for refuge visitors and promote activities that are compatible with protecting the resources.

At first glance, these seasonal closures give the appearance that opportunities for wildlife observation and photography are being significantly reduced or totally eliminated for over eight months during the proposed expanded hunting activities. To the contrary, the majority of the refuge would remain open to wildlife observation and other non-consumptive uses and provide more opportunities and open areas than under current management. More specifically, opportunities for wildlife observation and photography have been expanded to include seven new trails totaling 3.7 miles throughout the refuge in all four management units on existing maintained trails or interior refuge roads, bringing the total number of trails to 14 and 9.9 miles. The Headquarters area, which contains six trails covering six of the nine total miles of refuge trails, remains available 363 days a year for non-consumptive uses, but portions may be closed for turkey hunting. All other areas except for the Deep Branch Trail, Fowler Beach Road trail (southside), and Prime Hook Creek are open on every Sunday during the hunting seasons. The Deep Branch Trail, the Fowler Beach Road trail (southside), and Prime Hook Creek are open with seasonal closures of every day from September 1 through March 15 and if necessary during the snow goose conservation order or turkey hunting seasons. If and when the photography blind is available on the southside of Fowler Beach Road, this portion of the trail will be open year round and open every Sunday during the hunting season. The majority of the hunting will occur during the main hunting season, which typically runs for five months from September through January, with additional hunting opportunities for rabbit through the end of February. Hunting during the snow goose conservation order, which will occur for 2 ½ months from late January through mid-April, will take place mostly in the wetland areas, leaving the upland areas open to other uses. This hunt is not anticipated to bring large numbers of hunters, but is beneficial to the species and other wildlife due to overpopulation. With five or less turkey hunting permits issued in April and May, a vast majority of the refuge would still remain open to wildlife observation and other non-consumptive uses.

Increases in proposed hunting acreages will provide new hunting opportunties from current management; however, many of these proposed “new” hunting areas are currently open to some type of hunting or have been previously open either under refuge management or private ownership. For example, Unit I is currently open for deer and upland game hunting (including dove hunting) and is now proposed to be open for waterfowl hunting - same land, but with a new opportunity. The only refuge land proposed to be open for any type of hunting that is not currently being hunted for any species includes: an area located north of Prime Hook Road commonly referred to as Oak Island (deer only), an area north of Route 16 referred to as the Millman Tract (deer and turkey), an expanded area of the existing Jefferson Lofland Area and Headquarters Area (deer & turkey), an expanded area of the Unit III waterfowl hunt area (waterfowl only), and an area west of Petersfield Ditch in Unit 4. Of these areas,

Oak Island was previously hunted under refuge management up until 1995 and the Millman Tract was hunted under private ownership up until the Service purchased it in 2001. The expanded areas of the Jefferson-Lofland Area, Headquarters Area, and nearly all of the proposed Unit III waterfowl hunt area were previously hunted under refuge management. No prior hunting of the area west of Petersfield Ditch is known.

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, short-term minor adverse impacts may occur with some landowners due to hunter trespassing. These impacts will be minimized through enhanced law enforcement efforts. We anticipate some conflict between concurrent hunting programs (i.e., waterfowl, deer, and upland game hunting seasons overlapping). For the majority of the hunting seasons, the Delaware Division of Fish and Wildlife has made efforts to avoid these overlaps in the various hunting programs.

Although the refuge provides hunting maps and refuge-specific regulations, it is ultimately the responsibility of the hunter to know and obey them. Unfortunately, not all do. The Service will ensure that refuge boundaries are and continue to be properly posted to notify both refuge visitors and private landowners. Private landowners will be encouraged to contact either refuge and/or state law enforcement when these trespassing incidents occur and every effort will be made to respond in an efficient and timely manner. The Service also encourages private landowners to post their own property. Restricting hunter access within a 100 yard buffer to private property was discussed and it was concluded that too much hunting area would be lost by this zone and that there are already sufficient laws and regulations in place to discourage boundary shooting. Furthermore, neighboring landowners would benefit by having easy access to designated areas open to hunting on the refuge.

Visitor safety at refuges is a high priority when developing compatible wildlife-dependent recreation programs, such as hunting; however, it is ultimately the responsibility of every hunter to be safe. An accident involving hunter safety results from either a lack of hunting ethics or a violation of hunting regulations. Use of portable deer climbing stands will be recommended but not required. For hunters who may be unable to climb trees using portable deer stands or who may wish to hunt from permanent deer stands or duck blinds, the state-owned Prime Hook Wildlife Area, which adjacent to the Refuge, will continue to provide these opportunities.

Provision of elevated deer stands, and to a lesser degree waterfowl blinds, is relatively unique to Delaware. There are many areas on the Delmarva Peninsula, other than Prime Hook NWR, that offer public hunting opportunities in free-roam areas where the hunter is required to provide the blind or stand, if desired.

The Service conducted a web-search for public lands within the three states making up the Delmarva Penninsula in order that we evaluate the prevalence of permanent waterfowl blinds or deer stands on public hunting lands. A wide assortment of ownership and management regimes was evident across 215 tracts managed or described by 19 different designations, e.g. State Park, National Park Service, State Forest, Chesapeake Forest Lands, Natural Resources Management Area. For waterfowl hunting, 131 of the 215 tracts examined permitted waterfowl hunting. Of the 131, only 36 provided either a pit or standup blind somewhere on the tract. The Service makes this qualifying statement because some areas, Tuckahoe State Park for example, provide four pit blinds but also allow free roaming along the Tuckahoe River. Of the 36, 28 were located in Delaware, 8 in Maryland, and none in Virginia. Twenty

tracts required hunters to hunt at a stake or within some designated distance from a blind site where the hunter would provide the blind (if desired), including nine in Delaware, 11 in Maryland, and none in Virginia. A total of 84 tracts permitted free-roam hunting where the hunter would provide the blind (if desired), 17 in Delaware, 60 in Maryland, and seven in Virginia.

For deer hunting, of the 215 tracts examined, 181 permitted some form of deer hunting. Unfortunately, the Service did not make a distinction between the various methods, i.e. some tracts may be limited to bow hunting only. Of the 181 tracts, 95 were located in Delaware, 77 in Maryland and nine in Virginia. A total of 51 of the 181 tracts required hunters to use stands that were provided, all of which were located in Delaware. Free-roam hunting was permitted on 165 tracts, including 80 in Delaware, 76 in Maryland, and nine in Virginia. The Service acknowledges that some free roam areas were for bow hunting only, however such a distinction would only apply in Delaware; all deer hunting tracts in Maryland and Virginia permitted free-roam hunting regardless of hunting method.

For the 85 tracts located in Maryland and Virginia where no stands are provided, only two require an elevated stand, which the hunter must provide. For areas immediately adjacent to the building complex on Blackwater NWR, the hunter must use an assigned blind site where the hunter erects a stand with a platform minimum of eight feet above the ground. All other tracts on Blackwater NWR are free-roam where ground-hunting is permitted.

The second site where elevated deer hunting is required is on Chincoteague NWR, around the tour loop. Here the hunter must erect his/her own stand with a platform minimum of 14 feet above the ground. All other areas on Chincoteague NWR permit free-roam hunting. The Service should also add that rifle hunting, as well as deer drives, are permitted on most public hunting lands on the lower eastern shore of Maryland and the eastern shore of Virginia.

Preseason lottery drawings at PHNWR provide hunting opportunities for local, in State, and out-of-State hunters. Advance knowledge of a hunting opportunity allows hunters to prepare, plan, and scout, which ultimately helps to provide a quality hunting experience.

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 5,221 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 and close hunting in late November in designated areas to minimize bald eagle and waterfowl disturbance). Non-ambulatory hunters are allowed to hunt in all hunt zones in accordance with refuge policy and regulations. Only non-ambulatory hunters may hunt in the Island Farm Unit, where we have provided non-ambulatory hunt blinds to accommodate hunters with this need.

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 (no more than 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 3,432 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., close hunting in late November in designated areas to minimize bald eagle and waterfowl disturbance and provide access for non-consumptive users only on Sundays in designated areas during the hunting season). In all hunt areas, hunting will occur four days per week and cease at 3pm.

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 25-27 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.

Upland game and webless migratory bird hunting: A total of 1,995 acres are available for hunting of upland game and webless migratory birds. Dove hunting will not be open on 110 of these acres, which should affect few hunters. Some conflict with concurrent hunting and the potential for trespassing on adjacent private land are expected and previously discussed in this section. 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.

Wild turkey hunting: A total of 3,729 acres are open for hunting wild turkey during legal shooting hours on selected hunt days. In recent years, hunter and staff observations indicate that a huntable population

of turkeys may exist on the refuge (Refer to impacts to landbirds for more information). Limited opportunities exist on public lands to hunt turkey and the refuge may contribute to providing additional quality opportunities for hunters. Hunting of turkey will be permitted to a limited number of hunters (no more than five) and this number may be adjusted (increased or decreased) based on changes in turkey population data.

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 will still 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 and turkey; $15 for waterfowl), preseason application fee ($5/hunter), and processing fee for permits acquired after the preseason drawing ($2 to 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. 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. Application and permit fees for turkey hunting may be waived if the lottery drawing is administered by the State.

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 1.2; 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 0.5 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)

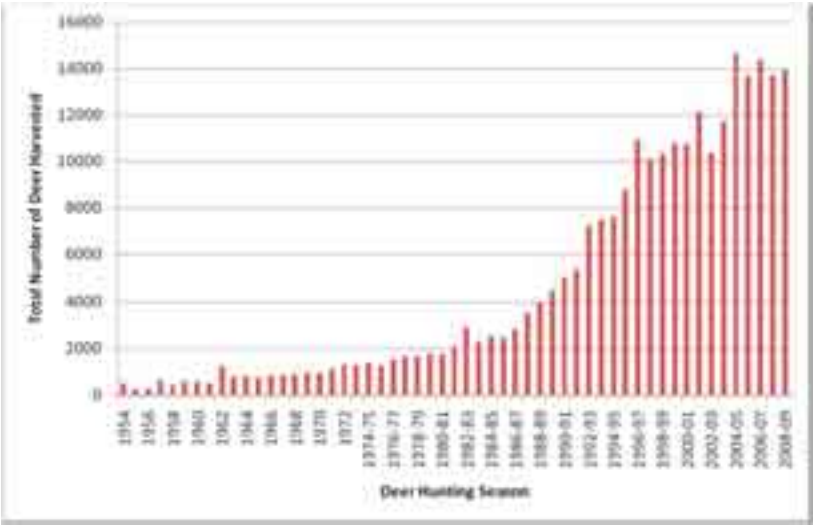


Table 1.11. Number of deer harvested and hunter visits on Prime Hook NWR compared to statewide harvest (Source: DNREC 2010b, refuge harvest data; http://www.dnrec.state.de.us/fw/deer.pdf)

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
2010	14,183	114	549
2011	13,559	66	513

*Data from DNREC (2010b).

Table 1.12. Cumulative impacts of existing deer hunting on Prime Hook NWR/State Deer Management Zone 9 (2011-2012 data) compared to Statewide Harvest.

Hunt Location & Type	Harvest
Prime Hook NWR	66
State Deer Management Zone 9	852
Statewide Harvest (all 17 Deer Management Zones)	13,559

The refuge will open 1,201 additional acres for deer hunting for a total of 5,221 acres. This additional acreage includes an area located north of Prime Hook Road commonly referred to as Oak Island, an area west of the existing Headquarters Area, an area north of Route 16 referred to as the Millman Tract, an expansion of the Headquarters Area and Jefferson Lofland Tract, and an area west of Petersfield Ditch in Unit IV (For more information about hunting on these areas, refer to Impacts to Public Use). 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 (66) has a negligible impact on the statewide deer population, which was last estimated at 31,071 deer in 2009 (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 3,729 acres for wild turkey hunting, which was permitted on the refuge in Unit I west of Slaughter Canal from 1993 up until 1998. This additional acreage includes many of the areas for deer hunting under this alternative. Turkey is a resident game species that is managed by DNREC's Division of Fish and Wildlife. The refuge falls within Zone 9 of DNREC's Wild Turkey Management Regions and the refuge will work closely with DNREC to evaluate the status of the turkey population and its hunting potential. Zone 9, which includes the state-owned Prime Hook Wildlife Area that is adjacent to the refuge, is currently open during the spring turkey hunting season. To ensure a sustainable harvest of the state's turkey population, DNREC biologists track their health, distribution and reproductive success. Current efforts include a volunteer-based survey used to generate an index of annual turkey productivity and recruitment, monitoring turkey harvest and hunter efforts, tracking turkeys with radio transmitters to evaluate their reproductive ecology, habitat use, and survival, and evaluating the genetic diversity of turkeys. Impacts from turkey hunting, which occurs in April and May, are expected to be negligible since only a very small number of hunters (five or fewer) will be permitted to hunt. The number of permitted hunters may be adjusted (increased or decreased) based on changes in turkey population data.

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
2010	4	0	1	3	108	129
2011	9	0	1	0	76	100

*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.

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 cumulative impacts to local or State populations (Reynolds, personal communication 2010).

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 October 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., U.S._ 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 four days per week during the hunting season with a 3pm 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 2011, the average annual waterfowl harvest at the refuge is 2.5 percent of Delaware's total waterfowl harvest (Table 1.14). Furthermore, in 2011, the refuge's harvest of ducks was only 2.3 percent of Delaware's total duck harvest, 0.06 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. 2012). Also in 2011, the refuge's harvest of geese (Canada and snow geese combined) was only 0.75 percent of Delaware's total goose harvest, 0.02 percent of the Atlantic Flyway's goose harvest, and less than 0.01 percent of the entire United States' goose harvest (Table 1.15; Raftovich et al. 2012).

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 2011, 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 2011-2012 hunting season, the refuge harvested between 0.58 percent and 1.61 percent of the State's estimated monthly duck population and between 0.02 percent

and 0.03 percent of the State's estimated monthly goose population (Table 1.16; October and November statewide waterfowl survey information was unavailable). Refuge hunters harvested between 1.60 percent and 7.04 percent of the refuge's estimated monthly duck population and between 0.04 percent and 0.08 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
2010	84,130	1,604	58,960	874
2011	56,370	1,050	138,894	908

* Statewide waterfowl harvest data from: *http://www.flyways.us/regulations-and-harvest/harvest-trends*; accessed October 2012.

** 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. Some monthly surveys were incomplete in 2007, 2010, and 2011, which may not have reflected the peak *(http://www.fw.delaware.gov/Hunting/Pages/Waterfowl%20Surveys.aspx;* accessed October 2012).

Table 1.15. Comparison of waterfowl harvest at Prime Hook NWR to State, Flyway, and United States harvest in the 2011 hunting season.

Waterfowl Harvest Area	Ducks	Geese
Prime Hook NWR	934	116
Delaware*	41,000	15,400
Atlantic Flyway*	1,672,900	580,400
United States*	15,931,200	2,879,900

*Harvest estimates from (Raftovich et al. 2012)

Table 1.16. Comparison of duck and goose (Canada & snow geese) harvest at Prime Hook NWR to State waterfowl surveys during the 2011-2012 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 2011	219	6,236	Data Unavailable	11	16,823	Data Unavailable
November 2011	126	7,857	Data Unavailable	12	15,540	Data Unavailable
December 2011	217	8,707	37,185	45	99,869	174,992
January 2012	372	5,287	23,053	48	133,634	199,204

* 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%20 Surveys.aspx;* accessed October 2012).

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.

Prior to the conservation order taking affect in late January, all snow goose hunting on-refuge will be isolated to the same areas/blinds and refuge specific hunting dates as other waterfowl hunting. A continuous period (except Sundays) from January 28 – April 13(for 2012-2013 hunting season) will be open for hunting snow geese during the Conservation Order which will open all emergent wetlands on-refuge to snow goose hunting only, once all other waterfowl seasons have closed. Snow geese present a fairly unique issue, finding themselves on the Service's Migratory Bird Program focal species list for actually being over abundant. It is the desire of the USFWS, Canadian Wildlife Service and all Provinces and States to drastically reduce the size of the current continental populations of light (snow) geese, primarily because of the dramatic damage excessive numbers of snow geese have inflicted on very fragile arctic breeding grounds, areas that are important to other breeding migratory species, as well. Seasons, bag limits and methods of take have been liberalized for the purpose. Opening all available habitats on the refuge from January 28 – April 13 is specifically designed to reduce damage sustained from overbrowsing of refuge saltmarshes.

Unfortunately, the Service projects, based upon documented history of similar hunts on-refuge, that very few hunters will take advantage of the snow goose hunting opportunity. The hunting season starts October 1, several weeks before any number of birds arrive on Delmarva, and while many hunters are more interested in deer hunting instead. Snow geese are difficult to hunt and there may be an incidental few killed during the regular duck and migratory Canada Goose season.

Over the period 2001 – 2006, when the refuge was open to late season snow goose hunting, 100 hunters harvested 96 snow geese over a shortened season extending from late January to mid-March and averaged 16.0 birds per year (Table 1.18). The hunter success rate averaged 0.96 birds per hunt. Because of the difficulty of hunting snow geese, hunting parties were likely composed of a minimum of two hunters. Thus a maximum of 50 total parties hunted over a combined total of approximately 216 days available over the 6 year period with each party potentially having several thousand acres upon which to hunt. 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). The Service projects negligible impacts to other refuge resources from snow goose hunting.

In addition, non-refuge areas in Delaware will also be open to snow goose hunting during the same period. It appears anecdotally that the limited few hunters that attempt snow goose hunting during the late season are likely to do so from agricultural fields, alleviating most waterfowl hunting pressure on Delaware's tidal marshes and impoundments.

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
2010	15	No	n/a	n/a	52,451
2011	60	No	n/a	n/a	103,301

* 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. Some monthly surveys were incomplete in 2007, 2010, and 2011, which may not have reflected the peak *(http://www.fw.delaware.gov/Hunting/Pages/Waterfowl%20 Surveys.aspx;* accessed October 2012).

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 1,710 additional acres for waterfowl hunting for a total of 3,432 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 Beach Road, and a reconfiguration of the existing waterfowl hunt area in Unit III. Of these new areas, Unit I was already open to deer and upland game (including dove) hunting.

To minimize waterfowl disturbance, the refuge has designated about 3,185 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 (approximately 1,800 acres), the southern half of Unit III (approximately 390 acres), and in Unit IV (approximately 995 acres). The northern portion of Unit IV, which contains a proposed trail and observation platform, will be closed from the Monday before Thanksgiving to March 15 to minimize disturbance to wildlife in this area. The southern portion of Unit IV will not be open to any public use. Furthermore, all waterfowl hunt areas will be open four days per week until 3pm during the hunting season, which is the same as current management.

The term “sanctuary”, as used in the context of the CCP, indicates an area free from hunting and other uses. A key feature of a sanctuary is to make it large enough that intrusions on it’s borders do not unduly disturb the normal lifecycle functions, e.g. feeding, resting, preening, courtship or cause the birds to take flight. The Service believes the areas designated for sanctuary are sufficiently large to reduce the detrimental affects of all forms of disturbance, including those resulting from hunting activity.

Sanctuaries also allow birds to have adequate escape distances (ED), which are defined as the shortest distance at which they flush or otherwise move away from the approaching person or other disturbing stimulus. Many factors influence EDs such as hunting, flock size, hunger, migratory motivation, etc. Laursen et. al (2005) suggested providing a mean ED of the largest ED of a bird species plus one to two standard deviations to calculate the size of the core area or buffer zone. In their study, the largest ED was 1000 meters for wigeon (other species included mallard, etal, pintail, waders, and gulls) and would be approximately 1700 meters with two standard deviations. Based on this information, refuge sanctuary areas can accommodate the ED’s of most species.

Disturbance to waterfowl in or adjacent to the refuge is not a new phenomenon. The Service agrees, in part, there is virtually no area of the refuge that is not susceptible to auditory and visual disturbance. The refuge is relatively narrow and is crossed by several county roads. Some days auto traffic on Route 1 can be clearly heard a couple miles to the west, aircraft fly overhead, patrons of the refuge drive the county roads, birders walk the trails, refuge staff run tractors and airboats as part of their management program, residents drive to and from the neighboring communities to the east, beach enthusiasts travel to the public beaches, kayakers paddle the creek, crabbers park along the roads, neighbors hunt right up to the refuge border, and refuge hunters occasionally fire guns. Unfortunately, this is the nature of NWRs in the heavily populated eastern US. Most NWRs on the east coast do not harbor qualities that we generally think of as constituting “wilderness”, eg. quiet, or solitude. Under an official wilderness

designation, refuge staff would not be permitted the use of many of the standard management tools used on PHNWR. Even so, hunting is in fact permitted on areas designated as wilderness.

More specifically, hunting on adjacent private property causes disturbance to waterfowl every year in the following areas: Unit 1 along the western boundary, Unit 2 along Cods Road and Fowlers Beach Road, Unit 3 along the southeastern portion near Broadkill Beach, along Prime Hook Creek, and in the state managed Prime Hook Wildlife Area, and Unit 4 along the Broadkill River, Petersfield Ditch, and in salt marshes on the western boundary. Hunting has been open in all four units of the refuge and Unit 1 has been hunted for years by free-roaming hunters seeking deer and upland game in refuge saltmarshes. Despite disturbance of waterfowl from vehicular traffic, refuge staff observe visitors year after year viewing and photographing waterfowl within 20 yards of vehicle even during the hunting season. Adding additional sanctuary areas on the refuge will only increase areas of respite for waterfowl and other wildlife and further enhance opportunities to enjoy them by refuge visitors.

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 with 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 hunting day and time restrictions), 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 14,700 birds were harvested in Delaware during the 2011 season (Table 1.19; Raftovich et al. 2012) when only nine 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 2011 hunting season.

Harvest Area	Dove	Woodcock	Snipe
Prime Hook NWR	9	1	0
Delaware*	14,700	500	500
Eastern Management Unit*	6,666,900	77,000	57,500
United States*	16,580,900	308,700	136,300

*Harvest estimates from (Raftovich et al. 2012); 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 3,729 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).

Hunting 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. The Service will continue to monitor use in Turkle Pond to determine if there is an impact on the eagle nest on Horse Island, which is currently abandoned.

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 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 be short-term and negligible and will be managed through seasonal closures. Negative reactions by some visitors may be caused by 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 and turkey hunts. The closure of the eastern end of Prime Hook Creek in September is only one month earlier than current management. In fact, for the last few years, the eastern end has been closed in early September for safety reasons due to the opening of the early teal hunting season on the adjacent state-owned Prime Hook Wildlife Area. The deer hunts in the refuge headquarters are the same as current management and only portions of this area will be closed for one-half day for turkey hunting. Seasonal closures for hunting occur during the fall and winter months, which is typically a slower period of use due to weather conditions. Law Enforcement Officers would enforce these and other current refuge regulations, where appropriate, and would seek the assistance and cooperation of Delaware Division of Fish and Wildlife in enforcing common regulations to provide a safe environment for refuge visitors and promote activities that are compatible with protecting the resources.

At first glance, these seasonal closures give the appearance that opportunities for wildlife observation and photography are being significantly reduced or totally eliminated for over eight months during the proposed expanded hunting activities. To the contrary, the majority of the refuge would remain open to wildlife observation and other non-consumptive uses and provide more opportunities and open areas than under current management. More specifically, opportunities for wildlife observation and photography have been expanded to include seven new trails totaling 3.7 miles throughout the refuge in all four management units on existing maintained trails or interior refuge roads, bringing the total number of trails to 14 and 9.9 miles. The Headquarters area, which contains six trails covering six of the nine total miles of refuge trails, remains available 363 days a year for non-consumptive uses, but portions may be closed for turkey hunting. All other areas except for the Deep Branch Trail, Fowler Beach Road trail (southside), and Prime Hook Creek are open on every Sunday during the hunting seasons. The Deep

Branch Trail, the Fowler Beach Road trail (southside), and Prime Hook Creek are open with seasonal closures of every day from September 1 through March 15 and if necessary during the snow goose conservation order or turkey hunting seasons. If and when the photography blind is available on the southside of Fowler Beach Road, this portion of the trail will be open year round and open every Sunday during the hunting season. The majority of the hunting will occur during the main hunting season, which typically runs for five months from September through January, with additional hunting opportunities for rabbit through the end of February. Hunting during the snow goose conservation order, which will occur for 2 ½ months from late January through mid-April, will take place mostly in the wetland areas, leaving the upland areas open to other uses. This hunt is not anticipated to bring large numbers of hunters, but is beneficial to the species and other wildlife due to overpopulation. With five or less turkey hunting permits issued in April and May, a vast majority of the refuge would still remain open to wildlife observation and other non-consumptive uses.

We anticipate some conflict between concurrent hunting programs (e.g., waterfowl, deer, and upland game hunting seasons overlapping). For the majority of the hunting seasons, the Delaware Division of Fish and 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. Conflicts among hunters over desired hunting locations are 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.

Cumulative impacts to vegetation communities resulting from hunter access are expected to be negligible, as most species will have already undergone senescence or become dormant. Salt marsh habitats were found to be the most resistant to human trampling when compared to other habitats such as a natural dune, a man-made dune, and man-made coastal grasslands (Anderson 1995). This study analyzed the vegetation of five paths (one in each of the habitats) created and sustained by human trampling and reported that trampling of vegetation (estimated to be 1,815-3,630 passages per year) can be considered as very light. Even though it created paths and reduced vegetation cover and species diversity, the paths still retained a persistent vegetation (Anderson 1995). Additional impacts to vegetation are minimized by not permitting hunters to cut vegetation for shooting lanes or for use as camouflage. Impacts to vegetation are further minimized because hunting from a stand that has been attached with nails, wire, screws, or permanently attached to a tree in any other way is prohibited.

Increases in proposed hunting acreages will provide a net gain in public hunting opportunities positively affecting the general public, nearby residents, and refuge visitors. Many of these proposed "new" hunting areas are currently open to some type of hunting or have been previously open either under refuge management or private ownership. For example, Unit I is currently open for deer and upland game hunting (including dove hunting) and is now proposed to be open for waterfowl hunting - same land, but with a new opportunity. The only refuge land proposed to be open for any type of hunting that is not currently being hunted for any species includes: an area located north of Prime Hook Road commonly referred to as Oak Island (deer only), an area north of Route 16 referred to as the Millman Tract (deer and turkey), an expanded area of the existing Jefferson Lofland Area and Headquarters Area (deer & turkey), an expanded area of the Unit III waterfowl hunt area (waterfowl only), and an area west of Petersfield Ditch in Unit 4. Of these areas, Oak Island was previously hunted under refuge management up until 1995 and the Millman Tract was hunted under private ownership up until the Service purchased it in 2001. The expanded areas of the Jefferson-Lofland Area, Headquarters Area, and nearly all of the proposed Unit III waterfowl hunt area were previously hunted under refuge management. No prior hunting of the area west of Petersfield Ditch is known.

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, short-term minor adverse impacts may occur with some landowners due to hunter trespassing. These impacts will be minimized through enhanced law enforcement efforts. We anticipate some conflict between concurrent hunting programs (i.e., waterfowl, deer, and upland game hunting seasons overlapping). For the majority of the hunting seasons, the Delaware Division of Fish and Wildlife has made efforts to avoid these overlaps in the various hunting programs.

Although the refuge provides hunting maps and refuge-specific regulations, it is ultimately the responsibility of the hunter to know and obey them. Unfortunately, not all do. The Service will ensure that refuge boundaries are and continue to be properly posted to notify both refuge visitors and private landowners. Private landowners will be encouraged to contact either refuge and/or state law enforcement when these trespassing incidents occur and every effort will be made to respond in an efficient and timely manner. The Service also encourages private landowners to post their own property. Restricting hunter access within a 100 yard buffer to private property was discussed and it was concluded that too much hunting area would be lost by this zone and that there are already sufficient laws and regulations in place to discourage boundary shooting. Furthermore, neighboring landowners would benefit by having easy access to designated areas open to hunting on the refuge.

Visitor safety at refuges is a high priority when developing compatible wildlife-dependent recreation programs, such as hunting; however, it is ultimately the responsibility of every hunter to be safe. An accident involving hunter safety results from either a lack of hunting ethics or a violation of hunting regulations. Use of portable deer climbing stands will be recommended but not required. For hunters who may be unable to climb trees using portable deer stands or who may wish to hunt from permanent deer stands or duck blinds, the state-owned Prime Hook Wildlife Area, which adjacent to the Refuge, will continue to provide these opportunities.

Provision of elevated deer stands, and to a lesser degree waterfowl blinds, is relatively unique to Delaware. There are many areas on the Delmarva Peninsula, other than Prime Hook NWR, that offer public hunting opportunities in free-roam areas where the hunter is required to provide the blind or stand, if desired.

The Service conducted a web-search for public lands within the three states making up the Delmarva Penninsula in order that we evaluate the prevalence of permanent waterfowl blinds or deer stands on public hunting lands. A wide assortment of ownership and management regimes was evident across 215 tracts managed or described by 19 different designations, e.g. State Park, National Park Service, State Forest, Chesapeake Forest Lands, Natural Resources Management Area. For waterfowl hunting, 131 of the 215 tracts examined permitted waterfowl hunting. Of the 131, only 36 provided either a pit or standup blind somewhere on the tract. The Service makes this qualifying statement because some areas, Tuckahoe State Park for example, provide four pit blinds but also allow free roaming along the Tuckahoe River. Of the 36, 28 were located in Delaware, 8 in Maryland, and none in Virginia. Twenty tracts required hunters to hunt at a stake or within some designated distance from a blind site where the hunter would provide the blind (if desired), including nine in Delaware, 11 in Maryland, and none in Virginia. A total of 84 tracts permitted free-roam hunting where the hunter would provide the blind (if desired), 17 in Delaware, 60 in Maryland, and seven in Virginia.

For deer hunting, of the 215 tracts examined, 181 permitted some form of deer hunting. Unfortunately, the Service did not make a distinction between the various methods, i.e. some tracts may be limited to bow hunting only. Of the 181 tracts, 95 were located in Delaware, 77 in Maryland and nine in Virginia. A total of 51 of the 181 tracts required hunters to use stands that were provided, all of which were located in Delaware. Free-roam hunting was permitted on 165 tracts, including 80 in Delaware, 76 in Maryland, and nine in Virginia. The Service acknowledges that some free roam areas were for bow hunting only, however such a distinction would only apply in Delaware; all deer hunting tracts in Maryland and Virginia permitted free-roam hunting regardless of hunting method.

For the 85 tracts located in Maryland and Virginia where no stands are provided, only two require an elevated stand, which the hunter must provide. For areas immediately adjacent to the building complex on Blackwater NWR, the hunter must use an assigned blind site where the hunter erects a stand with a platform minimum of eight feet above the ground. All other tracts on Blackwater NWR are free-roam where ground-hunting is permitted.

The second site where elevated deer hunting is required is on Chincoteague NWR, around the tour loop. Here the hunter must erect his/her own stand with a platform minimum of 14 feet above the ground. All other areas on Chincoteague NWR permit free-roam hunting. The Service should also add that rifle hunting, as well as deer drives, are permitted on most public hunting lands on the lower eastern shore of Maryland and the eastern shore of Virginia.

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 reduce the administrative burden and minimize the amount of staffing resources needed to conduct the hunt by 54 staff days and $17,890 from current management. The benefit 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 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 other opportunities such as mentored hunt programs 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 2, 3, 4, and 5) will be open to hunting on the refuge for the following game species:

Area	Species	Acres	Seasons**
Regular Deer Hunt Area	Deer	3,659	Sept-Feb
Regular Waterfowl Hunt Area	Waterfowl (& webless migratory birds)	1,891*	Sept- Feb
Lottery Waterfowl Hunt Area	Waterfowl	1,515*	Sept-Feb
Lottery Deer Hunt Area	Deer	841	Nov & Jan
Disabled Waterfowl Hunt Area	Waterfowl	26*	Sept-Feb
Disable Deer Hunt Area	Deer	721	Oct & Nov
Upland Game Hunt Area	Upland game & webless migratory birds except 110 acres closed to dove hunting	1,995	Sept-Feb
Lottery Turkey Hunt Area Snow Goose Conservation Order	Turkey Snow Geese	3,729 Refuge-wide***	Apr-May Late Jan-April

* A total of 3,432 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.

**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.

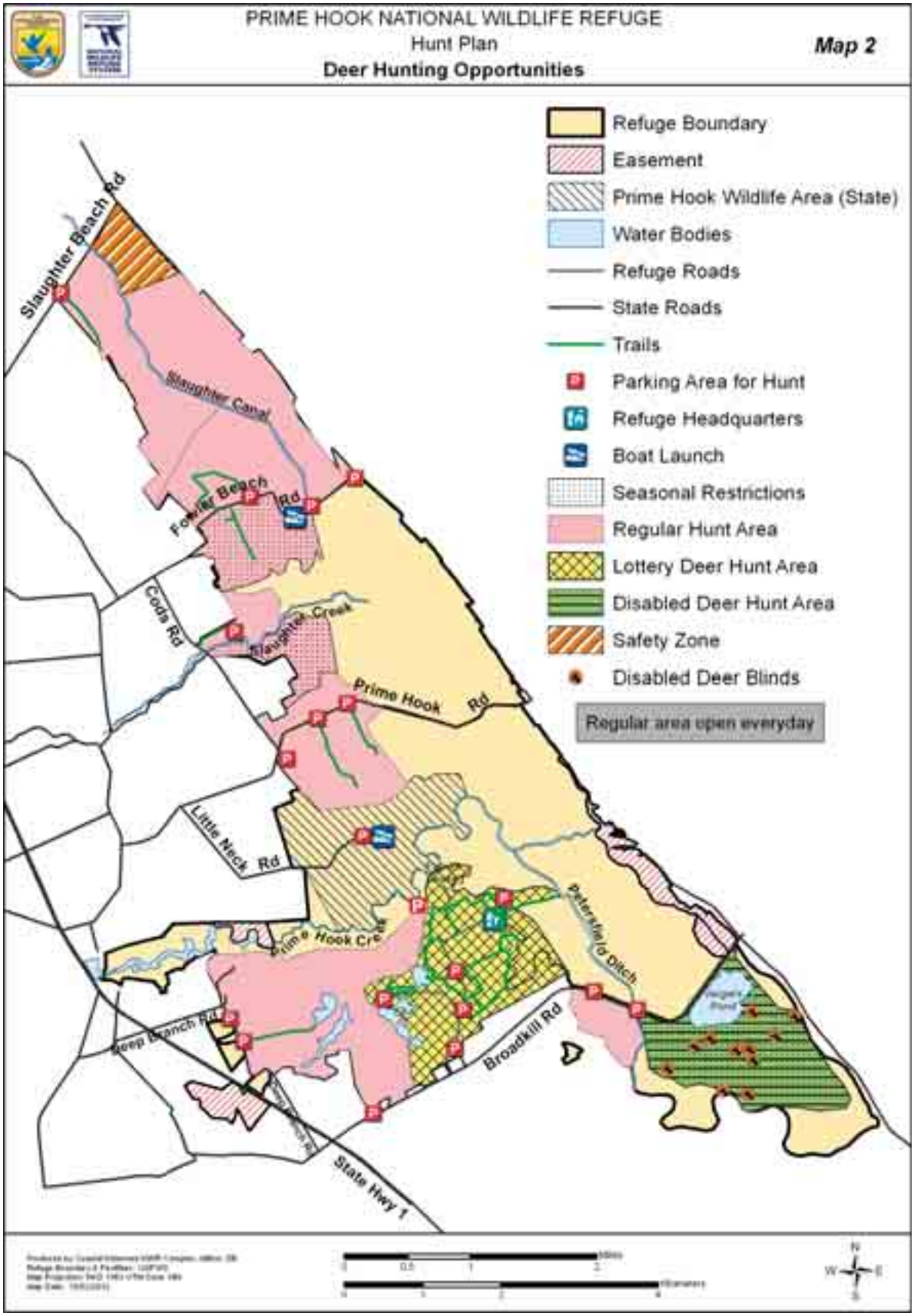
Future land acquisitions will be evaluated and if appropriate will be included in the refuge's hunting program.

Species to be Taken & Other Hunting Information

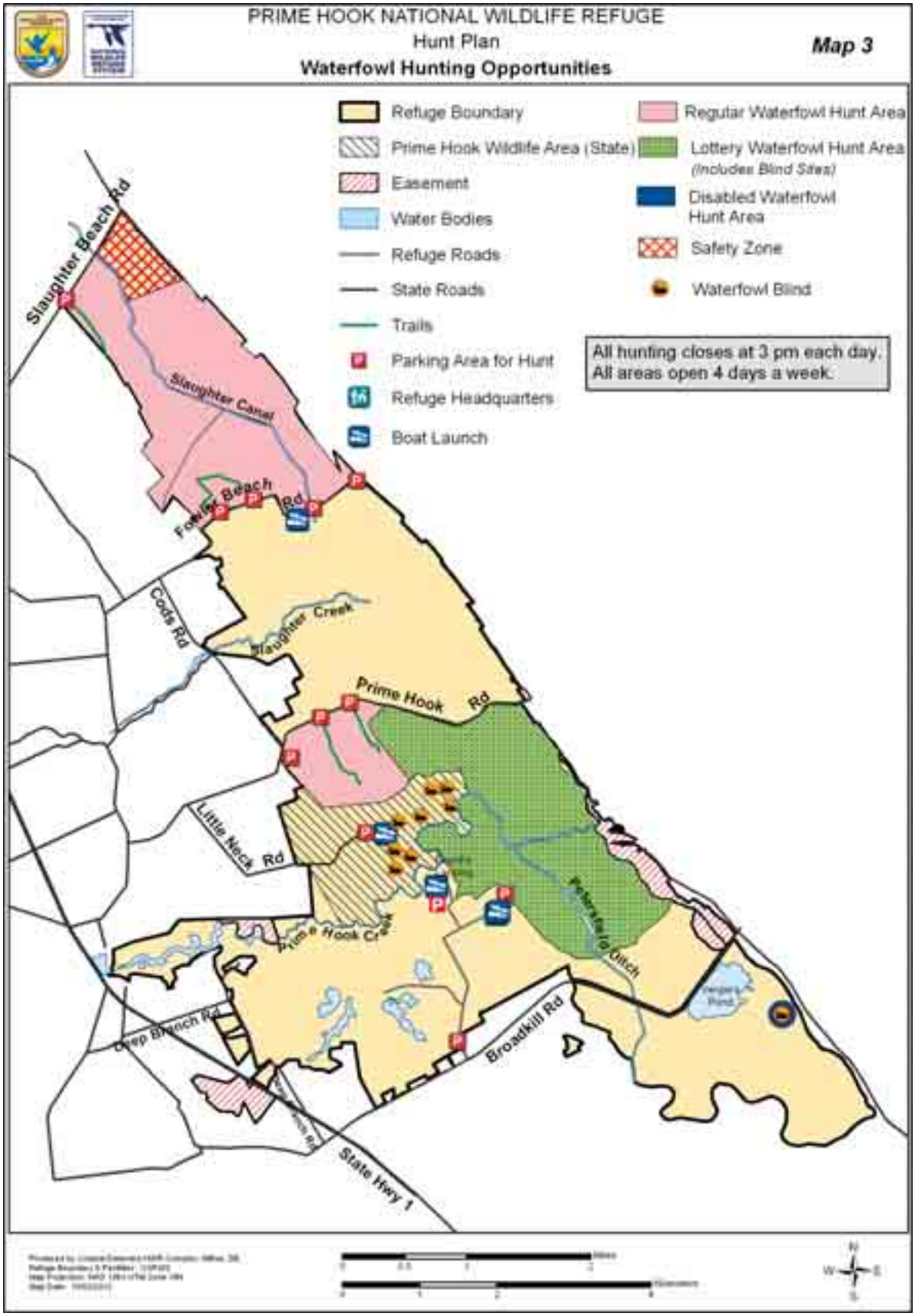
The refuge offers a wide diversity of hunting opportunity. Programs will include big game (white-tailed deer), upland game (rabbit, quail, pheasant, and red fox), waterfowl (including coot), wild-turkey, and other migratory game birds (mourning dove, snipe, & woodcock). Below are specific goals and objectives 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

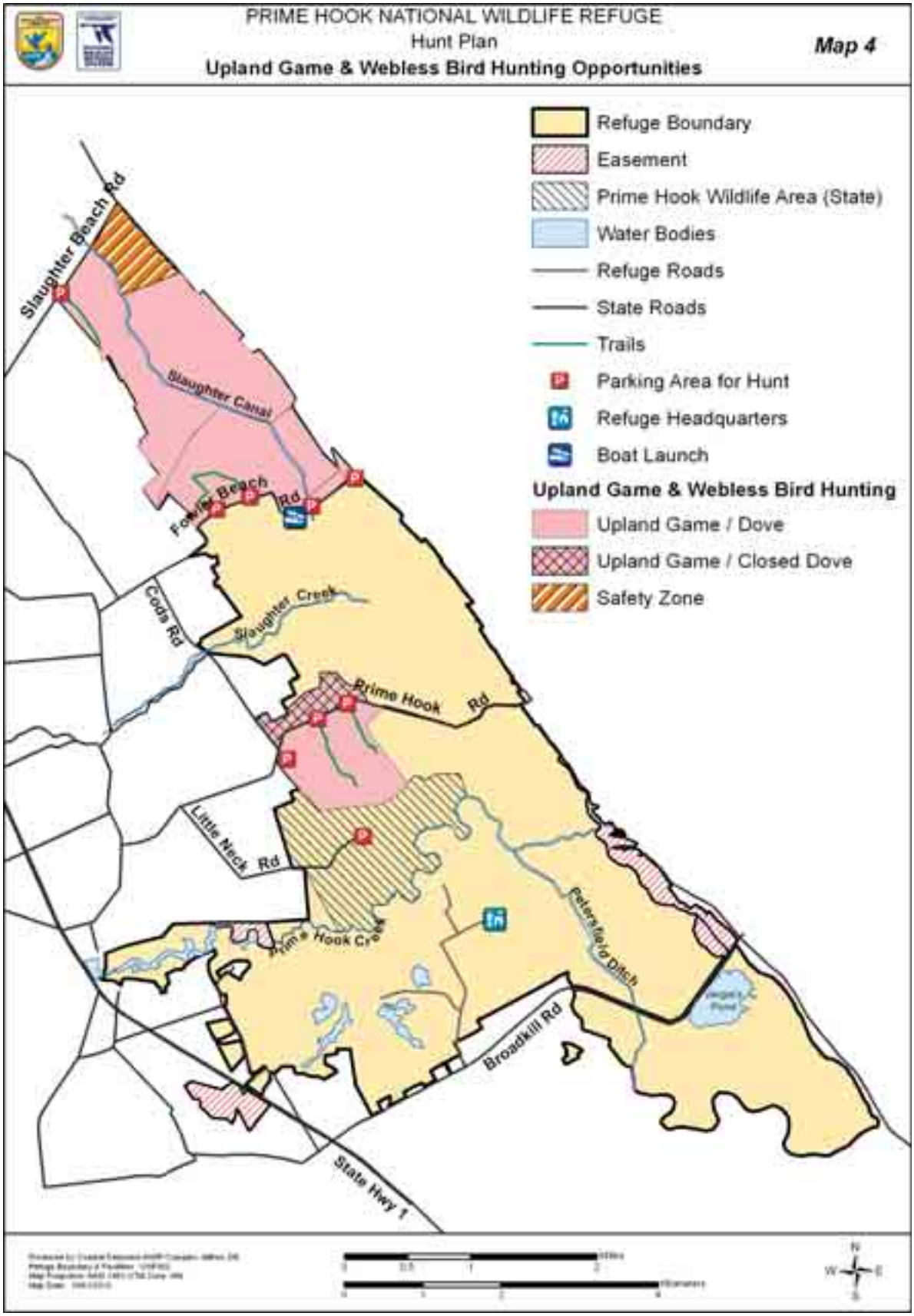
Map 2. Deer Hunting Opportunities



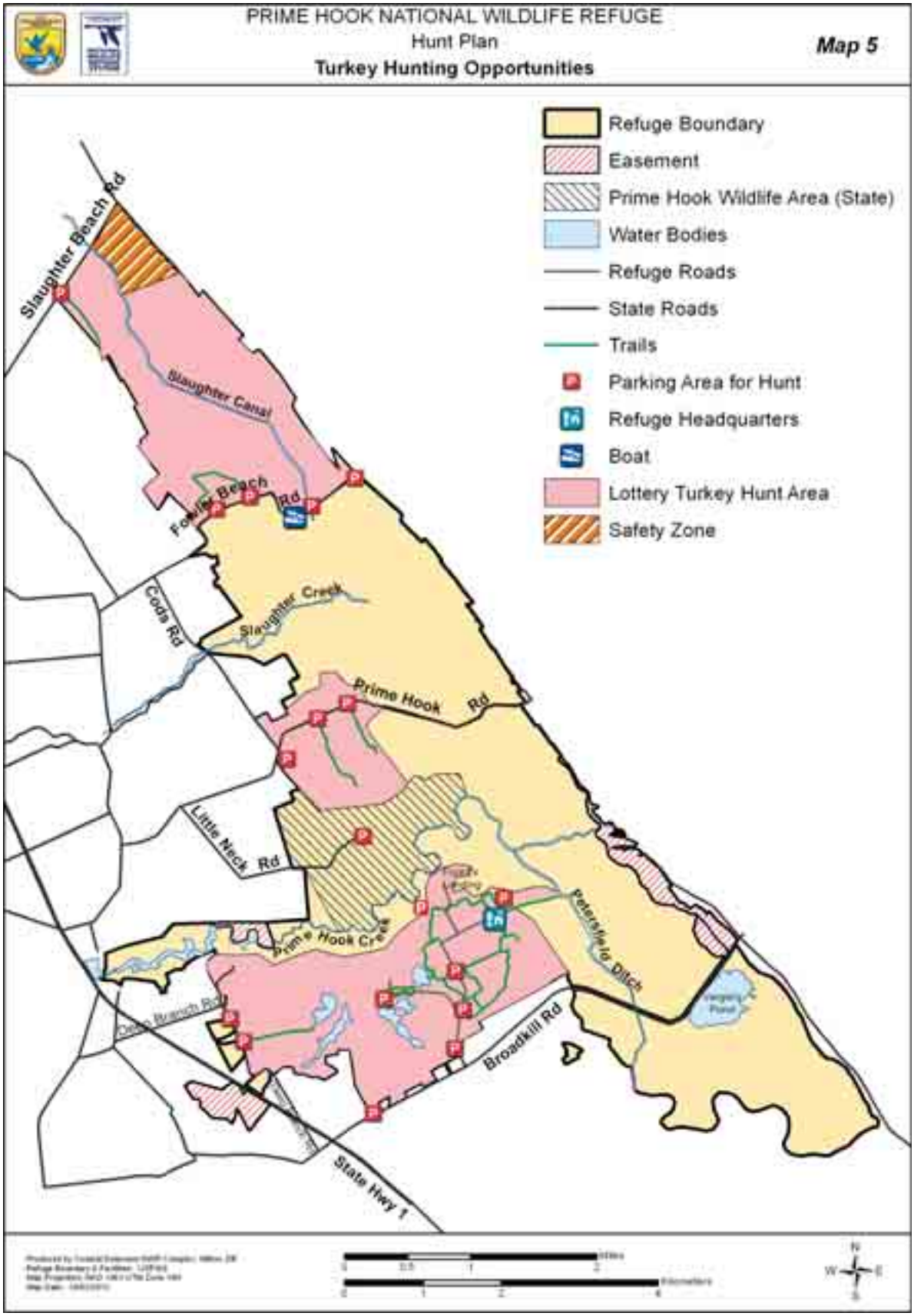
Map 3. Waterfowl Hunting Opportunities



Map 4. Upland Game and Webless Migratory Bird Hunting Opportunities



Map 5. Turkey Hunting Opportunities



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 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. Expanded hunting on refuge lands will enhance quality opportunities for hunting deer, waterfowl, upland game, webless migratory birds (dove), and turkey. Deer hunting would increase from 4,020 to 5,221 acres, waterfowl hunting from 1,722 to 3,432 acres, upland game & migratory bird hunting remains at 1,995 acres, and turkey hunting from zero to 3,729 acres.

Increases in proposed hunting acreages will provide new hunting opportunties from current management; however, many of these proposed "new" hunting areas are currently open to some type of hunting or have been previously open either under refuge management or private ownership. For example, Unit I is currently open for deer and upland game hunting and is now proposed to be open for waterfowl hunting - same land, but with a new opportunity. The only refuge land proposed to be open for any type of hunting that is not currently being hunted for any species includes: an area located north of Prime Hook Road commonly referred to as Oak Island (deer only), an area north of Route 16 referred to as the Millman Tract (deer and turkey), an expanded area of the existing Jefferson Lofland Area and Headquarters Area (deer & turkey), an expanded area of the Unit III waterfowl hunt area (waterfowl only), and an area west of Petersfield Ditch in Unit 4. Of these areas, Oak Island was previously hunted under refuge management up until 1995 and the Millman Tract was hunted under private ownership up until the Service purchased it in 2001. The expanded areas of the Jefferson-Lofland Area, Headquarters Area, and nearly all of the proposed Unit III waterfowl hunt area were previously hunted under refuge management. No prior hunting of the area west of Petersfield Ditch is known.

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 that can tolerate pedestrians or navigation without adverse impacts on a first-come, first-served basis following State regulations, adopting one-time seasonal permits for all hunting areas except lottery hunts, enhancing youth and disabled hunting opportunities, establishing seasonal closures to minimize wildlife disturbance and 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 Prime Hook NWR hunting regulations brochure, 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.

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, upland game, and turkey in designated areas on a first-come, first-served basis. Non-ambulatory hunters are allowed to hunt in all hunt zones in accordance with refuge policy and regulations. Only non-ambulatory hunters may hunt in the Island Farm Unit, where we have provided non-ambulatory hunt blinds to accommodate hunters with this need. For the Statewide youth hunts, all designated hunt areas would be open for waterfowl, deer, or turkey hunting on a first-come, first-served basis. We don't know the number of hunters who 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), disabled deer and waterfowl hunt areas, 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 more than 100 deer hunters show up for 32 available shotgun hunting opportunities and 80 waterfowl hunting parties (with up to 3 people per party) show up for 25 to 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 one in three chance of getting a hunting spot. As a national wildlife refuge, Prime Hook NWR will provide hunting opportunities through these preseason drawings for local, in-State, and out-of-State hunters. Knowing in advance allows hunters to prepare, plan, and scout, which ultimately improves the quality of their hunting experience.

Preseason lottery drawings would be administered by a contracted company that will feature online and telephone services to collect hunter information and 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 (no more than 30 hunters) would have access to the hunt area and may choose their hunting location on a first-come, first-served basis on the day of the hunt. For the lottery waterfowl hunt area and disabled deer and waterfowl hunt areas, 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. Only the first two days of each of the state's seasonal splits for waterfowl will be includeed in the preseason drawing for the disabled waterfowl area and will be first-come, first-serve thereafter. For the lottery waterfowl hunts, the selected hunter may take two additional people on that hunt day. Federal blind sites in addition to eight 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 may 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 prevent someone from claiming all available vacancies at one time. The licensing contractor would supply refuge staff with a list of permitted applicants. No daily standby lottery drawings would be conducted.

Permanent hunting structures, such as deer hunting stands and duck hunting blinds, would be phased out over a 5-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 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. In the case of waterfowl hunting, the phasing out of permanent waterfowl hunting blinds in the lottery hunt area will 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.

Visitor safety at refuges is a high priority when developing compatible wildlife-dependent recreation programs, such as hunting; however, it is ultimately the responsibility of every hunter to be safe. An accident involving hunter safety results from either a lack of hunting ethics or a violation of hunting regulations. Use of portable deer climbing stands will be recommended but not required. For hunters who may be unable to climb trees using portable deer stands or who may wish to hunt from permanent deer stands or duck blinds, the state-owned Prime Hook Wildlife Area, which adjacent to the Refuge, will continue to provide these opportunities. There are many areas on the Delmarva Peninsula, other than Prime Hook NWR, that offer public hunting opportunities in free-roam areas or from designated permanent structures. Additional information about free roam hunting and the use of deer stands and duck blinds on the refuge and on the Delmarva Peninsula can be found in the visitor services section in chapter 3 of the refuge's CCP and in the Impacts on Public Use and Access in this plan.

The refuge offers opportunities for all disabled individuals. Areas will be reestablished for non-ambulatory wheelchair hunters to ensure that these individuals have opportunities for quality hunting experiences. Non-ambulatory wheelchair hunters have limited mobility; opportunities to hunt on the refuge are limited unless refuge staff provides them with accessible infrastructure such as ground blinds and vehicular access to them. Other disabled, yet ambulatory hunters are provided opportunities to hunt in the free roam areas, are not required in any fixed location, and may choose how far they are capable or willing to travel to hunt. Because these proposed changes do not exclude hunters with other types of disabilities from the refuge's hunting program, these methods are in compliance with the intent of the Americans with Disabilities Act.

Non-ambulatory hunters have commented about their frustration with the current hunting system. The number of non-ambulatory hunters on the refuge has decreased since 2005, when access was granted

to all individuals with any permanent disability (not just non-ambulatory hunters) to hunt in the disabled hunting area along with additional hunting days. Hunter success rates for deer have also decreased from an average of 32% from 2000-2005 to an average of 18% from 2005 to present.

The Service proposes to enhance youth hunting opportunities by collaborating with State partners and NGO hunting organizations to develop hunter training programs that instruct beginning hunters in the knowledge and skills necessary to become responsible, respected individuals who strive to learn all they can about the species being hunted and to become knowledgeable in firearms safety, hunter ethics and wildlife conservation. The Service will also develop mentored hunting programs for both youth and adults and offer programs developed by NASP, or National Archery in the Schools program, to encourage family participation in archery shooting. Portions of any area open to hunting may be used to facilitate these mentored hunts and these areas will be temporarily closed to the general hunting public during those times.

Season dates, bag limits, and harvest methods for the hunting program at Prime Hook NWR 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 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 (For details, refer to Objectives 5.1a through 5.1d)
    - Supports Presidential Executive Order #13443: 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, disabled deer and waterfowl hunt areas, 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 disabled hunters; application and permit fees for turkey hunting may be waived if the lottery drawing is administered by the State)
   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 will 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. Application and permit fees for turkey hunting may be waived if the lottery drawing is administered by the State. 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 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, disabled deer and waterfowl hunt areas, 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. Hunters would have the option to forfeit their permit to the contractor if circumstances prevented them from hunting on that day, without compensation, i.e. no refunds, to make their reservation available to other hunters.
- 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 may be conducted by the Delaware Division of Fish and Wildlife and if so, application and permit fees may be waived.
- See discussion earlier in this section or Objectives 5.1a, 5.1b, or 5.1d for more info.

- Enhance disabled hunting opportunities, particularly for non-abulatory wheelchair hunters (See Objectives 5.1a and 5.1b for more information).

- Enhance youth hunting opportunities
  - Collaborate with State partners and NGO hunting organizations to develop hunter training programs that instruct beginning hunters in the knowledge and skills necessary to become responsible, respected individuals who strive to learn all they can about the species being hunted and to become knowledgeable in firearms safety, hunter ethics and wildlife conservation.
  - Develop mentored hunting programs for both youth and adults and offer programs developed by NASP, or National Archery in the Schools program, to encourage family participation in archery shooting.
  - Portions of any area open to hunting may be used to facilitate these mentored hunts and these areas will be temporarily closed to the general hunting public during those times.

- 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:
  - Deep Branch Road Trail (includes Goose and Flaxhole Ponds; Unit III), Eastern Prime Hook Creek (from Foord's Landing to headquarter ramp) (Unit III), and hiking trail on Fowler Beach Road (southside of Unit II): 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 or turkey hunting. If and when the photography blind is available on the southside of Fowler Beach Road, this portion of the trail will be open year round and open every Sunday during the hunting season.
  - Headquarters area (includes Turkle and Fleetwood Ponds) (Unit III): Closed only for a maximum of two days for deer hunts and portions may be closed for turkey hunts.
  - Island Farm Area in 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.

  - Hiking trails on Fowler Beach Road (Unit I), Prime Hook Road (Unit III), and Slaughter Beach Road and Slaughter Canal (Unit I): Open only on Sundays from September 1 through the deer and waterfowl hunting seasons, which typically end in February. Additional seasonal closures may apply through the second Saturday in May for hunting during the snow goose conservation order 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.

- 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 for access to Prime Hook Creek at Foord's Landing.

- General Regulations for All Hunting Programs (refer to "Conduct of Hunt" section for a complete list of state and refuge-specific regulations for hunting).
  - Areas may be closed on the refuge without prior warning.
  - Digging for any reason is prohibited.
  - Overnight camping and open fires are prohibited.
  - Non-toxic shot is required for all hunting except lead slugs are permitted for deer and fox hunting.

- 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 1,201 acres beyond current management for a total of 5,221 acres. We would open these acres for archery (to include the use of crossbows), muzzleloader, or shotgun hunting (to include the use of handguns), 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 and close hunting in late November in designated areas to minimize bald eagle and waterfowl disturbance). The disabled hunting areas in Unit IV would provide access to non-ambulatory wheelchair users only.

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 2 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.

- Expand deer hunting opportunities from 4,020 acres to 5,221 acres, an increase of 1,201 acres (See Map 2).
    - The refuge has adopted State hunting regulations and seasons for the Regular Deer Hunt Area with the following restrictions:
        a. No access by boat from Slaughter Creek on Cods Road
            i. There is no infrastructure to support boat launching.
        b. 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. The disabled deer hunt area in the Island Farm will be closed following the November shotgun season to minimize wildlife disturbance.

- 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 Island Farm area.
- Portable stands are permitted.
- Eliminate maintenance mowing except for disabled hunt areas.

- 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 non-ambulatory wheelchair users.
    - Reestablish areas for non-ambulatory wheelchair hunters only in a designated area in Unit IV.
    - Provide a limited number of hunting days during the early muzzleloader hunting season, the Statewide non-ambulatory hunt in November, and the early shotgun hunting seasons in the disabled hunt area to minimize deer disturbance and maximize quality hunting experience. A total of 11 ground blinds are currently available and required. Additional sites in this area may be provided.in designated areas to minimize deer disturbance and maximize quality hunting experience.
    - The refuge may 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 disabled deer hunt area for a limited number of days during the firearms deer hunting seasons
    - A limited number of permits (no more than 30 for the lottery deer hunt area) 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 disabled 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 participate in the Statewide non-ambulatory deer hunting. The lottery deer hunt area will not be open for this hunt.

- 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 and promote and establish youth and adult mentored hunting programs.

- General Regulations for Deer Hunting (refer to “Conduct of Hunt” section for a list of state and refuge-specific regulations for hunting).

- Enhanced opportunities for scouting will be allowed two weeks before the start of archery season and throughout the deer hunting season.

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 1,710 acres from current management for a total of 3,432 acres. Seasonal closures would occur to protect wildlife and minimize conflicts between different hunting activities or other non-consumptive recreational uses (e.g., close hunting in late November in designated areas to minimize bald eagle and waterfowl disturbance). We would phase-out permanent waterfowl hunting blinds. In all hunt areas, hunting is proposed to remain at four days per week and to cease at 3pm to minimize wildlife disturbance and provide quality hunting experiences. Non-ambulatory hunters are allowed to hunt in all hunt zones in accordance with refuge policy and regulations. Only non-ambulatory hunters may hunt in the Island Farm Unit, where we have provided non-ambulatory hunt blinds to accommodate hunters with this need.

The addition of new free-roam waterfowl hunting areas in salt marsh habitats in Unit I will provide quality opportunities, particularly when refuge impoundments freeze. Sanctuaries totaling 3,185 acres are provided as disturbance free areas for wildlife on a seasonal or annual basis where no recreational activity is permitted. Map 3 depicts waterfowl hunting opportunities and infrastructure.

Like deer hunting, waterfowl hunting is an established, traditional use on the Delmarva Peninsula. CCP Map 3 depicts waterfowl hunting opportunities and infrastructure.

Strategies

In addition to objective 5.1 strategies:

- Create waterfowl sanctuaries (disturbance free areas) in Unit II (approximately 1,800 acres), Unit III (approximately 390 acres), and Unit IV (approximately 995 acres)
    - The Unit II impoundment area will be closed annually to all public use.
    - Except for the disabled waterfowl hunt area (approximately 25 acres), most 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 or for wild turkey.

To support waterfowl conservation efforts, the refuge has designated about 3,185 acres as waterfowl sanctuaries that will be closed to hunting and other recreational use on a seasonal or annual basis. These sanctuaries lie in Unit II (1,800 acres), the southern half of Unit III (390 acres), and most of Unit IV (995 acres) and provide resting and feeding habitat for waterfowl to concentrate rather than dispersing throughout the refuge. These sanctuaries function to:

1. Provide migrating waterfowl a more balanced and effective network of feeding and resting areas
2. Minimize disturbance to feeding and resting waterfowl
3. Provide waterfowl hunters with more equitable hunting opportunities throughout the refuge
    a. Establish hunter spacing limits

4. Reduce hunter competition and improve hunting quality
   a. 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
   b. Expanded hunting areas will provide greater opportunity for hunters

- Expand hunting opportunities from 1,722 acres to 3,432 acres or 40 percent of the refuge to include new hunting opportunities in Unit I and III. We must follow the guidelines of the 40 percent 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 percent 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 with the following restrictions:
      - Hunting will be on a first-come, first-served basis that includes jump shooting (except for lottery hunts and disabled hunts).
      - In all waterfowl hunting areas, hunting is permitted four days per week until 3pm during the state waterfowl hunting seasons (except everyday during the snow goose conservation order).
      - Check-in and check-out by hunters would not be required for any waterfowl hunt.

- Phase-out permanent waterfowl hunting blinds over a 5-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 and disabled waterfowl hunt area).
    - Hunters would be required to hunt from hunting blind site areas in the lottery waterfowl hunt area and disabled 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 system.

- Enhance hunting opportunities for individuals with disabilities, particularly for non-ambulatory wheelchair users.
    - Reestablish areas for nonambulatory wheelchair hunters only in a designated area in Unit IV.
    - One disabled, wheelchair accessible, and camouflaged waterfowl hunting blind is available.

- Provide lottery hunts in the lottery waterfowl hunt area and disabled waterfowl hunt area.
    - Through a preseason lottery drawing, hunters must choose their hunt dates and blind site locations from among the designated blind locations.

- Only the first two days of each of the state's seasonal hunting splits for waterfowl will be included in the preseason drawing for the disabled waterfowl area and will be first-come, first-serve thereafter.
- Within 5 years of CCP signing, we will open boat ramp access at Foord's Landing 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 hunts, resident Canada goose season, and snow goose season (early and 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-served basis everyday of the season during legal shooting hours.
        - The light goose conservation order is an action implemented under the final environmental impact statement on the management of light geese (USFWS 2007a) 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.
        - Hunting is not permitted in upland areas.
    - The youth hunts will occur in all designated hunting areas on a first-come, first-served basis.
    - In the lottery hunt area and disabled waterfowl hunt area, snow geese may only be taken when already open for duck hunting or during the snow goose conservation order.

- General information for waterfowl hunting (refer to "Conduct of Hunt" section for a list of state and refuge-specific regulations for hunting).
    - Enhanced opportunities for scouting will be allowed during designated dates and times.

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 1,995 acres. However, the dove hunting acres will be decrease by 110 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 depicts upland game and webless migratory bird hunting opportunities and infrastructure.

Strategies
In addition to objective 5.1 strategies:

- Continue upland game and webless migratory bird hunting opportunities on 1,995 acres (110 of the total acres would not be open to dove hunting). See objective 5.1b for explanation of 40 percent 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 Hunting of red fox is permitted only when concurrently hunting deer and is only permitted in areas open to deer hunting.
        - c Chase hunting is prohibited.
        - d Rimfire or centerfire rifles are prohibited.
    - Dove hunting is open in the upland game hunting area except the designated area north of Prime Hook Beach Road.
    - Hunters will not be required to report their harvest data to the refuge.
    - Hunting will be on a first-come, first-served basis. Check-in and check-out by hunters would not be required for any upland game and webless migratory bird hunt.

Objective 5.1d Wild Turkey Hunting

Provide high quality hunting opportunities for turkey

Rationale
Wild turkey is a resident game species that is managed by DNREC's Division of Fish and Wildlife. Prime Hook NWR falls within Zone 9 of DNREC's Wild Turkey Management Regions. Zone 9, which includes the state-owned Prime Hook Wildlife Area that is adjacent to the refuge, is currently open during the spring turkey hunting season. To ensure a sustainable harvest of the state's turkey population, DNREC biologists track their health, distribution and reproductive success. Current efforts include a volunteer-based survey used to generate an index of annual turkey productivity and recruitment, monitoring turkey harvest and hunter efforts, tracking turkeys with radio transmitters to evaluate their reproductive ecology, habitat use, and survival, and evaluating the genetic diversity of turkeys.

We would provide new opportunities for hunting wild turkey on 3,729 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 5 depicts turkey hunting opportunities and infrastructure.

Strategies
In addition to objective 5.1 strategies:

- Collaborate with the Delaware Division of Fish and 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 to a limited number of hunters (no more than five) 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 may be administered by the Delaware Division of Fish and Wildlife and if so, application and permit fees may be waived.
    - Conduct a preseason lottery drawing. No daily standby drawings will be conducted.
    - During hunts, all public access will be closed in designated hunt areas during legal hunting hours.
    - Participate in the statewide youth/non-ambulatory disabled turkey hunt.
    - The number of permitted hunters may be adjusted (increased or decreased) based on changes in turkey population data.
    - 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 brochure 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. Turkey hunting application and permit fees may be waived if the lottery drawing is administered by the State.

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 will 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. Application and permit fees for turkey hunting may be waived if the lottery drawing is administered by the State. 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 brochure 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.

A. Migratory Game Bird Hunting. We allow the hunting of waterfowl, coot, mourning dove, snipe, and woodcock on designated areas of the refuge during designated seasons in accordance with State regulations subject to the following conditions:
   1. Only hunters aged 16 years and older may apply for or obtain a lottery hunt area permit (Waterfowl Lottery Application; FWS Form 3-2355).
   2. All hunters must have in their possession a signed and current refuge hunt permit (signed brochure) and government-issued picture ID on the refuge. All permits are non-transferable. Hunting brochures containing hunting application procedures, permits, seasons, scouting times, methods of hunting, maps depicting areas open to hunting, and the terms and conditions under which we issue hunting permits are available at the refuge office and on the refuge's website.

3. Hunting in violation of any Delaware State law is a violation of refuge hunting regulations.
4. When requested by Federal or State enforcement officers, hunters and assistants must display for inspection all permits, game, equipment, weapons, and ammunition.
5. Cutting or damaging vegetation for any purpose is prohibited. The use of natural vegetation for camouflaging a blind is prohibited.
6. Hunting blinds, stands, steps and equipment must be portable and removed at the end of each day.
7. Practice or target shooting is prohibited.
8. All public entry is prohibited in designated safety zones.
9. Hunters may not be on the refuge any earlier than two hours before the legal morning shooting time.
10. All boaters are required to operate their craft and possess all safety equipment in accordance with Delaware State and U.S. Coast Guard regulations during refuge hunts. The maximum horsepower allowed for boat motors is 30 HP. The Slaughter Canal and Headquarters' Canal are slow, no wake zones. Designated launching sites must be used to launch boats. We prohibit the use of air-thrust and inboard water-thrust boats on all waters within the refuge boundaries.
11. Only 3 individuals are allowed per blind site in the lottery hunting areas.
12. Motor vehicles are prohibited off of designated routes and parking areas.
13. We allow the use of dogs to assist in hunting and retrieval of harvested game in accordance with State law. Dog training is prohibited.
14. Only non-ambulatory hunters may hunt in the Island Farm Unit, where we have provided non-ambulatory hunt blinds to accommodate hunters with this need. All disabled hunters must obtain an Interagency Access Passport to receive a hunting permit for the disabled hunting areas. Wheelchair hunters are required to have an assistant in the disabled hunting areas, and must hunt from a government provided blind.
15. We allow up to two individuals assisting a disabled hunter to hunt waterfowl with the disabled hunter.
16. Waterfowl hunters must stop hunting at 3:00pm and be off of the refuge by 4:00 pm on hunting days except when snow goose hunting during a snow goose conservation order.
17. We prohibit the use or possession of toxic shot for hunting (see §32.2(k)).

B. Upland Game Hunting. We allow the hunting of rabbit, quail, pheasant, and red fox on designated areas of the refuge in accordance with State regulations subject to the following conditions:
1. The hunting of squirrel is prohibited.
2. Red fox hunting is only allowed while concurrently hunting deer in areas open to deer hunting. Hunting by chase is prohibited. Rimfire or centerfire rifles are prohibited.
3. We prohibit the use or possession of toxic shot for hunting (see §32.2(k)) with the following exception: while hunting red fox concurrently with deer we allow the use of shot approved for deer hunting in accordance with state and refuge regulations.
4. Hunters must be out of the hunting area one half hour after the legal evening shooting time.
5. Conditions A2 through A13 apply.

C. Big Game Hunting. We allow the hunting of white-tailed deer and turkey on designated areas of the refuge during designated seasons in accordance with State regulations subject to the following conditions:
   1. Only hunters aged 16 years and older may apply for or obtain a lottery hunt area permit (Quota Deer Hunt Application; FWS Form 3-2354, Big/Upland Game Hunt Application; FWS Form 3-2356).
   2. Access by boat is prohibited from Slaughter Creek on Cods Road.
   3. We prohibit the driving or pushing of deer by any means.
   4. All deer hunters must be out of the hunting areas one and one-half hours after the legal evening shooting time. All turkey hunters must be out of the hunting areas one hour after the legal closing time for turkey hunting.
   5. We prohibit the use or possession of buckshot while hunting. Only slugs may be used for hunting deer.
   6. Assistants for wheelchair hunters are prohibited from hunting in the disabled hunting area.
   7. Any time the State hunting regulations require that hunters display hunter orange, the material must be solid-colored. We prohibit the use of hunter-orange camouflage materials to meet state minimum hunter orange requirements.
   8. We prohibit the use or possession of toxic shot for hunting (see §32.2(k)) turkey.
   9. Conditions A2 through A12, and A14 apply.

Anticipated Public Reaction

The Service conducted public 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 #13443: 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; 5.) conflicts with adjacent landowners; and 6.) relocation of disabled but ambulatory hunters from using infrastructure for non-ambulatory wheelchair users in the disabled hunt areas. 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) 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 Service's Northeast Regional Office, 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 brochure, 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. All disabled hunters must obtain an Interagency Access Passport to receive a hunting permit for the disabled hunting 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 hunters are allowed to hunt in all hunt zones in accordance with refuge policy and regulations. Only non-ambulatory hunters may hunt in the Island Farm Unit, where we have provided non-ambulatory hunt blinds to accommodate hunters with this need. For the Statewide youth hunts, all designated hunt areas would be open for hunting on a first-come, first-serve basis.

Preseason lottery drawings will occur for high demand areas, including the lottery deer hunt area (headquarters area), disabled deer and waterfowl hunt areas, 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 32 available hunting opportunities and for 80 waterfowl hunting parties (with up to three people per party) show up for 25-27 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 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. Application and permit fees for turkey hunting may be waived if the lottery drawing is administered by the State. 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 disabled deer and waterfowl hunt areas, hunters would be selected for a hunt date and hunting blind site based on their date preferences during the preseason drawing. Only the first two days of each of the state's seasonal hunting splits for waterfowl will be included in the preseason drawing for the disabled waterfowl area and will be first-come, first-serve thereafter. 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 may 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. Hunters may forfeit their permits to the contractor without compensation to make available for other hunters.

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, unless the State conducts the lottery drawing. 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 and keep in their possession while hunting.

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. Additional seasonal restrictions (days of week) or spacing may be required to minimize these conflicts.

Appendix D

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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° 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 =Red Maple/ 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. **<u>Potential Focal Species:</u> 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.

Habitats (Plant Communities that Represent Existing BIDEH	Population/Habitat Attributes (Structure & Species Composition)	Natural Processes Responsible for these conditions	Limiting Factors
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.**		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	• Irregularly Flooded Eastern Tidal Salt Shrub • Maritime Red Cedar Woodland • Successional Maritime Forest	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.	

Keystone Resources of Concern		Life History and Habitat Structure Requirements ==➔ (Objectives)	Other Benefiting Species
Focal Species or Focal Group	**Habitat Type =➔ (Goals)**		
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).	
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).	

Keystone Resources of Concern		Life History and Habitat Structure Requirements ==➔ (Objectives)	Other Benefiting Species
Focal Species or Focal Group	**Habitat Type =➔ (Goals)**		
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.	
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.**	

Keystone Resources of Concern		Life History and Habitat Structure Requirements ==➔ (Objectives)	Other Benefiting Species
Focal Species or Focal Group	**Habitat Type =➔ (Goals)**		
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.
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.	

Keystone Resources of Concern		Life History and Habitat Structure Requirements ==➔ (Objectives)	Other Benefiting Species
Focal Species or Focal Group	**Habitat Type =➔ (Goals)**		
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,;
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.	

Keystone Resources of Concern		Life History and Habitat Structure Requirements ==➔ (Objectives)	Other Benefiting Species
Focal Species or Focal Group	**Habitat Type =➔ (Goals)**		
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.	
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.
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..	

Keystone Resources of Concern		Life History and Habitat Structure Requirements ==➔ (Objectives)	Other Benefiting Species
Focal Species or Focal Group	**Habitat Type =➔ (Goals)**		
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.	
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.	

Keystone Resources of Concern		Life History and Habitat Structure Requirements ==➔ (Objectives)	Other Benefiting Species
Focal Species or Focal Group	**Habitat Type =➔ (Goals)**		
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 $\geq$ 4 gm/m^2.	
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.	

Keystone Resources of Concern		Life History and Habitat Structure Requirements ==➔ (Objectives)	Other Benefiting Species
Focal Species or Focal Group	**Habitat Type =➔ (Goals)**		
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 $\geq$ 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

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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						
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						

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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			
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			

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SHOREBIRDS (cont.)														
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			
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			

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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												
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												

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LANDBIRDS (cont.)														
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												
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												

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LANDBIRDS (cont.)														
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						
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												

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LANDBIRDS (cont.)														
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												
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					

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LANDBIRDS (cont.)														
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					
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												

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LANDBIRDS (cont.)														
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						
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						

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MAMMALS (cont.)														
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													
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													

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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						
Four-toed salamander *Hemidactylium scutatum*	Yr							2						
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													

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AMPHIBIANS (cont.)														
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						
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						

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REPTILES (cont.)														
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						
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						

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FISH (cont.)														
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						
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													

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FISH (cont.)														
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*														
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				

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FISH (cont.)														
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*														
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													

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SHELLFISH (cont.)														
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						
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						

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INVERTEBRATES (cont.) (730+ species documented only a few are listed)														
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						
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													

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)														
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						
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						

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]
Honey vertigo								2						
Northern lance mussel								2						
FRESHWATER MUSSELS (cont.) (Unknown – No Inventories or Research ever conducted on Refuge)														
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						
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										

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]
PLANTS (cont.)														
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—Bee Keeping . . . E-1

Finding of Appropriateness—Camping . . . E-3

Finding of Appropriateness—Commercial Fishing and Crabbing . . . E-5

Finding of Appropriateness—Dog Walking (recreational and commercial) . . . E-7

Finding of Appropriateness—Furbearer Management . . . E-9

Finding of Appropriateness—Geocaching and Metal Detecting . . . E-11

Finding of Appropriateness—Horseback Riding . . . E-13

Finding of Appropriateness—Non-Service Competitive and Non-Competitive Events . . . E-15

Finding of Appropriateness—Off-road Bicycling/Mountain Bicycling . . . E-17

Finding of Appropriateness—Recreational Use of Off-road Vehicles . . . E-19

Finding of Appropriateness—Operation of Model Planes and Boats on the Refuge . . . E-21

Finding of Appropriateness—Organized or Facility-supported Picnicking . . . E-23

Finding of Appropriateness—Rollerblading and Ice Skating . . . E-25

Finding of Appropriateness—Swimming and Sunbathing . . . E-27

Finding of Appropriateness—Cooperative Farming . . . E-29

Finding of Appropriateness—Commercial Wildlife and Nature Photography . . . E-33

Compatibility Determination—Commercial Wildlife and Nature Photography . . . E-35

Finding of Appropriateness—Commercially Guided Wildlife Observation . . . E-41

Compatibility Determination—Commercially Guided Wildlife Observation . . . E-43

Finding of Appropriateness—Field Trails for Dogs . . . E-55

Compatibility Determination—Field Trials for Dogs . . . E-57

Finding of Appropriateness—Commercial Forest Management . . . E-61

Compatibility Determination—Commercial Forest Management . . . E-63

Finding of Appropriateness—Research by Non-Service Personnel . . . E-73

Compatibility Determination—Research by Non-Service Personnel . . . E-77

Finding of Appropriateness—Mosquito Management . . . E-85

Compatibility Determination—Mosquito Management . . . E-87

Finding of Appropriateness—Turtle Harvesting (Trapping) . . . E-107

Compatibility Determination—Turtle Harvesting (Trapping) . . . E-109

Compatibility Determination—Federal Aviation Administration (FAA) Vortac Tower . . . E-113

Compatibility Determination—Recreational Freshwater and Saltwater Fishing and Crabbing . . . E-117

Compatibility Determination—Hunting . . . E-127

Compatibility Determination—Wildlife Observation, Wildlife Photography, Environmental Education, and Interpretation . . . E-169

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FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Prime Hook National Wildlife Refuge

Use: Bee Keeping

This form is not required for wildlife-dependent recreational uses, 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, 603 FW 1, 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: 2/13/13

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: 3/11/13

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: Bee Keeping

NARRATIVE:

The National Wildlife Refuge System Improvement Act of 1997 enumerated six wildlife-dependent recreational uses of refuges that are considered priorities for the National Wildlife Refuge System (Refuge System). 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."

Bee keeping manages colonies of the European honey bee, which is an exotic species. Colonies have been declining over the past 30 years due to mites, disease, habitat loss, and a decline in beekeepers. However, there are about 4,000 species of native bees north of Mexico, of which 200 have been found in Delaware. Native bees are a vital component for the pollination of native flora, which are four times more attractive to bees than non-native plants. Currently, much effort is being given to promote these native habitats, particularly in Delaware *(http://dda.delaware.gov/plantind/pollinator.shtml;* accessed January 2013).

Bee keeping has been allowed on the refuge in the past; however, it is not a priority public use. It does not, as a stand alone activity, contribute to the fulfillment of refuge purposes, is not consistent with goals and objectives in any refuge management plan, is contrary to the Biological Integrity, Diversity, and Environmental Health policy by promoting an exotic species, 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.

Bee keeping 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 Refuge System mission.

5 RM 17, Commercial and Economic Uses on National Wildlife Refuges

Due to these reasons, this activity will materially interfere with and detract from the mission of the Refuge System and purposes for which Prime Hook NWR was established. In addition, this activity will not fulfill one or more purposes of the refuge or the Refuge System. The use of bee keeping is therefore determined to be inappropriate.

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FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Prime Hook National Wildlife Refuge

Use: Camping

This form is not required for wildlife-dependent recreational uses, 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, 603 FW 1, 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: 2/13/13

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: 3/11/13

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: 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.

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FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Prime Hook National Wildlife Refuge

Use: Commercial Fishing and Crabbing

This form is not required for wildlife-dependent recreational uses, 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, 603 FW 1, 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: 2/13/13

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: 3/11/13

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 (Refuge System) mission.

5 RM 17, Commercial and 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.

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FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Prime Hook National Wildlife Refuge

Use: Dog Walking (recreational and commercial)

This form is not required for wildlife-dependent recreational uses, 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, 603 FW 1, 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: 2/13/13

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: 3/11/13

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: Dog Walking (recreational and commercial)

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 reexamined and evaluated our existing policy on dog walking, which includes commercial 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 and 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 and 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 throughout the year 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. For similar reasons, this determination also does not extend to the use of service dogs, which are both more uncommon and more tightly controlled than is usual for "recreational or commercial" dog walkers, and which may be necessary to enable certain individuals to participate in permitted refuge activities. Finally, it does not extend to the use of search or rescue dogs by law enforcement personnel, which is not part of this use.

LITERATURE CITED

See CCP Bibliography.

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FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Prime Hook National Wildlife Refuge

Use: Furbearer Management

This form is not required for wildlife-dependent recreational uses, 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, 603 FW 1, 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: 2/13/13

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: 3/11/13

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: Furbearer Management

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."

Furbearer management is conducted on national wildlife refuges as a management tool primarily by state-licensed trappers to manage habitat and maintain the predator-to-prey balance. Furbearer management becomes necessary when a furbearer threatens a particular habitat type, such as an impoundment, by burrowing into the dikes and enabling water to flow out of an impoundment. This destroys habitat that the refuge creates and maintains for waterfowl and other species of waterbirds that are mentioned in the refuge's purposes. Furbearer management was at one time used to eliminate or reduce damage to refuge resources caused by overabundant species such as muskrats and beavers. Although trapping was once permitted on the refuge, recent changes from saltwater intrusion to the network of wetlands found on the refuge currently have resulted in habitat conditions that do not support fur bearer populations abundant enough to require fur bearer management. Other species that could be involved in such a program could include fox or coyote, both of which can devastate bird populations. Since trappers have the potential to profit financially from this use the refuge is required to complete a finding of appropriateness.

Fur bearer trapping 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 (Refuge System) mission.

5 RM 17, Commercial and Economic Uses on National Wildlife Refuges
> Furbearer trapping has been allowed on the refuge in the past; however, it is not a priority public use. A trapping plan was developed in 1987. At this time it does not, as a standalone activity, contribute to the fulfillment of refuge purposes, is no longer consistent with goals and objectives in any refuge management plan, 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.

Due to these reasons, this activity would materially interfere with, and detract from, the mission of the Refuge System and purposes for which Prime Hook NWR was established. The use of commercial furbearer trapping is, therefore, determined to be inappropriate at this time. If furbearer populations rebound or the evasive species such as nutria become established on the refuge, the Service may reevaluate this decision.

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FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Prime Hook National Wildlife Refuge

Use: Geocaching and Metal Detecting

This form is not required for wildlife-dependent recreational uses, 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, 603 FW 1, 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: 2/13/13

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: 3/11/13

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.

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FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Prime Hook National Wildlife Refuge

Use: Horseback Riding

This form is not required for wildlife-dependent recreational uses, 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, 603 FW 1, 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: 2/13/13

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: 3/11/13

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: Horseback Riding

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. 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.

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FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Prime Hook National Wildlife Refuge

Use: Non-Service Competitive and Non-Competitive Events (weddings, cross country races, volksmarch walks, running events, family reunions, fishing derbies, bicycle races, etc.)

This form is not required for wildlife-dependent recreational uses, 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, 603 FW 1, 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: 2/13/13

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: 3/11/13

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 and 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 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. 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 National Wildlife 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.

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FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Prime Hook National Wildlife Refuge

Use: Off-road Bicycling/Mountain Bicycling

This form is not required for wildlife-dependent recreational uses, 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, 603 FW 1, 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: 2/13/13

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: 3/11/13

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 bicycling/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 conflict with other users which carries the 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.

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02/06

FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Prime Hook National Wildlife Refuge

Use: Recreational Use of Off-road Vehicles

This form is not required for wildlife-dependent recreational uses, 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, 603 FW 1, 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: 2/13/13

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: 3/11/13

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: Recreational Use of 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."

The recreational 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 recreational use of off-road vehicles is determined to be inappropriate.

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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 form is not required for wildlife-dependent recreational uses, 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, 603 FW 1, 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: 2/13/13

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: 3/11/13

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: Operation of Model Planes and Boats on the Refuge

NARRATIVE:

The National Wildlife Refuge System Improvement Act of 1997 (P.L. 105-57) identifies sixpriority 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.

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FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Prime Hook National Wildlife Refuge

Use: Organized or Facility-supported Picnicking

This form is not required for wildlife-dependent recreational uses, 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, 603 FW 1, 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: 2/13/15

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: 3/11/13

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.

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FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Prime Hook National Wildlife Refuge

Use: Rollerblading and Ice Skating

This form is not required for wildlife-dependent recreational uses, 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, 603 FW 1, 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: 2/13/13

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: 3/11/13

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: 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.

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FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Prime Hook National Wildlife Refuge

Use: Swimming and Sunbathing

This form is not required for wildlife-dependent recreational uses, 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, 603 FW 1, 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: 2/13/13

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: 3/11/13

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: 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.

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FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Prime Hook National Wildlife Refuge

Use: Cooperative Farming

This form is not required for wildlife-dependent recreational uses, 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, 603 FW 1, 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: 2/13/13

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: 3/11/13

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 Farming

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. Therefore, cooperative farming no longer provides the benefits it once did.

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 for 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 approximately 8,000 acres of 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 to 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 Bird Conservation Region (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 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 resume 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 reevaluate 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.

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FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Prime Hook National Wildlife Refuge

Use: Commercial Wildlife and Nature Photography

This form is not required for wildlife-dependent recreational uses, 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, 603 FW 1, 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: 2/13/13

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: 3/11/13

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 National Wildlife Refuge System (Refuge System), natural habitats, and wildlife.

Commercial photography is not identified as a priority public use of the 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 Refuge System mission.

8 RM 16, Audio Visual Productions

5 RM 17, Commercial and 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 National Wildlife Refuge (NWR, refuge) was established. In addition, this activity will fulfill one or more purposes of the refuge or the 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 will contribute 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 (SUP) 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 SUP 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 SUP 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 final 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 the CCP). We do not expect this activity to considerably alter the demographic of economic characteristics of the local community. All 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 (USFWS 2007).

Commercial photography is expected to have negligible adverse short-term, long-term, or cumulative impacts on secretive marsh and waterbirds, and waterfowl. With the addition of new trails, commercial photography has the potential to increase disturbance to waterfowl, secretive marsh birds and waterbirds. However, a majority of the photography takes place along the four State roads minimizing the impact to the refuge habitats. To minimize waterfowl disturbance from this use, the refuge has designated approximately 3,185 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 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.While developing this commpatibality determination, we evaluated the use 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 from one-half hour before sunrise to one-half hour after sunset. Using existing roads will minimize impacts to refuge resources. Moderate beneficial impacts are expected by providing additional opportunities and general appreciation of nature. Some conflict between refuge users is expected to result in short-term moderate adverse impacts, which will be managed through seasonal closures. These seasonal closures are highlighted below and apply mostly to non-consumptive users during the hunting season. Other seasonal closures are in place to minimize wildlife disturbance.

(a) Designated beach dunes and overwash areas: Open year-round with seasonal closures from March 1 through September 1 due to nesting State-endangered least terns and American oystercatchers, and the potential for use by federally threatened piping plovers. Areas may be reopened if no nesting activity occurs or when nesting ends for the season.

(b) Deep Branch Road Trail (includes Goose and Flaxhole Ponds), Eastern Prime Hook Creek (from Foord's Landing to the headquarters ramp), and hiking trail on Fowler Beach Road (southside in Unit II): Open with seasonal closures of every day from September 1 through March 15 and if necessary during the snow goose conservation order or turkey hunting seasons. If and when the photography blind is available on the southside of Fowler Beach Road, this portion of the trail will be open year-round and open every Sunday during the hunting season.

(c) Headquarters area (includes Turkle and Fleetwood Ponds): Open 363 days a year (closed for two deer hunts) and portions may be closed for turkey hunts.

(d) The northern portion of Unit IV (includes trail overlooking Vergie's Pond): Open with a seasonal closure from the Monday before Thanksgiving through March 15 and if necessary during the snow goose conservation order hunting season.

(e) Hiking Trails on Fowler Beach Road (northside in Unit I), Prime Hook Road, and Slaughter Beach Road and Slaughter Canal: Opportunities available year-round but only open every Sunday during the hunting season.

(f) Roadside pull-offs and water control structures, fishing areas at Petersfield Ditch, Slaughter Canal, and Cods Road, and western Prime Hook Creek (from Foord's Landing to Waples Pond): Open year-round.

PUBLIC REVIEW AND COMMENT:

As part of the CCP process for Prime Hook NWR, this compatibility determination underwent extensive public review during an 89-day public review and comment period on the draft CCP/EIS from May 31 to August 27, 2012, and a 30-day public review period on the final CCP/EIS from December 28, 2012 to January 28, 2013. We announced the public review and comment periods in the *Federal Register* and through local media announcements. During the comment and review periods, we did not receive any comments on commercial wildlife and nature photography.

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 Refuge System and refuge goals and objectives and to minimize or exclude adverse impacts as described above, the activity will be subject to the following stipulations:

(1) Only commercial photography in support of conservation, refuge purposes, the 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 SUP as provided by the refuge manager. The SUP will detail who, what, where, when, why, and how the commercial operation will be conducted.

(3) Alterations to any vegetation are prohibited.

(4) Permittee will be required to minimize potential impacts to refuge visitors and natural and/or cultural resources within the refuge.

(5) Permittee is responsible for acquiring and/or renewing any necessary State and Federal permits prior to beginning or continuing their project.

(6) 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.

(7) 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.

(8) Permittee will clean up all sites of trash and litter to the satisfaction of the refuge manager.

(9) 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 by the refuge 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 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, as here, that the use contributes to the achievement of the national wildlife refuge purposes or the Refuge System mission.

8 RM 16, Audio Visual Productions

5 RM 17, Commercial and 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) _____ 2/13/13 (Date)

CONCURRENCE:

Regional Chief: _____ (Signature) _____ 3/13/2013 (Date)

MANDATORY 10-YEAR REEVALUATION DATE: 3/13/2023

FWS Form 3-2319
02/06

FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Prime Hook National Wildlife Refuge

Use: Commercially Guided Wildlife Observation

This form is not required for wildlife-dependent recreational uses, 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, 603 FW 1, 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: 2/13/13

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: 3/11/13

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 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.

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 use of the National Wildlife Refuge System (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 Refuge System mission.

5 RM 17, Commercial and 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 National Wildlife Refuge (NWR, refuge) was established. In addition, this activity will fulfill one or more purposes of the refuge or the Refuge System.

COMPATIBILITY DETERMINATION

USE:

Commercially Guided Wildlife Observation

REFUGE NAME:

Prime Hook National Wildlife Refuge (NWR, 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 (SUPs) 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 will contribute to priority public uses.

(b) Where would the use be conducted?
The use will be conducted within the refuge's 10,144 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. In Unit I, two trails provide 1.1 miles of hiking opportunities and associated recreation.

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. In Unit II, one trail provides 0.5 miles of hiking opportunites and associated recreation.

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 6 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 and 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; and wildlife observation and photography opportunities through special events, programs, and benches along hiking trails. The areas 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. In Unit III, 10 trails provide 8.1 miles of hiking opportunities and associated recreation.

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. In Unit IV, one trail provides 0.2 miles of hiking opportunities and associated recreation.

(c) When would the use be conducted?
Opportunities for commercially guided wildlife observation 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 from one-half hour before sunrise to one-half hour after sunset. Using existing roads will minimize impacts to refuge resources. Moderate beneficial impacts are expected. Some conflict between refuge users is expected to result in short-term moderate adverse impacts, which will be managed through seasonal closures. These seasonal closures are highlighted below and apply mostly to non-consumptive users during the hunting season. Other seasonal closures are in place to minimize wildlife disturbance.

(1) Designated beach dunes and overwash areas: Open year-round with seasonal closures from March 1 through September 1 due to nesting State-endangered least terns and American oystercatchers, and the potential for use by federally threatened piping plovers. Areas may be reopened if no nesting activity occurs or when nesting ends for the season.

(2) Deep Branch Road Trail (includes Goose and Flaxhole Ponds), Eastern Prime Hook Creek (from Foord's Landing to the headquarters ramp), and hiking trail on Fowler Beach Road (southside in Unit II): Open with seasonal closures of every day from September 1 through March 15 and if necessary during the snow goose conservation order or turkey hunting seasons. If and when the photography blind is available on the southside of Fowler Beach Road, this portion of the trail will be open year-round and open every Sunday during the hunting season.

(3) Headquarters area (includes Turkle and Fleetwood Ponds): Open 363 days a year (closed for two deer hunts) and portions may be closed for turkey hunts.

(4) The northern portion of Unit IV (includes trail overlooking Vergie's Pond): Open with a seasonal closure from the Monday before Thanksgiving through March 15 and if necessary during the snow goose conservation order hunting season.

(5) Hiking Trails on Fowler Beach Road (northside in Unit I), Prime Hook Road, and Slaughter Beach Road and Slaughter Canal: Opportunities available year-round but only open every Sunday during the hunting season.

(6) Roadside pull-offs and water control structures, fishing areas at Petersfield Ditch, Slaughter Canal, and Cods Road, and western Prime Hook Creek (from Foord's Landing to Waples Pond): 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 Foord's Landing, at suitable sites on Goose and Flaxhole Ponds, and at boat ramps at Turkle and Fleetwood Ponds. Non-motorized boaters are encouraged to do their canoeing or kayaking within 2-hour window on either side of high tides for best access.

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. Adaptive management is necessary if Fowler Beach Road, from Slaughter Canal to its terminus at the Delaware Bay, is abandoned by Delaware Department of Transportation (DelDOT) and donated to the Service. If, upon DelDOT's removal of the existing layer of asphalt overlying unconsolidated fill, the walking trail will serve its purpose of public use until marsh vegetation and hydrologic function reclaim the trail and the formally bisected habitat (Units I and II) function as one unit. When conditions are deemed unsafe, access will not be permitted to Fowler Beach for public use opportunities such as wildlife observation, wildlife photography, and fishing.

In addition to published 50CFR regulations and State regulations, refuge-specific regulations also apply for Wildlife Observation and Photography, Environmental Education and 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 and Fleetwood Ponds.
   (c) Manual propulsion only on Goose and Flaxhole Ponds.
   (d) Air thrust boats and jet skis are not permitted.
   (e) A "Slow No Wake" zone has been established on the Headquarters Canal and Slaughter Canal.

(3) Areas may be closed on the refuge without warning.

(4) Visitors must stay on the designated trail routes and areas.

(5) Opportunities for commercially guided wildlife observation 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 from one-half hour before sunrise to one-half hour after sunset. Using existing roads will minimize impacts to refuge resources. Moderate beneficial impacts are expected. Some conflict between refuge users is expected to result in short-term moderate adverse impacts, which will be managed through seasonal closures. These seasonal closures are highlighted below and apply mostly to non-consumptive users during the hunting season. Other seasonal closures are in place to minimize wildlife disturbance.

   (a) Designated beach dunes and overwash areas: Open year-round with seasonal closures from March 1 through September 1 due to nesting State-endangered least terns and American oystercatchers, and the potential for use by federally threatened piping plovers. Areas may be reopened if no nesting activity occurs or when nesting ends for the season.

   (b) Deep Branch Road Trail (includes Goose and Flaxhole Ponds), Eastern Prime Hook Creek (from Foord's Landing to the headquarters ramp), and hiking trail on Fowler Beach Road (southside in Unit II): Open with seasonal closures of every day from September 1 through March 15 and if necessary during the snow goose conservation order or turkey hunting seasons. If and when the photography blind is available on the southside of Fowler Beach Road, this portion of the trail will be open year-round and open every Sunday during the hunting season.

   (c) Headquarters area (includes Turkle and Fleetwood Ponds): Open 363 days a year (closed for two deer hunts) and portions may be closed for turkey hunts.

(d) The northern portion of Unit IV (includes trail overlooking Vergie's Pond): Open with a seasonal closure from the Monday before Thanksgiving through March 15 and if necessary during the snow goose conservation order hunting season.

(e) Hiking Trails on Fowler Beach Road (northside in Unit I), Prime Hook Road, and Slaughter Beach Road and Slaughter Canal: Opportunities available year-round but only open every Sunday during the hunting season.

(f) Roadside pull-offs and water control structures, fishing areas at Petersfield Ditch, Slaughter Canal, and Cods Road, and western Prime Hook Creek (from Foord's Landing to Waples Pond): 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 7:30 a.m. to 4 p.m. 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, 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 (CCP). 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 an SUP, if necessary. Compliance with the terms of the SUP 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 final 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 6 or more cyclists or groups of 15 or more pedestrian travelers will require an SUP.

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 the CCP). No adverse impacts are foreseen to be associated with changes in the community character or demographic composition.

This activity will 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 will 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 due to the low level of use authorized.

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, Broadkill Beach Road, and Slaughter Beach Road to facilitate wildlife observation/photography activities because existing interior roads and access routes will be utilized.

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 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 (USFWS 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 3,185 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 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 will be adjusted as needed to eliminate or minimize each conflict and provide quality wildlife-dependent recreational opportunities.

PUBLIC REVIEW AND COMMENT:

As part of the CCP process for Prime Hook NWR, this compatibility determination underwent extensive public review during an 89-day public review and comment period on the draft CCP/EIS from May 31 to August 27, 2012, and a 30-day public review period on the final CCP/EIS from December 28, 2012 to January 28, 2013. We announced the public review and comment periods in the *Federal Register* and through local media announcements. During the comment and review periods, we did not receive any comments on commercially guided wildlife observation.

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 SUP 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) 2/13/13 (Date)

CONCURRENCE:

Regional Chief: _____ (Signature) 3/13/2013 (Date)

MANDATORY 10-YEAR REEVALUATION DATE: 3/13/2023

ATTACHMENT:

Commercial Wildlife Observation Guide Program Stipulations on Prime Hook NWR

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 1 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. 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 percent 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.americancanoe.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. The license shall be valid for the area of operations and type(s) of vessel operated. This license applies to guides transporting patrons by water.

(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 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 U.S. Coast Guard-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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02/06

FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Prime Hook National Wildlife Refuge

Use: Field Trails for Dogs

This form is not required for wildlife-dependent recreational uses, 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, 603 FW 1, 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: 2/13/13

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: 3/11/13

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: Field Trials for Dogs

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. 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 National Wildlife Refuge System (Refuge System) or purposes for which Prime Hook National Wildlife Refuge (NWR, refuge) was established. In addition, this activity will fulfill one or more purposes of the refuge or the Refuge System by providing for a better hunting experience.

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 1 to 3 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 at 8 hrs/day at $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 will 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 will be during spring and early summer. Limited impacts to nesting birds could occur as described below, but will be relatively minor because the dog training will be limited to a confined area and will 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:

As part of the CCP process for Prime Hook NWR, this compatibility determination underwent extensive public review during an 89-day public review and comment period on the draft CCP/EIS from May 31 to August 27, 2012, and a 30-day public review period on the final CCP/EIS from December 28, 2012 to January 28, 2013. We announced the public review and comment periods in the *Federal Register* and through local media announcements. During the comment and review periods, we did not receive any comments on field trials for dogs.

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 Refuge System or the purpose for which the refuge was established.

SIGNATURE:

Refuge Manager: _____ (Signature) 2/13/13 (Date)

CONCURRENCE:

Regional Chief: _____ (Signature) 3/13/2013 (Date)

MANDATORY 10-YEAR REEVALUATION DATE: 3/13/2023

LITERATURE CITED:

See CCP Bibliography.

FWS Form 3-2319
02/06

FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Prime Hook National Wildlife Refuge

Use: Commercial Forest Management

This form is not required for wildlife-dependent recreational uses, 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, 603 FW 1, 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: 2/13/13

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: 3/11/13

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: 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 (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 National Wildlife Refuge (NWR, 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.

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 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 will 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 (percent of stand)
- Basal area
- Stocking rate per acre
- Vines in overstory (percent of area)
- Number of large trees (greater than 35 inch dbh) per acre
- Mid-story canopy (percent of stand)
- Vines in midstory (percent of area)
- Understory canopy cover (percent of area)
- Ground cover occupancy
- Regeneration of hard mast tree species (oaks and hickories) of inventory plot (percent 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 will 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 will be inventoried and current conditions would be monitored and then compared to desirable stand conditions. Forest inventory data will also be used to design appropriate management prescriptions required to meet the habitat objectives of our CCP/habitat management plan (HMP). It is anticipated that some site-specific forest management actions will 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) will 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 ensure 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 (approximately 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 will 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 will be instrumental in addressing the following DFS 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 percent of management units in mast-producing stands.

Mast-producing stands include oak species greater than 40 years old, sawtimber-size hardwood types with 50 percent of the basal area in oak, and any cover type with more than 30 square feet of basal area in oak and sawtimber (McShea and 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 will be no construction of any new facilities or improvements on refuge property for this use.

Refuge staff will 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 will be incurred for planning and conducting forest management during the years that such services will 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 final CCP/EIS.

The operation of heavy equipment for forest management over refuge roads and through natural habitats can 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 can result in the temporary removal of vegetation. Establishment of weedy or undesirable vegetation may also be a possible impact in regenerating managed stands, whether natural or planted, and will require control through mechanical or chemical means. Direct adverse effects are of short duration as vegetation grows quickly during the growing season.

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

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 will be temporarily closed. Only a small proportion of the refuge will 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 will be addressed in environmental education and interpretation programs about the refuge's forest management program. Furthermore, forest management activities will have some direct beneficial impact on the socioeconomic environment of the region, as many of these techniques will 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 will 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 will also increase. These are all anticipated desirable outcomes that 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 forested 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 CCP process for Prime Hook NWR, this compatibility determination underwent extensive public review during an 89-day public review and comment period on the draft CCP/EIS from May 31 to August 27, 2012, and a 30-day public review period on the final CCP/EIS from December 28, 2012 to January 28, 2013. We announced the public review and comment periods in the *Federal Register* and through local media announcements. During the comment and review periods, we received one comment on commercial forest management (see appendix M in the inal CCP). The commenter felt that active forest management is not necessary on the refuge. We respectfully disagreed with this comment because we believe that active forest management, including commercial forest management, is necessary to help achieve our habitat goals and will benefit migratory birds and Delmarva fox squirrel. We did not make any changes to this compatibility determination.

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 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 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 per inch of stump diameter up to 22 inches and $10 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 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) 2/13/13 (Date)

CONCURRENCE:

Regional Chief: _____ (Signature) 3/13/2013 (Date)

MANDATORY 10-YEAR REEVALUATION DATE: 3/13/2023

LITERATURE CITED:

See CCP Bibliography.

FINDING OF APPROPRIATENESS OF A REFUGE USE

FWS Form 3-2319
02/06

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 form is not required for wildlife-dependent recreational uses, 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, 603 FW 1, 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: 2/13/13

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: 3/11/13

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 (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 National Wildlife Refuge (NWR, refuge) 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 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 be required to 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 in the compatibility determination 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 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 special use permits (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 Refuge 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 10 to 20 SUPs 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 the Delaware Department of Natural Resources and Conservation (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, and will require a separate determination of their compatibility. 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 Refuge System mission or purposes of the refuge. Inherent in fulfilling the Refuge 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 will be dependent on the particular study being conducted and could occur in a variety of habitat types. Access would be restricted by SUP 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 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 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 will 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 at $12/day	$360
	Vehicle or boat	30 days at $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. These activities have been authorized in the past and Service personnel have not observed any serious impacts to refuge resources.

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 as none have been observed in the past; and the refuge manager can control the potential of long-term impacts through SUPs. Permits for multi-year research projects are renewed annually, providing the opportunity for an analysis of any impacts before issuing a SUP renewal.

Cumulative impacts:

Cumulative impacts will 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-Service research, in conjunction with any Service-sponsored research also taking place. However, no cumulative impacts are expected because refuge manager can control the potential for cumulative impacts through SUPs, 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 SUP 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:

As part of the CCP process for Prime Hook NWR, this compatibility determination underwent extensive public review during an 89-day public review and comment period on the draft CCP/EIS from May 31 to August 27, 2012, and a 30-day public review period on the final CCP/EIS from December 28, 2012 to January 28, 2013. We announced the public review and comment periods in the *Federal Register* and through local media announcements. During the comment and review periods, we did not receive any comments on the compatibility determination for research by non-Service personnel.

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 NWR 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 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 Refuge System mission or the purposes for which the refuge was established.

SIGNATURE:

Refuge Manager: _____ (Signature) 2/13/13 (Date)

CONCURRENCE:

Regional Chief: _____ (Signature) 3/13/2013 (Date)

MANDATORY 10-YEAR REEVALUATION DATE: 3/13/2023

FWS Form 3-2319
02/06

FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Prime Hook National Wildlife Refuge

Use: Mosquito Management

This form is not required for wildlife-dependent recreational uses, 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, 603 FW 1, 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: 2/13/13

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: 3/11/13

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: 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 (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 *Guidance for Mosquito Management on National Wildlife Refuges* (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, DMCS), 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). The State has documented mosquito-borne disease within the State's mosquito population through testing of mosquito pools, sentinenal chickens, wild birds, and human cases. Due to the potential health threat of mosquito borne disease, mosquito control is found to be appropriate.

COMPATIBILITY DETERMINATION

USE:

Mosquito Management

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.

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. Interim Guidance for Mosquito Management on National Wildlife Refuges (USFWS 2005) 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 the interim guidelines have been incorporated into this Compatibility Determination (CD).

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 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.

Areas Currently Permitted for Larvicide Treatments
In accordance with an annual larvicide special use permit (SUP), up to eight larvicide applications per year (by ground or air) can be made to any given marsh site, involving the following areas:

- **Unit I** – No larviciding is allowed, but none was requested by the DMCS. OMWM work was undertaken in Unit I in the 1990s with additional treatments in the early 2000s. Reduced salt marsh mosquito production in this unit is low enough that the DMCS has had no need to request any larviciding in this unit for a decade or so.

- **Unit II** – Up to 1,637 acres within what used to be, until about 2009, a heavily-vegetated freshwater wetland impoundment (prior to recent bayfront breaching) can be larvicided. However, relatively little larviciding actually occurred in this unit during the past decade, due to its former freshwater impoundment habitat conditions having reduced salt marsh mosquito production. The impounding of this unit did not eliminate all salt marsh mosquito production, but it occurred in a more diffuse manner over widespread areas within the unit, that in aggregate can occasionally produce large numbers of adult mosquitoes.

- **Unit III** – Up to 2,117 acres within what used to be, until about 2009, a heavily-vegetated freshwater wetland impoundment (prior to recent bayfront breaching) can be larvicided. But for reasons similar to Unit II above, relatively little larviciding actually occurred within this unit for the past decade.

- **Unit IV** – This unit received extensive OMWM treatment in the late 1980s and early 1990s, which greatly reduced saltmarsh mosquito production. DMCS is currently permitted to treat up to 371 acres that were missed by the original OMWM work, or which were not mosquito production areas at the time of treatment, but have since naturally become such. Approximately 90 acres of formerly OMWM-treated areas are currently dysfunctional requiring maintenance, for a total of 461 acres that are currently permitted for larvicide treatments.

Areas Currently Permitted for Adulticide Treatments
In accordance with an annual adulticide SUP, DMCS is currently permitted to aerially adulticide over a 600 footwide strip of refuge lands immediately behind or landward of the three bayfront communities of Slaughter Beach, Primehook Beach, and Broadkill Beach, up to six times per year for any given site. The northern portion of this strip in Unit I, located behind the south end of Slaughter Beach, totals 58 acres; the southern portion of this strip in Units II, III and IV, located behind Primehook Beach and Broadkill Beach, totals an additional 169 acres, for a total of 227 acres.

Larvicide use on-refuge
From 2007 to 2011, aerial larvicide applications on-refuge (by fixed-wing aircraft or helicopter) averaged 1.2 applications per year (range = 0 to 3 applications), and involved an average total of 188 acres per year (range = 0 to 880 acres. Ground larvicide applications on-refuge (by hand or backpack sprayer) averaged 4.6 applications per year (range from 2 to 8 applications), and involved an average total of 11 acres per year (range = 5 to 19 acres).

Adulticide use on-refuge
Aerial adulticide applications on-refuge (by fixed-wing aircraft or helicopter) consistently averaged 1 application event per year over the 5-year period examined (from 2007-2011), involving an average of 227 acres per application event (range = 55 to 227 acres).

(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 SUP, in accordance with Service Interim Guidance for Mosquito Management on National Wildlife Refuges (USFWS 2005), as well as the Biological Integrity Diversity and Environmental Health (BIDEH) policy (USFWS 2001).

(d) How will the use be conducted?
We will follow the "Interim Guidance for Mosquito Management on National Wildlife Refuges," prepared in spring 2005. This document provides refuges with 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. 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 should document composition to species 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 (off-refuge) or other reservoir hosts for levels of disease activity (pathogens or antibodies). High levels of pathogenic activity would indicate higher health risks.

DMCS representatives would officially identify an elevated risk for mosquito-borne disease based on documented mosquito vector population density and 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 Environmental Protection Agency (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 to 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/carbon dioxide traps, gravid traps, resting boxes, 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 SUP.

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.
- 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*; accessed January 2013).

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 effects of adulticides on non-target terrestrial organisms, and the potential effects on ecological processes, the Service will permit the use of the adulticide, naled, as a management tool once the DMCS surveillance program has detected a mosquito-borne human health threat on the refuge or within the flight range of vector mosquitoes, the average of which, according to the Rutgers Center for Vector Biology, is generally considered to be less than 5 miles for the eastern saltmarsh mosquito, *Ochlerotatus sollicitans.* To date, the Service has never received any real-time data indicating a mosquito-borne public health threat has existed or presently exists in or around the refuge.

Open Marsh Water Management

DMCS, 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 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 percent 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 percent 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 1930s 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 plants by creating areas of exposed soils that 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, alter 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 1930s, indicate that marshes with OMWM treatments and grid ditched marshes may be accreting at different rates (Kevin Holcomb, personal communication). 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." Salt marsh sharp-tailed sparrow is described as vulnerable on the International Union for Conservation of Naure 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 for further discussion of sea level rise). 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 3 to 5 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 sea level rise.

Integrated Pest Management(IPM) Approach

DMCS currently uses thresholds to determine how, when, and where to conduct mosquito control treatments. Mosquito control will be conducted using a tiered risk-assessment decision-making process. The threshold for adulticide application will require revision under the mosquito management plan to bring it in line with refuge guidelines and policies.

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 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 BIDEH Policy (USFWS 2001), Appropriate Refuge Uses Policy (USFWS 2006a), Compatibility Policy (USFWS 2000), the mission of the Refuge System (USFWS 2006b), and the purposes for which Prime Hook National Wildlife Refuge was established. Based on these Service mandates, we have reduced the use of adulticides on the refuge, permitting the use of adulticides as a management tool once the DMCS surveillance program has detected a mosquito-borne human health threat on the refuge or within the flight range of vector mosquitoes, the average of which, according to the Rutgers Center for Vector Biology, is generally considered to be less than 5 miles for the eastern salt marsh mosquito, *Ochlerotatus sollicitans.* 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 to 2009, although the mortality rate for those contracting the disease is high. The most recent EEE activity in humans in Delaware was in the 1970s, when three 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

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. The primary vectors of WNV to humans in Delaware are *Culex pipiens* and the subspecies *C. quinquefasciatus* in freshwater, and *Culex salinarius* in salt marsh/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*; accessed January 2013).

In areas where the virus is circulating, very few mosquitoes are infected with the virus. Even if the mosquito is infected, less than 1 percent 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 percent 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;* accessed January 2013). A study published by the Center for Disease Control (CDC) in 2009 in the journal, Emerging Infectious Diseases, calculated the prevalence of WNV in the U.S. population to be approximately 1 percent, or approximately 3 million total infections during the period 1999 to 2008 (Planitzer et al. 2009).

WNV was first recognized in the U.S. 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 U.S. reported 29,532 cases during the same period, 2002 to 2008, 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 percent confidence interval: 27,100, 55,700) over the period 1979 to 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;* accessed January 2013). Therefore, as discussed above, the numbers reported in the U.S. 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 potential 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 vector of EEE to humans. The common house mosquito *(Culex pipiens)* is the suspected primary vector of WNV to humans. 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

Response to Changing Hydrological Conditions On-Refuge

- **Unit I** – Due to extensive OMWM work performed in this unit, DMCS hasn't requested a SUP to conduct larvicide treatments in this Unit. However, the recent breaching of the Delaware Bay beachfront at Unit I has caused flooding and hydrological and geomorphological changes to many of the OMWM systems that were installed, in some areas now causing these systems to become dysfunctional for purposes of larval salt marsh mosquito control. Additionally, there has been formation of new ovipositioning and larval-rearing habitats within Unit I. Tidal intrusions to the west or landward into what was primarily non-flooded upland edge areas are now occurring, creating new salt marsh mosquito production sites on-refuge. DMCS staff are now undertaking expanded surveys to determine the extentof new breeding areas. The results of this survey work could lead to the DMCS requesting, as early as 2013, a SUP for larvicide treatment in Unit I.

- **Unit II** – The current habitat conditions throughout much of Unit II, resulting from the storm-caused breaches, has converted most of this unit's former emergent vegetation wetlands into open water at high tide and a mixture of ponded water and mudflats at low tide. Mosquito production in this newly created habitat has essentially been eliminated. Tidal intrusions to the west or landward into what was primarily a non-flooded upland edge are now occurring, creating new salt marsh mosquito production sites. DMCS staff are now undertaking expanded surveys to determine the extent of new breeding areas. The results of this survey work could lead to the DMCS requesting, as early as 2013, a SUP for larvicide treatment in Unit I.

- **Unit III** – Restricted tidal flow into Unit III is occurring via culvert connections with Unit II under Primehook Beach Road. Delaware Department of Transportation (DelDOT) now has plans to increase the number of culverts or culvert sizes under Primehook Beach Road that will potentially allow more tide water exchanges between Units II and III for purposes of roadway storm relief and roadbed protection. Many of the habitat changes now occurring in Unit II are also occurring in Unit III with corresponding changes in mosquito production. DMCS staff are now undertaking expanded surveys to determine the extent of new breeding areas. The results of this survey work could lead to the DMCS requesting, as early as 2013, an SUP for larvicide treatment in Unit I.

- **Unit IV** – The DMCS will continue to treat larval salt marsh mosquito production in this Unit. However, the Service anticipates that the need for larviciding in Unit IV will slowly increase and or shift geographically over time.

As changes in salt marsh (or freshwater) mosquito production continue to unfold in Units I, II, III and IV, sea levels rise, and growing season lengthens in response to the warming climate, the Service anticipates revisions in current SUPs for larval control, reflecting the geographic shift of production areas and perhaps the intensity of mosquito production requiring revision of current stipulations, e.g., total numbers of larvicide treatments or treatment intervals. However, in an effort to minimize non-target effects on-refuge, the annual SUP for adulticide treatments will be revised to permit the use of adulticides as a management tool once the DMCS surveillance program has detected a mosquito-borne human health threat on the refuge or within the flight range of vector mosquitoes, the average of which, according to the Rutgers Center for Vector Biology, is generally considered to be less than 5 miles for the eastern saltmarsh mosquito, *Ochlerotatus sollicitans.*

AVAILABILITY OF RESOURCES:

The administration of mosquito and mosquito-borne disease management on the Prime Hook NWR unit of the Coastal Delaware NWR Complex, the following staffing costs are estimated:

Staffing Needs To Conduct Use Of Mosquito Management On Prime Hook NWR

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 pesticide use permits, 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 and 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 final 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. Three 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 second 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 three 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 reduce the use of adulticides until an elevated risk of vector-borne disease is documented. 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). Under EPA label guidance, direct toxic effects are expected to be limited to insects, only. In an effort to minimize non-target effects on-refuge, the Service will permit the use of adulticides as a management tool once the DMCS surveillance program has detected a mosquito-borne human health threat on the refuge or within the flight range of vector mosquitoes, the average of which, according to the Rutgers Center for Vector Biology, is generally considered to be less than 5 miles for the eastern salt marsh mosquito, *Ochlerotatus sollicitans.*

While the estimated increase in costs due to increasing adulticide use off-refuge is 24 percent, DMCS 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:

As part of the CCP process for Prime Hook NWR, this compatibility determination underwent extensive public review during an 89-day public review and comment period on the draft CCP/EIS from May 31 to August 27, 2012, and a 30-day public review period on the final CCP/EIS from December 28, 2012 to January 28, 2013. We announced the public review and comment periods in the *Federal Register* and through local media announcements. During the comment and review periods, we received numerous comments on mosquito management (see appendix M in the final CCP). Overall, most commenters were concerned with our proposal to not allow the use of adulticides for mosquito control, except during declared public health emergencies. They felt

that this would not adequately ensure public safety, because it was reactionary, instead of preventative. Based on these comments, we have modified this compatibility determination to allow the use of adulticides when there is a documented human disease threat, as determined by the Delaware Department of Natural Resources and Environmental Control's Mosquito Control Section.

DETERMINATION (CHECK ONE BELOW):

____ Use is not compatible

__X__ Use is compatible, with the following stipulations

STIPULATIONS NECESSARY TO ENSURE COMPATIBILITY:

General

- Except during documented human disease threats 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 is 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 on or adjacent to the refuge to identify existing health threats or document an elevated risk of human infection. Disease surveillance adjacent to the refuge should be within flight range of vector species found on the refuge, the average of which, according to the Rutgers Center for Vector Biology, is generally considered to be less than 5 miles for the eastern saltmarsh mosquito, *Ochlerotatus sollicitans.* DMCS will be responsible for monitoring disease activity in reservoir hosts for pathogens or antibodies, and/or collect adult mosquito pools for virus or any other monitoring it requires to substantiate an elevated risk of human infection 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).

Risk Assessment and Mosquito Management Thresholds

- The refuge will collaborate with DMCS 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, and will be developed with refuge staff and DMCS. Thresholds should be species and life-stage specific and be related to the refuge decision-making response matrix.

- Numerical action thresholds should be established in collaboration with DMCS and identified in the mosquito management plan.

- All decisions for chemical interventions to control mosquitoes will be based on meeting or exceeding predetermined mosquito abundance and, or disease thresholds.

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.

The Service will permit the use of naled as a management tool once the DMCS surveillance program has detected a mosquito-borne human health threat on the refuge or within the flight range of vector mosquitoes, the average of which, according to the Rutgers Center for Vector Biology, is generally considered to be less than 5 miles for the eastern salt marsh mosquito, *Ochlerotatus sollicitans*.

Monitoring and Disease Surveillance

- The use of caged sentinel chickens on the refuge for reservoir host surveillance is not permitted due to the risk of spreading disease to wild birds.

- Capture of mosquitoes and wild birds on-refuge for disease analysis will be permitted, subject to a SUP.

Sensitive Areas

- Terms and conditions of the SUP 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 Refuge System mission.

Permits

- Mosquito control will be authorized if needed and requested by DMCS through a SUP. 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 CCP.

Reducing the use of adulticides during low disease risk situations, using Methoprene products conservatively, 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 Refuge System or the purpose for which the refuge was established.

SIGNATURE:

Refuge Manager: _____ (Signature) 2/13/13 (Date)

CONCURRENCE:

Regional Chief: _____ (Signature) 3/13/2013 (Date)

MANDATORY 15-YEAR REEVALUATION DATE: 3/13/2028

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

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

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

Appendix A. **Incidence of West Nile and EEE Virus' on the Delmarva Penninsula 2002-2008**

VA (eastern shore)	0	0	0	0	0	0
DELMARVA	17	0	0	0	38	1

		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

VA (eastern shore)	0	0	0	0	0	0
DELMARVA	0	0	0	0	0	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

FWS Form 3-2319
02/06

FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Prime Hook National Wildlife Refuge

Use: Turtle Harvesting (Trapping)

This form is not required for wildlife-dependent recreational uses, 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, 603 FW 1, 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: 2/13/13

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: 3/11/13

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: 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 (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 will 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 11-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 expected that these resources will be available in the future. The refuge manager will provide overall administration to the program. A wildlife biologist will be required to evaluate turtle harvesting activity along with current and potential impacts on refuge resources. The biologist will also evaluate trapper data and compile reports. An administrative assistant will process permits. A refuge law enforcement officer will be required to check refuge trappers and ensure compliance with State and Federal regulations.

Annual Costs:

Refuge Manager (GS-12)	2 hrs at $50/hr	$100
Wildlife Biologist (GS-11)	10 hrs at $40/hr	$400
Law Enforcement Officer (GS-9)	12 hrs at $30/hr	$360
Administrative Assistant (GS6)	10 hrs at $20/hr	$200
	Total	**$1,060**

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 will occur 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:

As part of the CCP process for Prime Hook NWR, this compatibility determination underwent extensive public review during an 89-day public review and comment period on the draft CCP/EIS from May 31 to August 27, 2012, and a 30-day public review period on the final CCP/EIS from December 28, 2012 to January 28, 2013. We announced the public review and comment periods in the *Federal Register* and through local media announcements. During the comment and review periods, we received one comment on turtle harvesting (trapping) (see appendix M in the final CCP). The commenter agreed with our finding that turtle harvesting is not a compatible use on Prime Hook NWR. We did not make any changes to this compatibility determination.

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. and 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. and 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 percent 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 percent), and that the predation rate of reptiles (14.2 percent) was lower than mammals (31.7 percent) and similar to that of fish (9.2 percent) and birds (11.7 percent). Abel (1992) reported attacks of snapping turtles on swan cygnets of 7 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 NWR 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, Refuge 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) 2/13/13 (Date)

CONCURRENCE:

Regional Chief: _____ (Signature) 3/13/2013 (Date)

MANDATORY 10-YEAR REEVALUATION DATE: 3/13/2023

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 Farms, 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 5 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 U.S. Government.

To help minimize environmental impacts and ensure compatibility with the purposes for which the refuge was established and the mission of the 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:

As part of the CCP process for Prime Hook NWR, this compatibility determination underwent extensive public review during an 89-day public review and comment period on the draft CCP/EIS from May 31 to August 27, 2012, and a 30-day public review period on the final CCP/EIS from December 28, 2012 to January 28, 2013. We announced the public review and comment periods in the *Federal Register* and through local media announcements. During the comment and review periods, we did not receive any comments on the compatibility determination for the FAA Vortac Tower.

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 if pesticides are to be used that 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 mph 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 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 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 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) 2/13/13 (Date)

CONCURRENCE:

Regional Chief: _____ (Signature) 3/13/2013 (Date)

MANDATORY 10-YEAR REEVALUATION DATE: 3/13/2023

COMPATIBILITY DETERMINATION

USE:

Recreational Freshwater and Saltwater Fishing and 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.

(b) Where would the use be conducted?
The use would be conducted within the refuge's 10,144 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 (mainstem of creek and HQ canal)	Boat only (Shore only at HQ Canal)
Turkle & Fleetwood Ponds	Boat & shore
Goose & Flaxhole Ponds	Boat only
Petersfield Ditch	Shore only
Pulloffs on Prime Hook Beach Road	Shore only (restricted to pulloff area)

(c) When would the use be conducted?
Fishing and crabbing will 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 will 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. For example, regulations, such as catch-and-relese and the use of barbless hooks, may be modified if fishery surveys and analysis indicate that other management options are needed to sustain healthy fish populations such as creel or size limits.

Crabbing will be conducted using only hand lines, collapsible traps, crab nets, and hoop crab nets. 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 allow fishing and crabbing at the pulloffs along Prime Hook Road due to increased visitor demand in this area and because existing pulloffs already provide safe parking areas. Access is restricted to only the pulloff area to provide safety for visitors and to avoid traffic issues. The refuge will consider fishing and crabbing along Broadkill Road and Fowler Beach Road in the future if there is a demand and if visitor safety and adequate parking can be guaranteed. Adequate parking and visitor safety along State-maintained roads has historically been an issue. Crabbing decreased significantly from 3,644 visits in 1976 to 880 visits in 1977 due to new regulations making State highway bridges into refuge waterways off limits in an effort to increase pedestrian safety along these roads.

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.

Adaptive management is necessary if Fowler Beach Road, from Slaughter Canal to its terminus at the Delaware Bay, is abandoned by Delaware Department of Transportation (DelDOT) and donated to the Service. If, upon DelDOT's removal of the existing layer of asphalt overlying unconsolidated fill, the walking trail will serve its

purpose of public use until marsh vegetation and hydrologic function reclaim the trail and the formally bisected habitat (Units I and II) function as one unit. When conditions are deemed unsafe, access will not be permitted to Fowler Beach for public use opportunities such as wildlife observation, wildlife photography, and fishing.

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 west of Foord's Landing.

(5) Opportunities for fishing and crabbing are available in designated areas from one-half hour before sunrise to one-half hour after sunset (except night fishing by permit at Fowler Beach). Some conflict between refuge users is expected to result in short-term moderate adverse impacts, which will be managed through the following seasonal closures. Other seasonal closures are in place to minimize wildlife disturbance.

   (a) Designated beach dunes and overwash areas: Open year-round with seasonal closures from March 1 through September 1 due to nesting State-endangered least terns and American oystercatchers, and the potential for use by federally threatened piping plovers. Areas may be reopened if no nesting activity occurs or when nesting ends for the season.

   (b) Goose and Flaxhole Ponds and Eastern Prime Hook Creek (from Foord's Landing to the headquarters ramp): Open with seasonal closures of every day from September 1 through March 15 and if necessary during the snow goose conservation order or turkey hunting seasons.

   (c) Turkle and Fleetwood Ponds (in Headquarters Area): Open 363 days a year (closed for two deer hunts) and portions may be closed for turkey hunts.

   (d) Slaughter Canal (boat access): Open year-round and only 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.

   (e) Water Control Structures at Petersfield Ditch (shore only), Slaughter Canal (shore only), Cods Road (shore only), and pulloffs on Prime Hook 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 and Fleetwood Ponds

   (c) Manual propulsion only on Goose and Flaxhole Ponds (includes float tubes)

   (d) Air thrust boats and jet skis are not permitted

   (e) A "Slow No Wake" zone has been established on the Headquarters Canal and Slaughter Canal.

(8) Restriction of bank fishing (where permitted) to designated area off of State-maintained highways at Petersfield Ditch, Slaughter Creek, Slaughter Canal, and pulloffs on Prime Hook Beach Road.

(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, collapsible traps, crab nets, and hoop crab nets. 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 Refuge System mission or the purposes of the 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 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 Web site 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 5 years and is not included in the annual cost of the fishing program below.

Item	**PROPOSED**	
	Staff Days	Cost
Planning	1	$300

Item	PROPOSED	
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 final 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 will 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 will 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 will not considerably alter the demographic or 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, based on past experience (and expected level of use), according to which fishermen have not affected air quality or significantly worn down the vegetation of the refuge.

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. Based on past use of the area the refuge does not expect soil compaction with any increase of use. 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 as they have not done so in the past and we don't anticipate such a rise in level of use as to cause any further change in water quality.

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 to 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 will be similar to those associated with the molting process. To minimize waterfowl disturbance from fishing and other recreational uses, the refuge has designated approximately 3,185 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 because the ponds and watercontrol structures are not preferred habitats of shorebirds and most of the landbird species of concern.

Impacts on secretive marsh and waterbirds are expected to negligible because the preferred habitats of these species is not impacted by recreational fishing and crabbing. 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 will 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 because 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 will serve the demand for more fishing opportunities in Sussex County. The improved habitat quality resulting from ongoing habitat restorations on the refuge will 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. In addition, there are few or no safety concerns with fishermen "sharing space" with other users, unlike hunters.

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:

As part of the CCP process for Prime Hook NWR, this compatibility determination underwent extensive public review during an 89-day public review and comment period on the draft CCP/EIS from May 31 to

August 27, 2012, and a 30-day public review period on the final CCP/EIS from December 28, 2012 to January 28, 2013. We announced the public review and comment periods in the *Federal Register* and through local media announcements. During the comment and review periods, we received several comments on recreational freshwater and saltwater fishing and crabbing, including requests to increase law enforcement when night fishing as allowed and concerns about parking for crabbing (see appendix M). None of these comments necessitated changes to this compatibility determination.

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, final CCP, 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. Open to fishing include the mainstem of Prime Hook Creek and the Headquarters Canal.

(6) Restriction of bank fishing (where permitted) to designated areas off of state maintained highways at Petersfield Ditch, Slaughter Creek, Slaughter Canal, and the pulloffs on Prime Hook Road.

(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 west of Foord's Landing.

(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) Opportunities for fishing and crabbing are available in designated areas from one-half hour before sunrise to one-half hour after sunset (except night fishing by permit at Fowler Beach). Some conflict between refuge users is expected to result in short-term moderate adverse impacts, which will be managed through the following seasonal closures. Other seasonal closures are in place to minimize wildlife disturbance.

(a) Designated beach dunes and overwash areas: Open year-round with seasonal closures from March 1 through September 1 due to nesting State-endangered least terns and American oystercatchers, and the potential for use by federally threatened piping plovers. Areas may be reopened if no nesting activity occurs or when nesting ends for the season.

(b) Goose and Flaxhole Ponds and Eastern Prime Hook Creek (from Foord's Landing to the headquarters ramp): Open with seasonal closures of every day from September 1 through March 15 and if necessary during the snow goose conservation order or turkey hunting seasons.

(c) Turkle and Fleetwood Ponds (in HQ Area): Open 363 days a year (closed for two deer hunts) and portions may be closed for turkey hunts.

(d) Slaughter Canal (boat access): Open year-round and only 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.

(e) Water Control Structures at Petersfield Ditch (shore only), Slaughter Canal (shore only), Cods Road (shore only), and pulloffs on Prime Hook 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, collapsible traps, crab nets, and hoop crab nets. 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 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) 2/13/13 (Date)

CONCURRENCE:

Regional Chief: _____ (Signature) 3/13/2013 (Date)

MANDATORY 15-YEAR REEVALUATION DATE: 3/13/2028

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).

(b) Where would the use be conducted?
The use will be conducted within the refuge's 10,144 acres, which lie between Slaughter Beach and the Broadkill River along the southeastern coastline of Delaware. A total of 5,221 acres would be open for deer hunting, 3,432 acres open for migratory bird hunting, 1,995 acres open for upland game hunting, and 3,729 acres open for wild

turkey hunting. Forty percent of the refuge (3,432 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 will be conducted on the refuge.

Area	Species	Acres	Seasons**
Regular Deer Hunt Area	Deer	3,659	Sept-Feb
Regular Waterfowl Hunt Area	Waterfowl (& webless migratory birds)	1,891*	Sept-Feb
Lottery Waterfowl Hunt Area	Waterfowl	1,515*	Sept-Feb
Lottery Deer Hunt Area	Deer	841	Nov & Jan
Disabled Waterfowl Hunt Area	Waterfowl	26*	Sept-Feb
Disabled Deer Hunt Area	Deer	721	Oct & Nov
Upland Game Hunt Area	Upland game & webless migratory birds except 110 acres closed to dove hunting	1,995	Sept-Feb
Lottery Turkey Hunt Area	Turkey	3,729	Apr-May
Snow Goose Conservation Order	Snow Geese	Refuge-wide***	Late Jan-April

** A total of 3,432 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.*

***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 will 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 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:

(a) Deep Branch Road Trail (includes Goose and Flaxhole Ponds; Unit III), Eastern Prime Hook Creek (from Foord's Landing to headquarter ramp) (Unit III), and hiking trail on Fowler Beach Road (southside of Unit II): 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 or turkey hunting. If and when the photography blind is available on the southside of Fowler Beach Road, this portion of the trail will be open year-round and open every Sunday during the hunting season.

(b) Headquarters area (includes Turkle and Fleetwood Ponds) (Unit III): Closed only for a maximum of 2 days for deer hunts and portions may be closed for turkey hunts.

(c) Island Farm Area in 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.

(d) Hiking trails on Fowler Beach Road (Unit I), Prime Hook Road (Unit III), and Slaughter Beach Road and Slaughter Canal (Unit I): Open only on Sundays from September 1 through the deer and waterfowl hunting seasons, which typically end in February. Additional seasonal closures may apply through the second Saturday in May for hunting during the snow goose conservation order or turkey hunting.

The refuge may 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 Foord's Landing. 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 memorandum of understanding 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:

All Hunting Programs

(1) All hunters must have in their possession a signed and current refuge hunting permit (signed brochure) and government-issued picture identification on the refuge. 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 application fee for the preseason lottery drawing is required. In addition, a daily permit fee of $10 for turkey and deer hunting, and a $15 fee for waterfowl hunting are required. Everyone in the lottery drawing has an equal chance of being selected multiple times. Application and permit fees for turkey hunting may be waived if the lottery drawing is administered by the State.

(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 to $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 percent discount on permit fees to Interagency Senior and Access passholders does not apply.

(4) Youth hunters aged 15 years and younger must obtain a free seasonal permit. Only hunters aged 16 years and older may apply or obtain a lottery hunt area permit (Waterfowl Lottery Application–FWS Form 3-2355 or Quota Deer Hunt Application–FWS Form 3-2354).

(5) Non-ambulatory hunters are allowed to hunt in all hunt zones in accordance with refuge policy and regulations. However, in the Island Farm Unit, we have provided non-ambulatory hunt blinds to accommodate hunters with this need. All disabled hunters must obtain an Interagency Access Passport to receive a hunting permit for the disabled hunting areas. Wheelchair hunters are required to have an assistant in the disabled hunting areas, and must hunt from a Government-provided blind.

(6) Hunting in violation of any Delaware State law is a violation of refuge hunting regulations.

(7) When requested by Federal or State enforcement officers, hunters, and assistants must display for inspection all permits, game, equipment, and ammunition.

(8) The refuge will not provide permanent hunting structures except for disabled hunting activities. Hunting blinds/stands/steps must be portable and removed at the end of each day.

(9) Hunters may not be on the refuge any earlier than 2 hours before the legal morning shooting time.

(10) Areas may be closed on the refuge without prior warning.

(11) All boaters are required to operate their craft and possess all safety equipment in accordance with Delaware State and U.S. Coast Guard regulations during refuge hunts. The maximum horsepower allowed for boat motors is 30 HP. The Slaughter Canal and Headquarters' Canal are slow, no wake zones. Designated launching sites must be used to launch boats. We prohibit the use of air-thrust and inboard water-thrust boats on all waters within the refuge boundaries.

(12) Cutting or damaging vegetation for any purpose is prohibited. The use of natural vegetation for camouflaging a blind is prohibited.

(13) No check-in or check-out is required and hunters are not required to report their harvest data to the refuge.

(14) Practice or target shooting on the refuge is prohibited.

(15) Overnight camping and open fires are prohibited.

(16) All public entry is prohibited in designated safety zones.

(17) Motor vehicles are prohibited off of designated routes and parking areas.

(18) Permits are non-transferable.

(19) Submission of harvest information to refuge staff is not required.

(20) For the Statewide youth hunts, all designated hunt areas will be open for waterfowl and deer hunting on a first-come, first-served basis. Portions of hunt areas may be closed for mentored hunting programs.

(21) 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.

Deer Hunting

(1) The hunting of white-tailed deer will be allowed on designated areas of the refuge during designated seasons in accordance with State regulations.

(2) 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) Access by boat is prohibited from Slaughter Creek on Cods Road.

(b) Seasonal closures to deer hunting from the Monday before Thanksgiving through March 15 will occur on the designated area north of Prime Hook Beach Road (Oak Island) and south of Fowler Beach Road to minimize disturbance to waterfowl and nesting bald eagles. The disabled deer hunt area in the Island Farm will be closed following the November shotgun season to minimize wildlife disturbance.

(3) For the lottery hunts in the lottery deer hunt areas, a limited number of permits (no more than 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 1 day during the November shotgun season and for 1 day during the January shotgun season. For the lottery hunts in the disabled deer hunt area, hunters must choose from among 11 ground blinds during designated dates in October and November.

(4) 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 and Wildlife and concurrence by the refuge, and conflicts with other user groups can be minimized.

(5) Assistants for disabled hunters are prohibited from hunting in the disabled hunting area.

(6) Any time the State hunting regulations require that hunters display hunter orange, the material must be solid-colored. Hunter-orange camouflage materials are prohibited.

(7) The use or possession of buckshot while hunting is prohibited. Only slugs may be used.

(8) The driving or pushing of deer by any means is prohibited.

(9) Hunters must be out of the hunting areas 1 and 1/2 hours after the evening shooting time.

(10) Opportunities for scouting will be allowed 2 weeks before the start of archery season and throughout the deer hunting season.

Waterfowl Hunting

(1) The hunting of waterfowl, coot, mourning dove, snipe, and woodcock will be allowed on designated areas during designated seasons in accordance with State regulations.

(2) All waterfowl hunt areas are open 4 days per week during the State waterfowl hunting seasons and hunters must stop hunting at 3 p.m. and be off of the refuge by 4 p.m. on hunting days except when snow goose hunting during the snow goose conservation order.

(3) Free-roam hunting is available in the regular waterfowl hunting area on a first-come, first-served basis.

(4) 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. 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. Only the first 2 days of each of the State's seasonal hunting splits for waterfowl will be included in the preseason drawing for the disabled waterfowl area and will be first-come, first-serve thereafter.

(5) The refuge will participate in all State waterfowl hunting seasons unless otherwise restricted. This includes the duck seasons, early teal season, youth waterfowl hunts, 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.

(6) In the lottery hunt area, snow geese may only be taken when the area is open for duck hunting or during the snow goose conservation order.

(7) Hunting is not permitted in upland areas during the snow goose conservation order.

(8) The use or possession of toxic shot for hunting is prohibited (see §32.2(k)).

(9) A maximum of three people are permitted per blind site in the lottery hunt areas.

(10) Only enrollees who complete mentored hunting programs may participate in their associated hunts. Only enrollees may possess or discharge a weapon.

(11) Up to two individuals assisting a disabled hunter are allowed to hunt waterfowl with the disabled hunter.

(12) The use of dogs is allowed to assist in hunting and retrieval of harvested game in accordance with State law. Dog training is prohibited.

(13) Opportunities for scouting will be allowed on Sundays immediately prior to each of the duck seasons.

Upland Game and Webless Migratory Bird Hunting

(1) The hunting of rabbit, quail, pheasant, and red fox will be allowed on designated areas of the refuge during designated seasons in accordance with State regulations with the following restrictions:

(a) The hunting of squirrel is prohibited.

(b) Hunters must be out of the hunting areas one half hour after legal evening shooting time.

(c) Dove hunting is open in the upland game hunting area except the designated area north of Prime Hook Road.

(d) Red fox hunting is only allowed while concurrently hunting deer in areas open to deer hunting. Hunting by chase is prohibited. Rimfire or centerfire rifles are prohibited.

(2) The use of dogs is allowed to assist in hunting and retrieval of harvested game in accordance with State law. Dog training is prohibited.

(3) Scouting is allowed during designated dates and times.

Turkey Hunting

(1) The hunting of wild turkey will be allowed on designated areas of the refuge during designated seasons in accordance with State regulations.

(2) A limited number of hunters (no more than five) will be selected through a preseason lottery drawing and required to hunt in designated areas.

(3) The refuge will collaborate with the Delaware Division of Fish and 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.

(4) 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 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 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 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 Refuge System.

AVAILABILITY OF RESOURCES:

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. Application and permit fees for turkey hunting may be waived if the lottery drawing is administered by the State. 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 to $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) and 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 percent 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 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. This can translate into more widespread and stronger support for the refuge, the 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 will 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 will 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 will 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 will 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 will 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 will 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 percent) and total employment (0.05 percent) 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 will not expect this activity to considerably alter the demographic of economic characteristics of the local community. All 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.

This activity will 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 will 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 will be more than offset by the benefits of maintaining the refuge in natural vegetation. The hunting program will not violate Environmental Protection Agency standards and will 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, Broadkill Beach Road, and Slaughter Beach Road.

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 will not violate Federal or State standards for contributing pollutants to water sources and will 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 will 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 are permitted for deer and 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 will 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 Unit III. 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.

Salt marsh habitats were found to be the most resistant to human trampling when compared to other habitats such as a natural dune, a man-made dune, and man-made coastal grasslands (Anderson 1995). This study analyzed the vegetation of five paths (one in each of the habitats) created and sustained by human trampling and reported that trampling of vegetation (estimated to be 1,815 to 3,630 passages per year) can be considered as very light. Even though it created paths and reduced vegetation cover and species diversity, the paths still retained a persistent vegetation (Anderson 1995). Even using inflated and unlikely estimates of free roam use in refuge salt marsh habitats for deer and waterfowl hunting, the impact from the trampling of vegetation would be considered very light and consistent with the findings reported in Anderson (1995).

The phasing out and elimination of all of the refuge's 115 deer hunting stands and waterfowl hunting blinds will also 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 will 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 will not be affected, however.

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 by increasing regeneration, plant density and diversity, and the potential to reduce the spread of invasive species.

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 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 and 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 will 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 will not likely affect this species and the use was permitted. Monitoring will continue in Turkle Pond to determine if there is an impact on the eagle nest on Horse Island, which is currently abandoned.

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 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 to 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 3 hours after daylight, or the last 3 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 to 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 1 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 (greater than 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 to 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 to 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 NWR 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 to 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 to 500 m (1312 to 1640 ft) are detrimental to waterfowl use and subsequent rates of return (Belanger and Bedard 1989). Thus, repeated

disturbances (greater than 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 recognized as important, but 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 1900s 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. Bregnballe et al. (2003) also reported that to ensure high species diversity, a waterbird reserve should include a non-shooting refuge that encompasses adjoining shooting marshland. Reducing hunting to a few hours on shooting days may be used to mitigate hunting disturbance in zones surrounding shooting-free refuges.

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 to 4 hunts/week).

(3) Regulate hunter access limiting boat access and traffic to specific areas.

To minimize waterfowl disturbance, the refuge has designated approximately 3,185 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 Unit II (approximately 1,800 acres), the southern half of Unit III (approximately 390 acres), and in Unit IV (approximately 995 acres). The northern portion of Unit IV, which contains a trail and observation platform, will be closed from the Monday before Thanksgiving to March 15 to also minimize disturbance to wildlife in this area. The southern portion of Unit IV will not be open to any public use. Waterfowl hunting will stop at 3 p.m. in all hunting areas and will be limited to 4 days per week to reduce disturbance to waterfowl feeding patterns, which in turn will result in high-quality hunting experiences. Disturbance is also decreased by closing the Oak Island Area in Unit II, the area south of Fowler Beach Road in Unit II, and disabled deer hunting area in Unit IV in late November to hunting and by closing the Deep Branch Trail to non-consumptive users from September 1 through March 15. 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 Service (DeLong 2002).

The term “sanctuary”, as used in the context of the CCP, indicates an area free from hunting and other uses. A key feature of a sanctuary is to make it large enough that intrusions on it’s borders do not unduly disturb the normal lifecycle functions, e.g., feeding, resting, preening, courtship, or causing the birds to take flight. The Service believes the areas designated for sanctuary are sufficiently large to reduce the detrimental affects of all forms of disturbance, including those resulting from hunting activity.

Sanctuaries also allow birds to have adequate escape distances (ED), which are defined as the shortest distance at which they flush or otherwise move away from the approaching person or other disturbing stimulus. Many factors influence EDs such as hunting, flock size, hunger, migratory motivation, etc. Laursen et al. (2005) suggested providing a mean ED of the largest ED of a bird species plus one to two standard deviations to calculate the size of the core area or buffer zone. In their study, the largest ED was 1,000 meters for wigeon (other species included mallard, etal, pintail, waders, and gulls) and would be approximately 1,700 meters with 2 standard deviations. Based on this information, refuge sanctuary areas can accommodate the ED's of most species.

Disturbance to waterfowl in or adjacent to the refuge is not a new phenomenon. The Service agrees, in part, there is virtually no area of the refuge that is not susceptible to auditory and visual disturbance. The refuge is relatively narrow and is crossed by several county roads. Some days auto traffic on Route 1 can be clearly heard a couple miles to the west, aircraft fly overhead, patrons of the refuge drive the county roads, birders walk the trails, refuge staff run tractors and airboats as part of their management program, residents drive to and from the neighboring communities to the east, beach enthusiasts travel to the public beaches, kayakers paddle the creek, crabbers park along the roads, neighbors hunt right up to the refuge border, and refuge hunters occasionally fire guns. Unfortunately, this is the nature of national wildlife refuges in the heavily populated eastern U.S. Most NWRs on the east coast do not harbor qualities that we generally think of as constituting "wilderness", e.g. quiet or solitude. Under an official wilderness designation, refuge staff would not be permitted the use of many of the standard management tools used on Prime Hook NWR. Even so, hunting is in fact permitted on areas designated as wilderness.

More specifically, hunting on adjacent private property causes disturbance to waterfowl every year in the following areas: Unit 1 along the western boundary, Unit 2 along Cods Road and Fowlers Beach Road, Unit 3 along the southeastern portion near Broadkill Beach, along Prime Hook Creek, and in the State-managed Prime Hook Wildlife Area, and Unit 4 along the Broadkill River, Petersfield Ditch, and in salt marshes on the western boundary. Hunting has been open in all four units of the refuge and Unit 1 has been hunted for years by free-roaming hunters seeking deer and upland game in refuge saltmarshes. Despite disturbance of waterfowl from vehicular traffic, refuge staff observe visitors year-after-year viewing and photographing waterfowl within 20 yards of vehicle even during the hunting season. Adding additional sanctuary areas on the refuge will only increase areas of respite for waterfowl and other wildlife and further enhance opportunities to enjoy them by refuge visitors.

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.

(3) Disrupt pair and family bonds and contribute to increased hunting mortality.

The Service annually prescribes 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 U.S. 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 Service as the lead Federal agency for managing and conserving migratory birds in the U.S. 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 Web site: *http://www.fws.gov/migratorybirds/* (accessed October 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 Finding of No Significant Impact (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., U.S. 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 2011, the average annual waterfowl harvest at the refuge is 2.5 percent of Delaware's total waterfowl harvest (table 1.1). Furthermore, in 2011, the refuge's harvest of ducks was only 2.3 percent of Delaware's total duck harvest, 0.06 percent of the Atlantic Flyway's duck harvest, and 0.01 percent of the entire U.S.'s duck harvest (table 1.2; Raftovich et al. 2012). Also in 2011, the refuge's harvest of geese (Canada and snow geese combined) was only 0.75 percent of Delaware's total goose harvest, 0.02 percent of the Atlantic Flyway's goose harvest, and less than 0.01 percent of the entire U.S.'s goose harvest (table 1.2; Raftovich et al. 2012).

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 2011, 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 2011 to 2012 hunting season, the refuge harvested between 0.58 percent and 1.61 percent of the State's estimated monthly duck population and between 0.02 percent and 0.03 percent of the State's estimated monthly goose population (table 1.3; October and November Statewide waterfowl survey information was unavailable). Refuge hunters harvested between 1.60 percent and 7.04 percent of the refuge's estimated monthly duck population and between 0.04 percent and 0.08 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
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

Year	Statewide Waterfowl Harvest*	Refuge Waterfowl Harvest	Refuge Waterfowl Survey**	Refuge Hunter Visits
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
2010	84,130	1,604	58,960	874
2011	56,370	1,050	138,894	908

** Statewide waterfowl harvest data from: http://www.flyways.us/regulations-and-harvest/harvest-trends; accessed October 2012.*

*** 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. Some monthly surveys were incomplete in 2007, 2010, and 2011, which may not have reflected the peak (http://www.fw.delaware.gov/Hunting/Pages/Waterfowl%20Surveys.aspx; accessed October 2012).*

Table 1.2. Comparison of waterfowl harvest at Prime Hook NWR to State, Flyway, and U.S. harvest in the 2011 hunting season.

Waterfowl Harvest Area	Ducks	Geese
Prime Hook NWR	934	116
Delaware*	41,000	15,400
Atlantic Flyway*	1,672,900	580,400
United States*	15,931,200	2,879,900

**Harvest estimates from (Raftovich et al. 2012)*

Table 1.3. Comparison of duck and goose (Canada and snow geese) harvest at Prime Hook NWR to State waterfowl surveys during the 2011 to 2012 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 2011	219	6,236	Data Unavailable	11	16,823	Data Unavailable
November 2011	126	7,857	Data Unavailable	12	15,540	Data Unavailable
December 2011	217	8,707	37,185	45	99,869	174,992
January 2012	372	5,287	23,053	48	133,634	199,204

** 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;* accessed October 2012).

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 2011, refuge hunters harvested between 0.03 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 NWR.

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 NWR.

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
2010	15	No	n/a	n/a	52,451
2011	60	No	n/a	n/a	103,301

* *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. Some monthly surveys were incomplete in 2007, 2010, and 2011, which may not have reflected the peak (http://www.fw.delaware.gov/Hunting/Pages/Waterfowl%20Surveys.aspx;* accessed October 2012).

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. But given the numbers above, probably a relatively small one.

Direct disturbance to waterfowl occurs during white-tailed deer hunting seasons, as hunters flush deer through wetlands, creeks, and open water habitats. Deer hunters have been free-roam hunting in Unit I of the refuge for years and upland game hunters free-roam hunt in areas in Unit I, Unit II, and Unit III. Free-roam hunting of

deer was permitted in all deer hunting areas between 9 a.m. and 3 p.m. up until the 2002 to 2003 hunting season, but was prohibited due to complaints of unethical hunting behaviour such as harvesting deer from the stands of other hunters. 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 hunting areas and is expected to be negligible (refer to impacts to waterfowl for more information). 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 with greater access and also increase the potential for waterfowl disturbance. These disturbances are mitigated by creating sanctuary areas where no waterfowl hunting occurs.

Prior to the conservation order taking effect in late January, all snow goose hunting on-refuge will be isolated to the same areas/blinds and refuge specific hunting dates as other waterfowl hunting. A continuous period (except Sundays) from January 28 to April 13 (for 2012 to 2013 hunting season) will be open for hunting snow geese during the Conservation Order which will open all emergent wetlands on-refuge to snow goose hunting only, once all other waterfowl seasons have closed. Snow geese present a fairly unique issue, finding themselves on the Service's Migratory Bird Program focal species list for actually being over abundant. It is the desire of the Service, Canadian Wildlife Service, and all Provinces and States to drastically reduce the size of the current continental populations of light (snow) geese, primarily because of the dramatic damage excessive numbers of snow geese have inflicted on very fragile arctic breeding grounds, areas that are important to other breeding migratory species, as well. Seasons, bag limits and methods of take have been liberalized for the purpose. Opening all available habitats on the refuge from January 28 to April 13 is specifically designed to reduce damage sustained from overbrowsing of refuge salt marshes.

Unfortunately, the Service projects, based upon documented history of similar hunts on-refuge, that very few hunters will take advantage of the snow goose hunting opportunity. The hunting season starts October 1, several weeks before any number of birds arrive on Delmarva, and while many hunters are more interested in deer hunting instead. Snow geese are difficult to hunt and there may be an incidental few killed during the regular duck and migratory Canada Goose season.

Over the period 2001 to 2006, when the refuge was open to late season snow goose hunting, 100 hunters harvested 96 snow geese over a shortened season extending from late January to mid-March and averaged 16 birds per year. The hunter success rate averaged 0.96 birds per hunt. Because of the difficulty of hunting snow geese, hunting parties were likely composed of a minimum of two hunters. Thus, a maximum of 50 total parties hunted over a combined total of approximately 216 days available over the 6-year period with each party potentially having several thousand acres upon which to hunt. From 2000 to 2009, refuge hunters harvested between 0.04 percent and 0.43 percent of the refuge's estimated monthly snow goose population. The Service projects negligible impacts to other refuge resources from snow goose hunting.

In addition, non-refuge areas in Delaware will also be open to snow goose hunting during the same period. It appears anecdotally that the limited few hunters that attempt snow goose hunting during the late season are likely to do so from agricultural fields, alleviating most waterfowl hunting pressure on Delaware's tidal marshes and impoundments.

Waterfowl hunting in Unit I salt marshes have the potential to increase adverse impacts and disturbance on refuge wintering American black ducks. Since black ducks are a focal species of conservation concern, monitoring and evaluation of impacts of increased recreational use of salt marsh habitats will be required to identify and respond to unacceptable impacts. Unit IV salt marshes will continue to be a sanctuary area.

The American black duck was selected as a "focal" or indicator species by the refuge because of its listing on Federal and State conservation lists, but more importantly for its close association with native saltmarsh. Targeting conservation actions to a few focal species, specifically in habitat management objectives, is made with the assumption that hundreds of other fish, wildlife and native plant species will benefit.

From the larger Service perspective, the Service Migratory Bird Program, has generated its own list of birds of management concern and "focal" species. The birds of management concern is a list of species, subspecies, populations, or geographic segments of populations that warrant management or conservation attention. Birds of management concern are drawn from the list of species afforded protection under the Migratory Bird Treaty

Act (50 CFR Part 10) and therefore, fall under Federal jurisdiction. To be of management concern, a bird must be a high priority gamebird, on the Birds of Conservation Concern 2008 list, a Federal threatened or endangered species listed in the U.S., or overly abundant leading to management conflicts. Full species are considered of management concern throughout their U.S. range (including Caribbean and Pacific islands) unless specific subspecies populations, or geographic units (e.g., Service regions or bird conservation regions) are designated.

The Migratory Bird Program's "focal" species or "focal" populations are covered under the Migratory Bird Treaty Act, are a subset of the birds of management concern, and are those the program believes need additional investment of resources to address pertinent conservation or management issues. Also included in the list are species occurring in the U.S. that are listed under the Endangered Species Act or are on the Bird of Conservation Concern 2008 list but are not protected under the Migratory Bird Treaty Act.

Within the Migratory Bird Program's list of "focal" species, not to be confused with the Prime Hook NWR specific list generated by the refuge for this CCP, are some species of game birds, including the American black duck. The Migratory Bird Treaty Act, grants the Secretary of the Interior the authority to establish hunting seasons for any of the migratory game bird species. For waterfowl management specifically, the U.S. and Canada are divided into four flyways; the Atlantic, Mississippi, Central, and Pacific. In the US, the Flyway Councils, consisting of representatives from state and provincial game-management agencies, recommend regulations to the Service for waterfowl and for most migratory, shore and upland game birds.

The Councils are advised by flyway technical committees consisting of state and provincial biologists. These technical committees evaluate species and population status, harvest, and hunter-participation data during the development of the Council recommendations.

The Service's Office of Migratory Bird Management (MBMO), with advice from biologists in the Service's Regional Offices, evaluates the Council recommendations, considering species status and biology, cumulative effects of regulations, and existing regulatory policy, and makes recommendations to the Service's Regulations Committee to set hunting seasons for migratory birds that ensure healthy game populations in years to come and fair distribution of hunting opportunities throughout the migration routes.

The Service Regulations Committee considers both the Council and MBMO recommendations, then forwards its recommendations for annual regulations to the Service Director.

Once regulatory proposals are approved, they are published in the *Federal Register* for public comment. After the comment period, final regulations are developed, which are then signed by the Assistant Secretary of the Interior for Fish, Wildlife, and Parks. From this Federal framework, individual States may select hunting seasons and bag limits. Once the States have adopted their respective seasons and bag limits, individual refuges may choose to adopt State regulations in-whole, or the refuge may choose additional refuge specific regulations.

In an effort to reduce undesirable impacts on refuge resources and management programs, Prime Hook NWR has adopted more restrictive regulations than those adopted by either the Service's MBMO or the State of Delaware. These regulations include area closures (sanctuaries), hunting 4 of 7 days/week instead of 6 of 7, and ending the hunt day at 3 p.m. instead of sunset.

As indicated above, black ducks and black duck hunting are managed on a state, flyway, and continental scale. The process of setting hunting regulations is a deliberative one, based on substantial data. Regulations are set with the full knowledge and desire that a proportion of the population will be removed by hunters, whether on or off of NWRs. Within the northeastern US and eastern Canada particularly, the black duck is considered a valuable recreational and economic resource. The apparent 50 percent decline in black duck numbers over the last half of the last century, has raised concern for the long-term sustainability of a currently viable, albeit reduced, population. Thus, the American black duck has received the designation of "focal" species by the Service's Migratory Bird Program for some reasons other than those presented by Prime Hook NWR.

Under both the Administration Act, as amended, and 43 CFR 24, the Director as the Secretary of the Interior's designee will ensure that Refuge System regulations permitting hunting and fishing are, to the extent practicable, consistent with State laws, regulations, and management plans (605 FW 2). The Service and the State of Delaware consider the black duck population capable of sustaining harvest; so Prime Hook NWR will comply with State seasons and bag limits.

Impacts to Shorebirds

Disturbance to shorebirds from hunting (or just from human presence generally) 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 from human presence generally 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 3,729 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 and 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
2010	4	0	1	3	108	129
2011	9	0	1	0	76	100

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

For migratory birds such as mourning dove, an estimated 14,700 birds were harvested in Delaware during the 2011 season (table 1.6; Raftovich et al. 2012) when only 9 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 2011 hunting season.

Harvest Area	Dove	Woodcock	Snipe
Prime Hook NWR	9	1	0
Delaware*	14,700	500	500
Eastern Management Unit*	6,666,900	77,000	57,500
United States*	16,580,900	308,700	136,300

**Harvest estimates from (Raftovich et al. 2012); Estimates for snipe are from the Atlantic Flyway*

The refuge proposes to open 3,729 acres for wild turkey hunting. This additional acreage includes many of the areas open for deer hunting. Turkey hunting was permitted on the refuge in Unit I west of Slaughter Canal from 1993 up until 1998. Turkey is a resident game species that is managed by Delaware Department of Natural Resources and Environmental Conservation's (DNREC) Division of Fish and Wildlife. The refuge falls within Zone 9 of DNREC's Wild Turkey Management Regions and the refuge will work closely with DNREC to evaluate the status of the turkey population and its hunting potential. Zone 9, which includes the State-owned Prime Hook Wildlife Area that is adjacent to the refuge, is currently open during the spring turkey hunting season. To ensure a sustainable harvest of the State's turkey population, DNREC biologists track their health, distribution, and reproductive success. Current efforts include a volunteer-based survey used to generate an index of annual turkey productivity and recruitment; monitoring turkey harvest and hunter efforts; tracking turkeys with radio transmitters to evaluate their reproductive ecology, habitat use, and survival; and evaluating the genetic diversity of turkeys. The number of permitted hunters, which will be no more than five, may be adjusted (increased or decreased) based on changes in turkey population data.

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 will 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 will receive added benefits from the establishment of new sanctuary areas or zones, where 3,185 acres will be protected from hunting activities and other public use that cause disturbances to secretive marsh and waterbirds. Furthermore, the refuge has limited the number of hunting days and has restricted hunting hours. Disturbance is also decreased by closing the Oak Island Area in Unit II, the area south of Fowler Beach Road in Unit II, and disabled deer hunting area in Unit IV in late November to hunting and by closing the Deep Branch Trail to non-consumptive users from September 1 through March 15.

Impacts on Fisheries

Impacts to fisheries from visitors engaged in hunting are expected to be temporary and negligible. Anticipated increases in hunting 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 will not affect their populations regionally. Impacts of hunting to migratory bat species will 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 to October and March to April when these species are migrating; however, hunter interaction will 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 will 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 0.5 percent to 1.5 percent of Delaware's total deer harvest each year. The current harvest level of deer on the refuge (66) has a negligible impact on the Statewide deer population, which was last estimated at 31,071 deer in 2009 (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 to 2008/09 seasons. ***(Source: Rogerson 2010)***

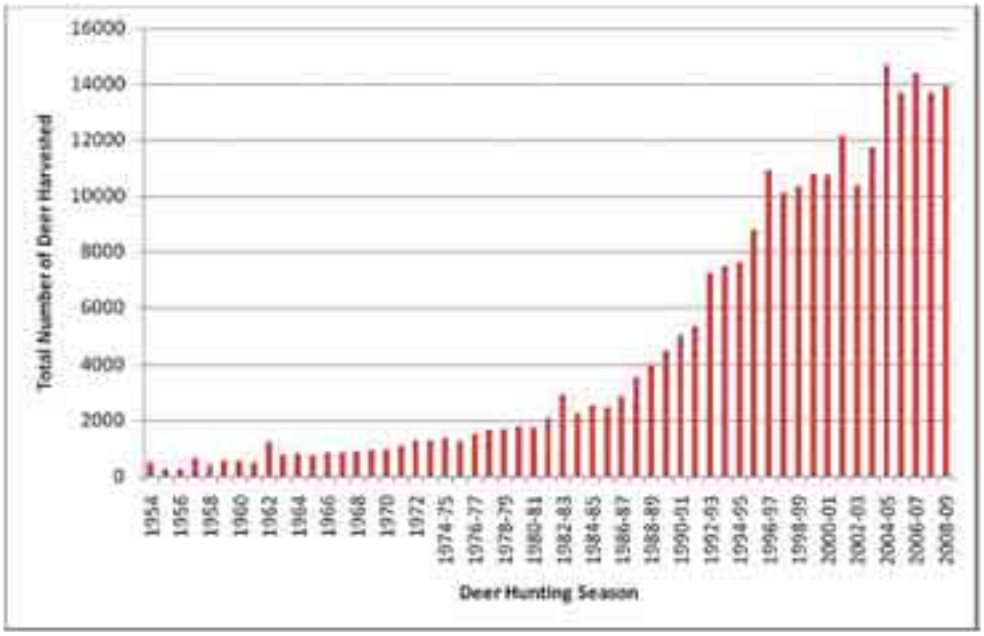

Table 1.8. Number of deer harvested and hunter visits on Prime Hook NWR compared to Statewide harvest (Source: DNREC 2010b, refuge harvest data; *http://www.dnrec.state.de.us/fw/deer.pdf*).

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

Year	Statewide Deer Harvest	Refuge Deer Harvest	Refuge Hunter Visits
2008	13,926	106	670
2009	12,400*	107	552
2010	14,183	114	549
2011	13,559	66	513

**Data from DNREC (2010b).*

Table 1.9. Cumulative impacts of existing deer hunting on Prime Hook NWR/State Deer Management Zone 9 (2011 to 2012 data) compared to Statewide Harvest.

Hunt Location and Type	Harvest
Prime Hook NWR	66
State Deer Management Zone 9	852
Statewide Harvest (all 17 Deer Management Zones)	13,559

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 will 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 will 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 will 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 percent 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 2009) and in the Visitor and Community Survey (Sexton et. al 2007). Visitors interested in hunting will 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 will also benefit local communities.

The refuge will also promote a wildlife-oriented recreational opportunity that is compatible with the purpose for which the refuge was established. The public will have an increased awareness of Prime Hook NWR and the 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 will increase, and, in turn, visitation will increase on the areas open to hunting. The refuge may or may not be capable of meeting the demand as it increases and will 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 in the next 15 years. 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, webless migratory birds, and turkey provides an administratively simple program that balances other public use activities. The program supports Presidential Executive Order #13443: 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.

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. Short-term, moderate adverse impacts are expected for non-consumptive users due to the seasonal closures that are highlighted below:

(1) Deep Branch Road Trail (includes Goose and Flaxhole Ponds; Unit III), Eastern Prime Hook Creek (from Foord's Landing to headquarter ramp) (Unit III), and hiking trail on Fowler Beach Road (southside of Unit II): 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 or turkey hunting. If and when the photography blind is available on the southside of Fowler Beach Road, this portion of the trail will be open year-round and open every Sunday during the hunting season.

(2) Headquarters area (includes Turkle and Fleetwood Ponds) (Unit III): Closed only for a maximum of 2 days for deer hunts and portions may be closed for turkey hunts.

(3) Island Farm Area in 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.

(4) Hiking trails on Fowler Beach Road (Unit I), Prime Hook Road (Unit III), and Slaughter Beach Road and Slaughter Canal (Unit I): Open only on Sundays from September 1 through the deer and waterfowl hunting seasons, which typically end in February. Additional seasonal closures may apply through the second Saturday in May for hunting during the snow goose conservation order or turkey hunting.

Negative reactions by some visitors may be caused by 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 and turkey hunts. The closure of the eastern end of Prime Hook Creek in September is only 1 month earlier than current management. In fact, for the last few years, the eastern end has been closed in early September for safety reasons due to the opening of the early teal hunting season on the adjacent State-owned Prime Hook Wildlife Area. The deer hunts in the refuge headquarters are the same as current management and only portions of this area will be closed for one-half day for turkey hunting. 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 will enforce these and other current refuge regulations, where appropriate, and will seek the assistance and cooperation of Delaware Division of Fish and Wildlife in enforcing common regulations to provide a safe environment for refuge visitors and promote activities that are compatible with protecting the resources.

At first glance, these seasonal closures give the appearance that opportunities for wildlife observation and photography are being significantly reduced or totally eliminated for over 8 months during the proposed expanded hunting activities. To the contrary, the majority of the refuge will remain open to wildlife observation and other non-consumptive uses and provide more opportunities and open areas than under current management. More specifically, opportunities for wildlife observation and photography have been expanded to include seven new trails totaling 3.7 miles throughout the refuge in all four management units on existing maintained trails or interior refuge roads, bringing the total number of trails to 14 and 9.9 miles. The Headquarters Area, which contains six trails covering 6 of the 9 total miles of refuge trails, remains available 363 days a year for non-consumptive uses, but portions may be closed for turkey hunting. All other areas except for the Deep Branch Trail, Fowler Beach Road trail (southside), and Prime Hook Creek are open on every Sunday during the hunting seasons. The Deep Branch Trail, the Fowler Beach Road trail (southside), and Prime Hook Creek are open with seasonal closures of every day from September 1 through March 15 and if necessary during the snow goose conservation order or turkey hunting seasons. If and when the photography blind is available on the southside of Fowler Beach Road, this portion of the trail will be open year round and open every Sunday during the hunting season. The majority of the hunting will occur during the main hunting season, which typically runs for 5 months from September through January, with additional hunting opportunities for rabbit through the end of February. Hunting during the snow goose conservation order, which will occur for 2 ½ months from late January through mid-April, will take place mostly in the wetland areas, leaving the upland areas open to other uses. This hunt is not anticipated to bring large numbers of hunters, but is beneficial to the species and other wildlife due to overpopulation. With five or less turkey hunting permits issued in April and May, a vast majority of the refuge will still remain open to wildlife observation and other non-consumptive uses.

Table 1.10 shows what areas of the refuge will be open for hunting and wildlife observation by month. Where overlaps in hunting and wildlife observation occur, the table also described how conflicts between user groups are minimized. For example, some areas are only open to wildlife observation on Sundays and in other areas only hunted portions are closed to wildlife observation.

Table 1.10 Alternative B Public Use Comparison by Season

KEY

H = Hunting Open W = Wildlife Observation/Photography Open

Unit Name	Area	Month											
		Jan[1]	Feb[1]	Mar[1]	Apr[1]	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Unit I	Slaughter Canal Area	H, W*	H, W*	H, W	H[2], W	H[2], W	W	W	W	H, W*	H, W*	H, W*	H, W*
	Slaughter Canal	H, W*	H, W*	H, W	H, W	W	W	W	W	H, W*	H, W*	H, W*	H, W*
	Fowler North Area	H, W*	H, W*	H, W	H[2], W	H[2], W	W	W	W	H, W*	H, W*	H, W*	H, W*
	Fowler Beach	W	W	WB	WB	WB	WB	WB	WB	W	W	W	W
	Roadside Viewing on Slaughter Beach Road & Fowler Beach Road	W	W	W	W	W	W	W	W	W	W	W	W
	Viewing at Water Control Structure at Slaughter Canal	W	W	W	W	W	W	W	W	W	W	W	W

**Open only on Sundays*

[1] *Wetland areas only open to hunting during the snow goose conservation order from Jan/Feb through mid-April and will involve temporary closures of portions of the hunt area to other users*

[2] *Turkey hunting for five hunters is available in portions of the 3,700 acre turkey hunt area; only hunted portions will be closed to other visitors*

[B] *Indicates a seasonal closure of designated beach dunes and overwash areas – access to the intertidal zone is permitted*

Unit Name	Area	Month											
		Jan[1]	Feb[1]	Mar[1]	Apr[1]	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Unit II	Fowler Beach	W	W	WB	WB	WB	WB	WB	WB	W	W	W	W
	Fowler South Area	HS1, W**	HS1, W**	HS1, W	H, W	W	W	W	W	H, W**	H, W**	H S1, W**	W**
	Cods Road Area	H	H	H	H	CLOSED	CLOSED	CLOSED	CLOSED	H	H	H	H
	Oak Island	HS1	HS1	HS1	H	CLOSED	CLOSED	CLOSED	CLOSED	H	H	H	CLOSED
	Prime Hook North Area	H	H	H	H2	H2	CLOSED	CLOSED	CLOSED	H	H	H	H
	Roadside Viewing on Prime Hook Beach Road & Cods Road	W	W	W	W	W	W	W	W	W	W	W	W
	Unit II Marsh (Sanctuary)	CLOSED[S]	CLOSED[S]	CLOSED[S]	CLOSED[S]	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED

**Open only on Sundays*

***Upon completion of photography blind, this portion of trail will be open year round and only on Sundays during the hunting season*

[1] *Wetland areas only open to hunting during the snow goose conservation order from Jan/Feb through mid-April and will involve temporary closures of portions of the hunt area to other users*

[2] *Turkey hunting for five hunters is available in portions of the 3,700 acre turkey hunt area; only hunted portions will be closed to other visitors*

[S] *Indicates a sanctuary area unless open for hunting during the snow goose conservation order*

[S1] *Indicates a sanctuary area from the end of November through March 15 unless open for snow goose conservation order*

[B] *Indicates a seasonal closure of designated beach dunes and overwash areas – access to the intertidal zone is permitted*

Unit Name	Area	Month											
		Jan[1]	Feb[1]	Mar[1]	Apr[1]	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Unit III	Prime Hook South Area	H, W*	H, W*	H, W	H[2], W	H[2], W	W	W	W	H, W*	H, W*	H, W*	H, W*
	Prime Hook Creek – East of Foord's Landing	H	H	H	H,W	W	W	W	W	H	H	H	H
	Prime Hook Creek – West of Foord's Landing	W	W	W	W	W	W	W	W	W	W	W	W
	Unit III Marsh (North & Mid Sections)	H	H[S2]	H[S2], W	H[S2],W	W	W	W	W	H	H	H	H
	Unit III Marsh (Southern Section = Sanctuary)	CLOSED[S]	CLOSED[S]	CLOSED[S]	CLOSED[S]	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED
	Headquarters Area	H, W[D]	W	W	H[2], W	H[2], W	W	W	W	W	W	H, W[D]	W
	Jefferson Lofland Area (Deep Branch Road Trail)	H, W***	H, W***	W***	H[2], W	H[2], W	W	W	W	H, W***	H, W***	H, W***	H, W***
	Millman Area	H	H	H[2]	H[2]	CLOSED	CLOSED	CLOSED	CLOSED	H	H	H	H
	Viewing at Water Control Structure at Petersfield Ditch	W	W	W	W	W	W	W	W	W	W	W	W
	Roadside Viewing on Prime Hook Beach Road & Broadkill Beach Road	W	W	W	W	W	W	W	W	W	W	W	W

**Open only on Sundays*

****Seasonal closures to non-consumptive users from September 1 to March 15 to reduce cumulative disturbance to waterfowl from all users in and adjacent to Goose & Flaxhole Ponds*

[1] *Wetland areas only open to hunting during the snow goose conservation order from Jan/Feb through mid-April and will involve temporary closures of portions of the hunt area to other users*

[2] *Turkey hunting for five hunters is available in portions of the 3,700 acre turkey hunt area; only hunted portions will be closed to other visitors*

[S] *Indicates a sanctuary area unless open for hunting during the snow goose conservation order*

[S2] *Indicates a sanctuary area from the end of the hunting season through March 15 unless open for snow goose conservation order*

[D] *Indicates that the HQ area is only closed to non-consumptive users for a deer hunt for one day during the indicated month*

Unit Name	Area	Month											
		Jan[1]	Feb[1]	Mar[1]	Apr[1]	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Unit IV	Graves Area	H	H	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	H	H	H	H
	Trail on Vergie's Pond	H[S1], W[S1]	H[S1], W[S1]	H[S1], W[S1]	H, W	W	W	W	W	W	W	W[S1]	W[S1]
	Island Farm Area	H[S]	H[S]	H[S]	H[S]	CLOSED	CLOSED	CLOSED	CLOSED	H	H	H	H
	Southern Section of Unit IV (Sanctuary)	CLOSED[S]	CLOSED[S]	CLOSED[S]	CLOSED[S]	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED
	Roadside Viewing on Broadkill Beach Road	W	W	W	W	W	W	W	W	W	W	W	W

[1] *Wetland areas only open to hunting during the snow goose conservation order from Jan/Feb through mid-April and will involve temporary closures of portions of the hunt area to other users*

[S] *Indicates a sanctuary area unless open for hunting during the snow goose conservation order*

[S1] *Indicates a sanctuary area from the end of November through March 15 unless open for hunting during the snow goose conservation order*

Increases in proposed hunting acreages will provide new hunting opportunities from current management; however, many of these proposed "new" hunting areas are currently open to some type of hunting or have been previously open either under refuge management or private ownership. For example, Unit I is currently open for deer and upland game hunting (including dove hunting) and is now proposed to be open for waterfowl hunting—same land, but with a new opportunity. The only refuge land proposed to be open for any type of hunting that is not currently being hunted for any species includes: an area located north of Prime Hook Road commonly referred to as Oak Island (deer only), an area north of Route 16 referred to as the Millman Tract (deer and turkey), an expanded area of the existing Jefferson Lofland Area and Headquarters Area (deer and turkey), an expanded area of the Unit III waterfowl hunt area (waterfowl only), and an area west of Petersfield Ditch in Unit IV. Of these areas, Oak Island was previously hunted under refuge management up until 1995 and the Millman Tract was hunted under private ownership up until the Service purchased it in 2001. The expanded areas of the Jefferson-Lofland Area, Headquarters Area, and nearly all of the proposed Unit III waterfowl hunt area were previously hunted under refuge management. No prior hunting of the area west of Petersfield Ditch is known.

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, short-term minor adverse impacts may occur with some landowners due to hunter trespassing. These impacts will be minimized through enhanced law enforcement efforts. We anticipate some conflict between concurrent hunting programs (i.e., waterfowl, deer, and upland game hunting seasons overlapping). For the majority of the hunting seasons, the Delaware Division of Fish and Wildlife has made efforts to avoid these overlaps in the various hunting programs.

Although the refuge provides hunting maps and refuge-specific regulations, it is ultimately the responsibility of the hunter to know and obey them. Unfortunately, not all do. The Service will ensure that refuge boundaries are and continue to be properly posted to notify both refuge visitors and private landowners. Private landowners will be encouraged to contact either refuge and/or state law enforcement when these trespassing incidents occur and every effort will be made to respond in an efficient and timely manner. The Service also encourages private landowners to post their own property. Restricting hunter access within a 100-yard buffer to private property was discussed and it was concluded that too much hunting area would be lost by this zone and that there are already sufficient laws and regulations in place to discourage boundary shooting. Furthermore, neighboring landowners would benefit by having easy access to designated areas open to hunting on the refuge.

Visitor safety at refuges is a high priority when developing compatible wildlife-dependent recreation programs, such as hunting; however, it is ultimately the responsibility of every hunter to be safe. An accident involving hunter safety results from either a lack of hunting ethics or a violation of hunting regulations. Use of portable deer climbing stands will be recommended but not required. For hunters who may be unable to climb trees using portable deer stands or who may wish to hunt from permanent deer stands or duck blinds, the State-owned Prime Hook Wildlife Area, which adjacent to the refuge, will continue to provide these opportunities.

Provision of elevated deer stands, and to a lesser degree waterfowl blinds, is relatively unique to Delaware. There are many areas on the Delmarva Peninsula, other than Prime Hook NWR, that offer public hunting opportunities in free-roam areas where the hunter is required to provide the blind or stand, if desired.

The Service conducted a Web search for public lands within the three states making up the Delmarva Penninsula in order to evaluate the prevalence of permanent waterfowl blinds or deer stands on public hunting lands. A wide assortment of ownership and management regimes was evident across 215 tracts managed or described by 19 different designations, e.g., State Park, National Park Service, State Forest, Chesapeake Forest Lands, and natural resources management area. For waterfowl hunting, 131 of the 215 tracts examined permitted waterfowl hunting. Of the 131, only 36 provided either a pit or standup blind somewhere on the tract. The Service makes this qualifying statement because some areas, Tuckahoe State Park for example, provide four pit blinds but also allow free roaming along the Tuckahoe River. Of the 36, 28 were located in Delaware, 8 in Maryland, and none in Virginia. Twenty tracts required hunters to hunt at a stake or within some designated distance from a blind site where the hunter would provide the blind (if desired), including 9 in Delaware, 11 in Maryland, and 0 in Virginia. A total of 84 tracts permitted free-roam hunting where the hunter would provide the blind (if desired), 17 in Delaware, 60 in Maryland, and 7 in Virginia.

For deer hunting, of the 215 tracts examined, 181 permitted some form of deer hunting. Unfortunately, the Service did not make a distinction between the various methods, i.e., some tracts may be limited to bow hunting only. Of the 181 tracts, 95 were located in Delaware, 77 in Maryland and 9 in Virginia. A total of 51 of the 181 tracts required hunters to use stands that were provided, all of which were located in Delaware. Free-roam hunting was permitted on 165 tracts, including 80 in Delaware, 76 in Maryland, and 9 in Virginia. The Service acknowledges that some free-roam areas were for bow hunting only, however, such a distinction would only apply in Delaware; all deer hunting tracts in Maryland and Virginia permitted free-roam hunting regardless of hunting method.

For the 85 tracts located in Maryland and Virginia where no stands are provided, only 2 require an elevated stand, which the hunter must provide. For areas immediately adjacent to the building complex on Blackwater NWR, the hunter must use an assigned blind site where the hunter erects a stand with a platform minimum of 8 feet above the ground. All other tracts on Blackwater NWR are free-roam where ground-hunting is permitted.

The second site where elevated deer hunting is required is on Chincoteague NWR, around the tour loop. Here the hunter must erect his/her own stand with a platform minimum of 14 feet above the ground. All other areas on Chincoteague NWR permit free-roam hunting. The Service should also add that rifle hunting, as well as deer drives, are permitted on most public hunting lands on the lower eastern shore of Maryland and the eastern shore of Virginia.

Preseason lottery drawings at Prime Hook NWR provide hunting opportunities for local, in State, and out-of-State hunters. Advance knowledge of a hunting opportunity allows hunters to prepare, plan, and scout, which ultimately helps to provide a quality hunting experience.

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, webless migratory birds (dove), and wild turkey.

White-tailed deer hunting: A total of 5,221 acres is open for deer hunting, which includes archery (to include the use of crossbows), muzzleloader, handgun, and shotgun hunting. Seasonal closures will 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 and close hunting in late November in designated areas to minimize bald eagle and waterfowl disturbance). Non-ambulatory hunters are allowed to hunt in all hunt zones in accordance with refuge policy and regulations. However, in the Island Pond Unit, we have provided non-ambulatory hunt blinds to accommodate hunters with this need.

Permanent deer hunting stands will be phased out over a 5-year period in all areas except the disabled hunting area. A limited number of permits (no more than 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 3,432 acres is open to migratory bird hunting, which is 40 percent of the refuge (includes lands purchased with Land and Water Conservation Funds which are excluded from the 40 percent rule). Seasonal closures will occur to not only protect wildlife, but also to minimize conflicts between different hunting activities and/or other non-consumptive recreational uses (e.g., close hunting in late November in designated areas to minimize bald eagle and waterfowl disturbance and provide access for non-consumptive users only on Sundays in designated areas during the hunting season). In the lottery hunt area, hunting will occur 3 days per week and cease at noon. In all hunt areas, hunting will occur four days per week and cease at 3 p.m.

Although the permanent waterfowl blinds on the refuge will be phased out over a 5-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 25 to 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 will 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.

Upland game and webless migratory bird hunting: A total of 1,995 acres are available for hunting of upland game and webless migratory birds. Dove hunting will not be open on 110 of these acres, which should affect few hunters. Some conflict with concurrent hunting and the potential for trespassing on adjacent private land are expected and previously discussed in this section. 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.

Wild turkey hunting: A total of 3,729 acres are open for hunting wild turkey during legal shooting hours on selected hunt days. In recent years, hunter and staff observations indicate that a huntable population of turkeys may exist on the refuge (refer to impacts to landbirds for more information). Limited opportunities exist on public lands to hunt turkey and the refuge may contribute to providing additional quality opportunities for hunters. Hunting of turkey will be permitted to a limited number of hunters (no more than five) and this number may be adjusted (increased or decreased) based on changes in turkey population data.

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 will still 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 and turkey; $15 for waterfowl), preseason application fee ($5/hunter), and processing fee for permits acquired after the preseason drawing ($2 to $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. 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. Application and permit fees for turkey hunting may be waived if the lottery drawing is administered by the State.

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 will 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 will not diminish resources dedicated to other refuge management programs. Impacts to refuge resources are expected to be negligible.

For the entire cumulative impact analysis of hunting, refer to the refuge's hunting management plan.

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 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 Division 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 and 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.

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 Division of Fish and Wildlife 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:

As part of the CCP process for Prime Hook NWR, this compatibility determination underwent extensive public review during an 89-day public review and comment period on the draft CCP/EIS from May 31 to August 27, 2012, and a 30-day public review period on the final CCP/EIS from December 28, 2012 to January 28, 2013. We announced the public review and comment periods in the *Federal Register* and through local media announcements. During the comment and review periods, we received numerous comments on hunting (see appendix M in the final CCP). The majority of comments on hunting fell into the following categories: concerns about public safety if tree stands for deer hunting and waterfowl hunting blinds are phased out, concerns about conflicts between hunters and other user groups, concerns about the impacts of hunting on wildlife and refuge habitats, and requests to maintain the existing hunting days, hours, and lottery process. Based on these comments, we made the following changes to our hunting program proposal:

- We revised objective 5.1a to no longer propose opening the refuge to white-tailed deer hunting on Prime Hook Creek.
- We revised objective 5.1b to allow waterfowl hunting 4 days per week until 3 p.m. in all waterfowl hunting areas to be consistent with State hunting regulations.
- We modified our proposed waterfowl hunting areas under objective 5.1b. Open areas now include:
  - Unit I (open to free-roam hunting)
  - Unit III (south of Prime Hook Road—open to free-roam hunting; lottery hunt area that now includes the area south of the Headquarters Ditch and six blind locations)
  - Unit IV (disabled blind only)

  Closed areas now include:
  - The area near Prime Hook Beach for disabled hunters is now closed and all disabled waterfowl hunting will be in the current wheelchair-accessible blind in Unit IV.
  - Areas of free-roam hunting along the Broadkill River and hunting west of Foord's Landing on Prime Hook Creek are now closed.
- We revised objective 5.1b to update information on the non-ambulatory waterfowl blinds on the Island Farm. We now propose to issue permits by preseason lottery drawing for first 2 days of each waterfowl season split; days thereafter will be first-come; first-serve.
- We removed the number of proposed waterfowl blinds sites under objective 5.1b because the habitat is constantly changing. The number of blind sites will be a function of the habitat conditions when the CCP is implemented.
- We revised objective 5.1 to permit snow goose conservation hunting in only wetland areas (no conservation order hunting in the uplands).
- We revised objective 5.1d to allow turkey hunting until 1 p.m. on the refuge to be consistent with State hunting regulations.
- We revised objective 5.1d to state that the number of turkey hunting numbers may be increased or decreased from the proposed five hunters based on trends in population data.
- We revised objective 5.1 to require that all wheelchair hunters to have an assistant.

- We clarified our proposal for red fox hunting under objective 5.1c. We propose to offer red fox hunting opportunities concurrent with deer hunting season. We will not allow chase hunting and will not permit centerfire and rimfire rifles.

- We revised goal 5 to continue to allow year-round access to the western 4 miles of Prime Hook Creek for visitors engaged in uses such as wildlife observation, wildlife photography, and fishing.

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 final CCP, Hunting Management Plan, and refuge-specific regulations (see Description of Use section).

To ensure compatibility with refuge purposes and the mission of the 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 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 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) 2/13/13 (Date)

CONCURRENCE:

Regional Chief: _____ (Signature) 3/13/2013 (Date)

MANDATORY 15-YEAR REEVALUATION DATE: 3/13/2028

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 will be conducted within the refuge's 10,144 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 will 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. In Unit I, two trails provide 1.1 miles of hiking opportunities and associated recreation.

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. In Unit II, one trail provides 0.5 miles of hiking opportunites and associated recreation.

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 6 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 and 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 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. In Unit III, 10 trails provide 8.1 miles of hiking opportunities and associated recreation.

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. In Unit IV, one trail provides 0.2 miles of hiking opportunities and associated recreation.

(c) When would the use be conducted?

Opportunities for wildlife observation, wildlife photography, environmental education, and environmental interpretation 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 from one-half hour before sunrise to one-half hour after sunset. Using existing roads will minimize impacts to refuge resources. Moderate beneficial impacts are expected. Some conflict between refuge users is expected to result in short-term moderate adverse impacts, which will be managed through seasonal closures. These seasonal closures are highlighted below and apply mostly to non-consumptive users during the hunting season. Other seasonal closures are in place to minimize wildlife disturbance.

(1) Designated beach dunes and overwash areas: Open year-round with seasonal closures from March 1 through September 1 due to nesting State-endangered least terns and American oystercatchers, and the potential for use by federally threatened piping plovers. Areas may be reopened if no nesting activity occurs or when nesting ends for the season.

(2) Deep Branch Road Trail (includes Goose and Flaxhole Ponds), Eastern Prime Hook Creek (from Foord's Landing to the headquarters ramp), and hiking trail on Fowler Beach Road (southside in Unit II): Open with seasonal closures of every day from September 1 through March 15 and if necessary during the snow goose conservation order or turkey hunting seasons. If and when the photography blind is available on the southside of Fowler Beach Road, this portion of the trail will be open year-round and open every Sunday during the hunting season.

(3) Headquarters area (includes Turkle and Fleetwood Ponds): Open 363 days a year (closed for two deer hunts) and portions may be closed for turkey hunts.

(4) The northern portion of Unit IV (includes trail overlooking Vergie's Pond): Open with a seasonal closure from the Monday before Thanksgiving through March 15 and if necessary during the snow goose conservation order hunting season.

(5) Hiking Trails on Fowler Beach Road (northside in Unit I), Prime Hook Road, and Slaughter Beach Road and Slaughter Canal: Opportunities available year-round but only open every Sunday during the hunting season.

(6) Roadside pull-offs and water control structures, fishing areas at Petersfield Ditch, Slaughter Canal, and Cods Road, and western Prime Hook Creek (from Foord's Landing to Waples Pond): Open year-round.

(d) How would the use be conducted?

These four priority public uses will 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 will 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 Web site.

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 Foord's Landing, at suitable sites on Goose and Flaxhole Ponds, and at boat ramps at Turkle and Fleetwood Ponds. Non-motorized boaters are encouraged to do their canoeing or kayaking within 2-hour windows on either side of high tides for best access.

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. Adaptive management is necessary if Fowler Beach Road, from Slaughter Canal to its terminus at the Delaware Bay, is abandoned by Delaware Department of Transportation (DelDOT) and donated to the Service. If, upon DelDOT's removal of the existing layer of asphalt overlying unconsolidated fill, the walking trail will

serve its purpose of public use until marsh vegetation and hydrologic function reclaim the trail and the formally bisected habitat (Units I and II) function as one unit. When conditions are deemed unsafe, access will not be permitted to Fowler Beach for public use opportunities such as wildlife observation, wildlife photography, and fishing.

In addition to published 50CFR regulations and State regulations, refuge-specific regulations also apply for Wildlife Observation and Photography, Environmental Education and 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 and Fleetwood Ponds.
   (c) Manual propulsion only on Goose and Flaxhole Ponds.
   (d) Air thrust boats and jet skis are not permitted.
   (e) A "Slow No Wake" zone has been established on the Headquarters Canal and Slaughter Canal.

(4) Areas may be closed on the refuge without warning.

(5) Visitors must stay on the designated trail routes and areas.

(6) Opportunities for wildlife observation, wildlife photography, environmental education, and environmental interpretation 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 from one-half hour before sunrise to one-half hour after sunset. Using existing roads will minimize impacts to refuge resources. Moderate beneficial impacts are expected. Some conflict between refuge users is expected to result in short-term moderate adverse impacts, which will be managed through seasonal closures. These seasonal closures are highlighted below and apply mostly to non-consumptive users during the hunting season. Other seasonal closures are in place to minimize wildlife disturbance.

   (a) Designated beach dunes and overwash areas: Open year-round with seasonal closures from March 1 through September 1 due to nesting State-endangered least terns and American oystercatchers, and the potential for use by federally threatened piping plovers. Areas may be reopened if no nesting activity occurs or when nesting ends for the season.

   (b) Deep Branch Road Trail (includes Goose and Flaxhole Ponds), Eastern Prime Hook Creek (from Foord's Landing to the headquarters ramp), and hiking trail on Fowler Beach Road (southside in Unit II): Open with seasonal closures of every day from September 1 through March 15 and if necessary during the snow goose conservation order or turkey hunting seasons. If and when the photography blind is available on the southside of Fowler Beach Road, this portion of the trail will be open year round and open every Sunday during the hunting season.

   (c) Headquarters area (includes Turkle and Fleetwood Ponds): Open 363 days a year (closed for two deer hunts) and portions may be closed for turkey hunts.

   (d) The northern portion of Unit IV (includes trail overlooking Vergie's Pond): Open with a seasonal closure from the Monday before Thanksgiving through March 15 and if necessary during the snow goose conservation order hunting season.

   (e) Hiking Trails on Fowler Beach Road (northside in Unit I), Prime Hook Road, and Slaughter Beach Road and Slaughter Canal: Opportunities available year-round but only open every Sunday during the hunting season.

   (f) Roadside pull-offs and water control structures, fishing areas at Petersfield Ditch, Slaughter Canal, and Cods Road, and western Prime Hook Creek (from Foord's Landing to Waples Pond): 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 7:30 a.m. to 4 p.m. 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, 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 will 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 Service's 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 Web site.

Sufficient staff and maintenance funding within our base budget of nearly $544,000 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 final CCP/EIS.

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.

Visitors engaging in these 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 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 do 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 because any increases in visitation are not expected to have any negative impacts to vegetation from what is already occurring. Negligible disturbance to vegetation will occur during the construction of new parking areas on Fowler Beach Road, Broadkill Beach Road, and Slaughter 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. The staff has not observed any impacts as a result of trampling of vegetation under current conditions.

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 (USFWS 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 3,185 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. 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. We expect negligible impacts to secretive marsh and waterbirds due to proposed expansions in public use activities.

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 2009) 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.

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 enable staff to provide better customer service. We 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:

As part of the CCP process for Prime Hook NWR, this compatibility determination underwent extensive public review during an 89-day public review and comment period on the draft CCP/EIS from May 31 to August 27, 2012, and a 30-day public review period on the final CCP/EIS from December 28, 2012 to January 28, 2013. We announced the public review and comment periods in the *Federal Register* and through local media announcements. During the comment and review periods, we received numerous comments on wildlife observation, wildlife photography, environmental education, and interpretation (see appendix M). The majority of

comments fell into the following categories: concerns about conflicts between these uses and hunting, requests to expand these uses on the refuge, and impacts of these uses on wildlife. In response to comments about conflicts with hunters, we revised goal 5 to continue to allow year-round access to the western 4 miles of Prime Hook Creek for visitors engaged in uses such as wildlife observation and photography (i.e., we no longer propose to open Prime Hook Creek to hunting). We did not make any other changes to this compatibility determination.

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; final 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, 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 and Fleetwood Ponds.

(c) Manual propulsion only on Goose and Flaxhole Ponds.

(d) Air thrust boats and jet skis are not permitted.

(e) A “Slow No Wake” zone has been established on the Headquarters Canal and Slaughter Canal.

(6) Areas may be closed on the refuge without warning.

(7) Visitors must stay on the designated trail routes and areas.

(8) Opportunities for wildlife observation, wildlife photography, environmental education, and environmental interpretation 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 from one-half hour before sunrise to one-half hour after sunset. Using existing roads will minimize impacts to refuge resources. Moderate beneficial impacts are expected. Some conflict between refuge users is expected to result in short-term moderate adverse impacts, which will be managed through seasonal closures. These seasonal closures are highlighted below and apply mostly to non-consumptive users during the hunting season. Other seasonal closures are in place to minimize wildlife disturbance.

(a) Designated beach dunes and overwash areas: Open year-round with seasonal closures from March 1 through September 1 due to nesting State-endangered least terns and American oystercatchers, and the potential for use by federally threatened piping plovers. Areas may be reopened if no nesting activity occurs or when nesting ends for the season.

(b) Deep Branch Road Trail (includes Goose and Flaxhole Ponds), Eastern Prime Hook Creek (from Foord's Landing to the headquarters ramp), and hiking trail on Fowler Beach Road (southside in Unit II): Open with seasonal closures of every day from September 1 through March 15 and if necessary during the snow goose conservation order or turkey hunting seasons. If and when the photography blind is available on the southside of Fowler Beach Road, this portion of the trail will be open year-round and open every Sunday during the hunting season.

(c) Headquarters area (includes Turkle and Fleetwood Ponds): open 363 days a year (closed for two deer hunts) and portions may be closed for turkey hunts.

(d) The northern portion of Unit IV (includes trail overlooking Vergie's Pond): Open with a seasonal closure from the Monday before Thanksgiving through March 15 and if necessary during the snow goose conservation order hunting season.

(e) Hiking Trails on Fowler Beach Road (northside in Unit I), Prime Hook Road, and Slaughter Beach Road and Slaughter Canal: Opportunities available year-round but only open every Sunday during the hunting season.

(f) Roadside pull-offs and water control structures, fishing areas at Petersfield Ditch, Slaughter Canal, and Cods Road, and western Prime Hook Creek (from Foord's Landing to Waples Pond): 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 7:30 a.m. to 4 p.m. 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, 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) 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.

(15) 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. No refuge-specific permits are required.

(16) 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

(17) 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 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 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) 2/13/13 (Date)

CONCURRENCE:

Regional Chief: _____ (Signature) 3/13/2013 (Date)

MANDATORY 15-YEAR REEVALUATION DATE: 3/13/2028

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 10,144 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 10,144 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 10,144 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

Appendix G

Intra-Service Section 7 Biological Evaluation Form

INTRA-SERVICE SECTION 7 BIOLOGICAL EVALUATION FORM

Originating Person: Arthur Coppola
Telephone Number: 302-684-8419

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:

- Delmarva Fox Squirrel (DFS) (*Sciurus niger cinereus*)
- 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:
- Red Knot (*Calidris canutus*)

D. Include species/habitat occurrence on a map.
Habitat maps are found in Chapter 3 of the final CCP/EIS.

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 has prepared 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 final CCP/EIS.

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:

- **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.

- **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.

- **Red Knots** are a candidate species which may use the refuge during migration. It is generally restricted to the overwash and beach areas but occasionally may move inland and use mudflats.

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 final CCP/EIS.

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 final CCP/EIS.

VII. Determination of effects:

A. Explanation of effects of the action on species in item III:
Refer to Chapter 4 of the final CCP/EIS 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 final CCP/EIS, (Chapter 4, Alternative B, the Service-Preferred Alternative), Goals One through Four outline the proposed preservation, restoration, and management of barrier beach and saltmarsh habitats, forests, the wetland impoundment complex, and early successional habitats. Proposed actions include reforestation of substantial potential Delmarva Fox Squirrel habitat, restoration of salt marsh within the impounded wetland complex, and protection of beach overwash habitats created in certain parts of the refuge, which would be suitable for piping plovers and red knots.

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 preferred 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 Squirrel (any effects completely beneficial)
2) Piping Plover (any effects completely beneficial)
3) Red Knot (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 1/4/13

Refuge Manager, Prime Hook NWR

IX. Reviewing ESO Evaluation:

A. Concurrence _X_ Non-concurrence____

B. Formal consultation required_____

C. Conference required _____

D. Informal conference required _____

E. Remarks (attach additional pages as needed):

Signature, Field Supervisor Date 2/4/2013

[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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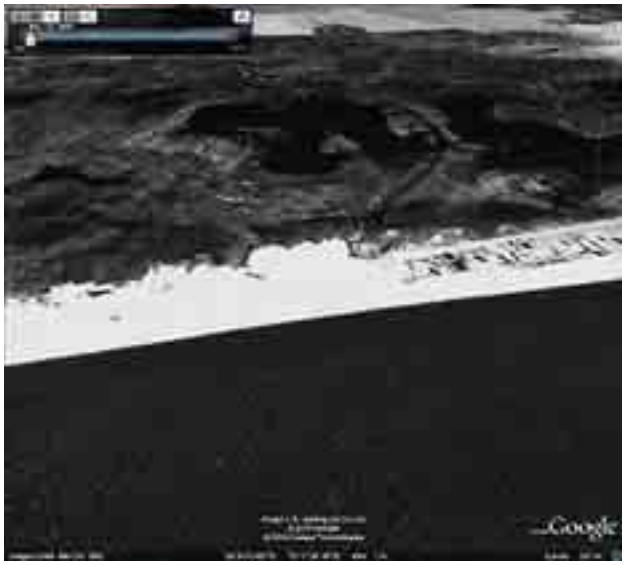
Flock of snow geese on the refuge

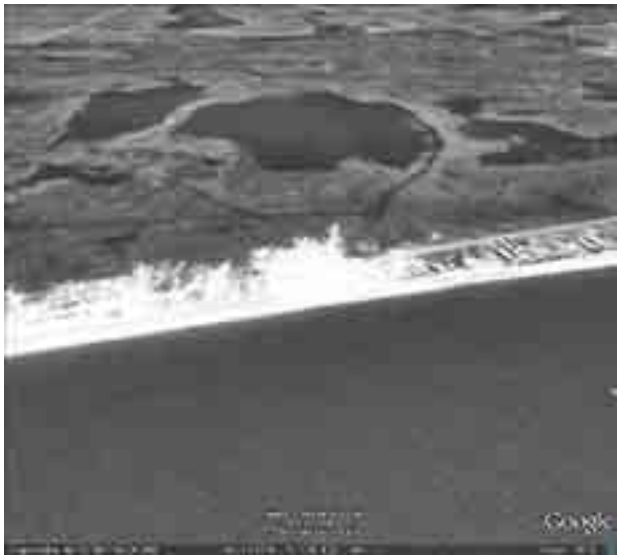
Aerial Photography

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.



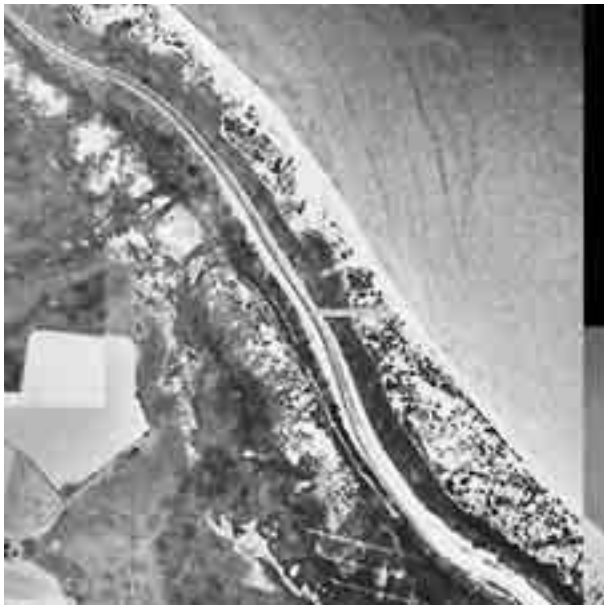
1992



1998

2007

2) Broadkill Beach, dated 1937, 1961, 1968, and 2007 showing pattern of natural overwash and subsequent island community development.



1937

1961

1968

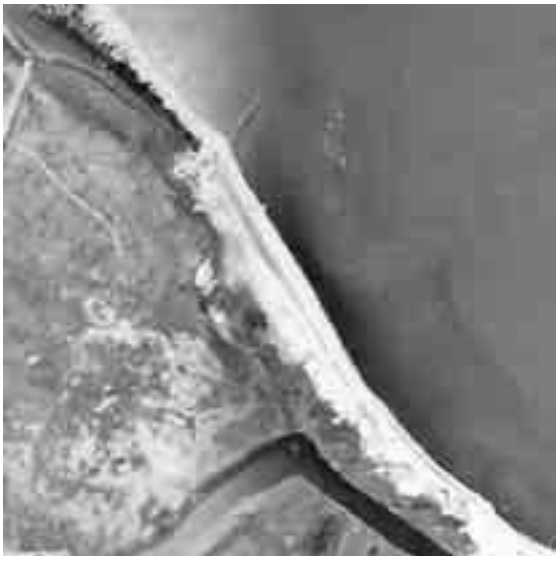
2007

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).

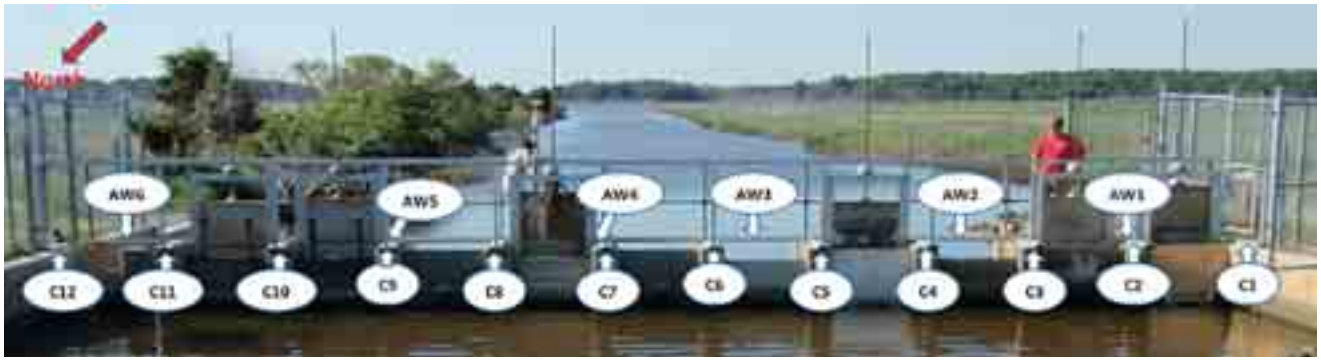
The water control structure and wetland elevation surveys were conducted using VPR "Prim 1" as the primary control point. This VPR was established by the Delaware Department of Natural Resources and Environmental Control (DNREC) Shoreline and Waterway Section. This VPR was established by a loop closure 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.)



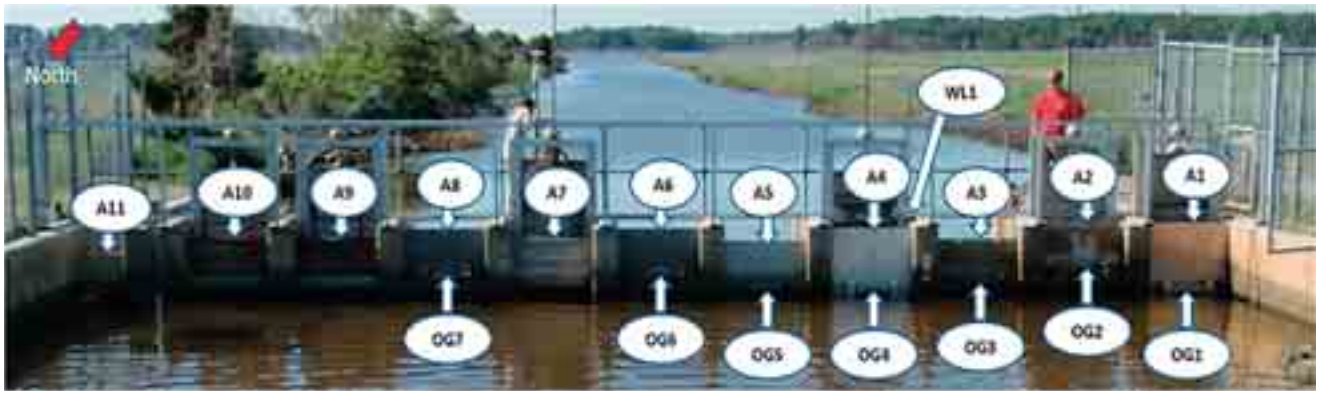
Tops of Concrete Structures

	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)	1.154 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	1.171 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 0.006 m VP 0.045 m	1.104 m HP 0.007 m VP 0.011 m	0.950 m HP 0.012 m VP 0.019 m	1.053 m HP 0.008 m VP 0.008 m	0.950 m HP 0.007 m VP 0.012 m	1.120 m HP 0.009 m VP 0.012 m	0.950 m HP 0.010 m VP 0.020 m	1.121 m HP 0.009 m VP 0.013 m	0.920 m HP 0.007 m VP 0.010 m	0.964 m HP 0.007 m VP 0.010 m	1.121 m 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	0.385 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 0.043 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)	0.803 m HP 0.007 m VP 0.031 m
Constructed Elevation (m NAVD 88: 1991)	0.717 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	1.018 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 0.007 m VP 0.010 m	0.888 m HP 0.012 m VP 0.017 m	1.008 m HP 0.007 m VP 0.010 m	0.889 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	0.731 m 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	0.231 m 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

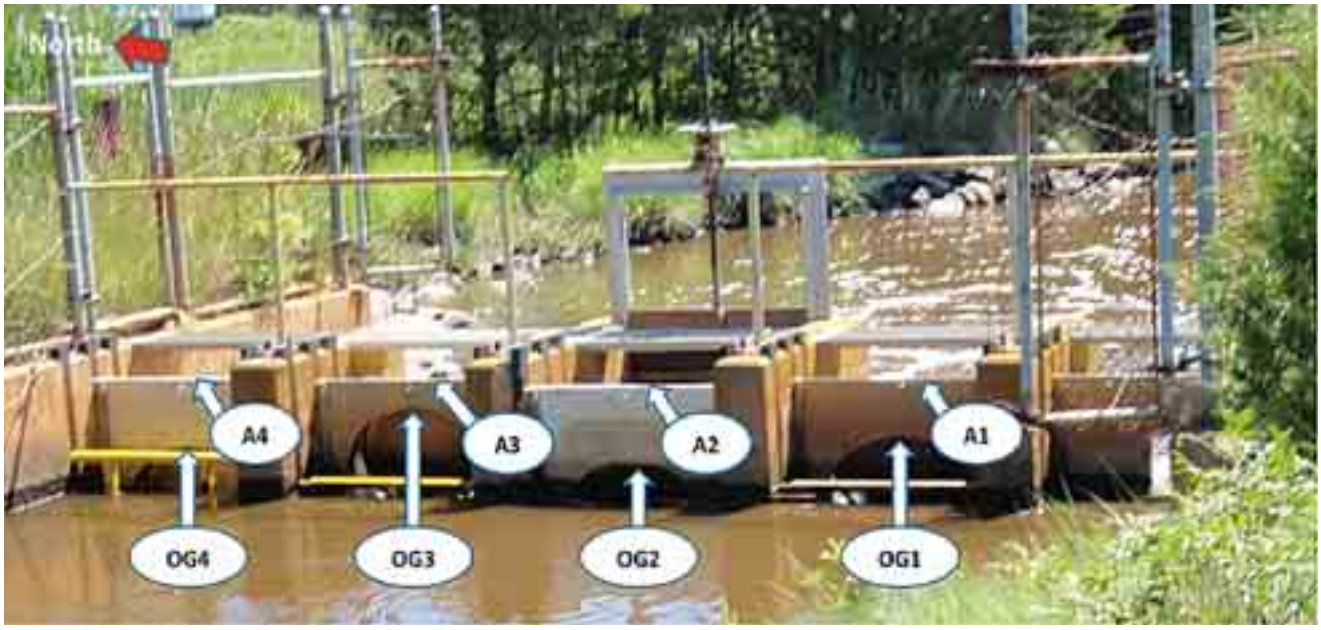
Tops of Aluminum Walkways

	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

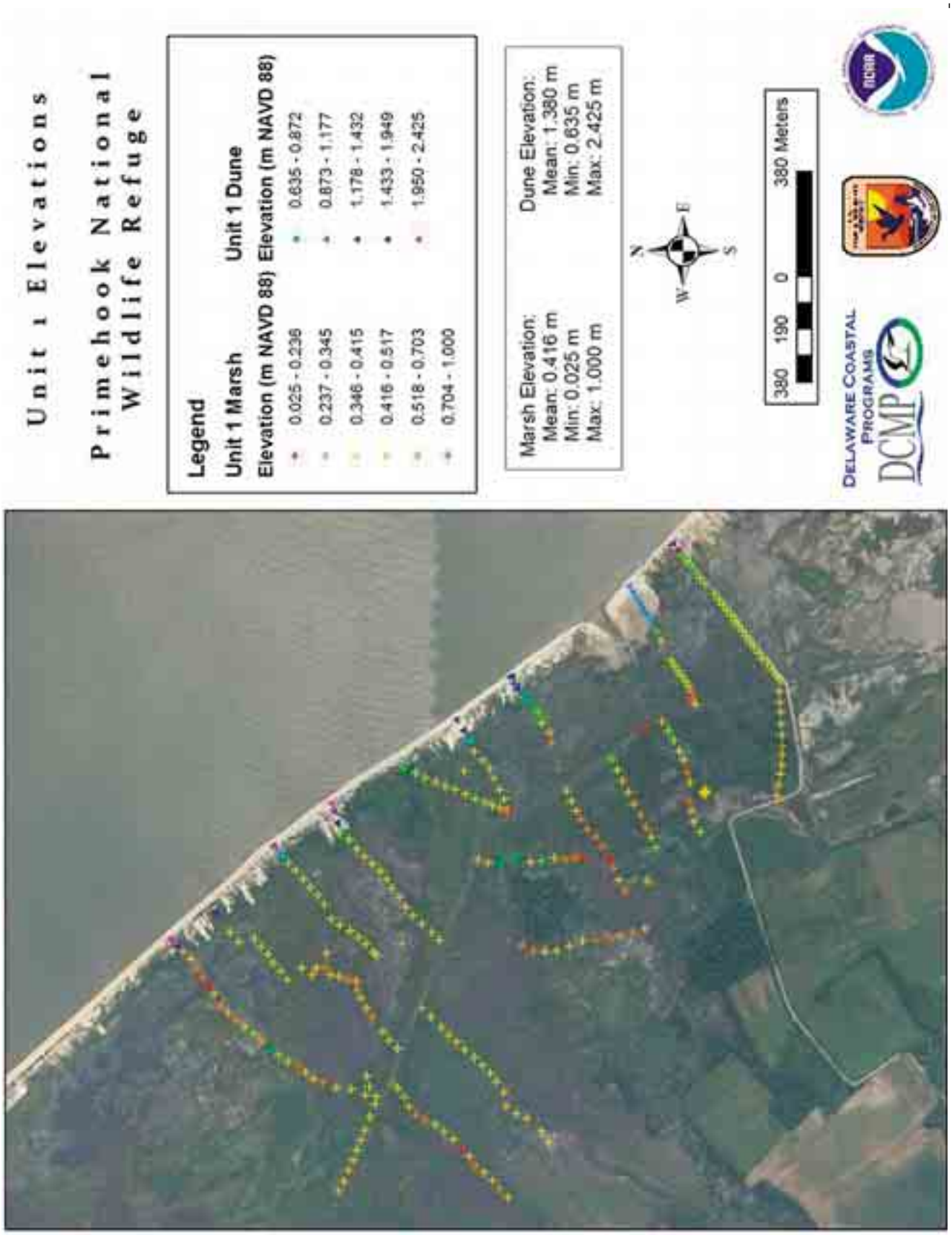
	A1	A2	A3	A4
Current Elevation (m NAVD 88; 06/07/10)	0.802 m HP 0.007 m VP 0.013 m	0.810 m HP 0.009 m VP 0.014 m	0.812 m HP 0.009 m VP 0.013 m	0.828 m HP 0.009 m VP 0.013 m

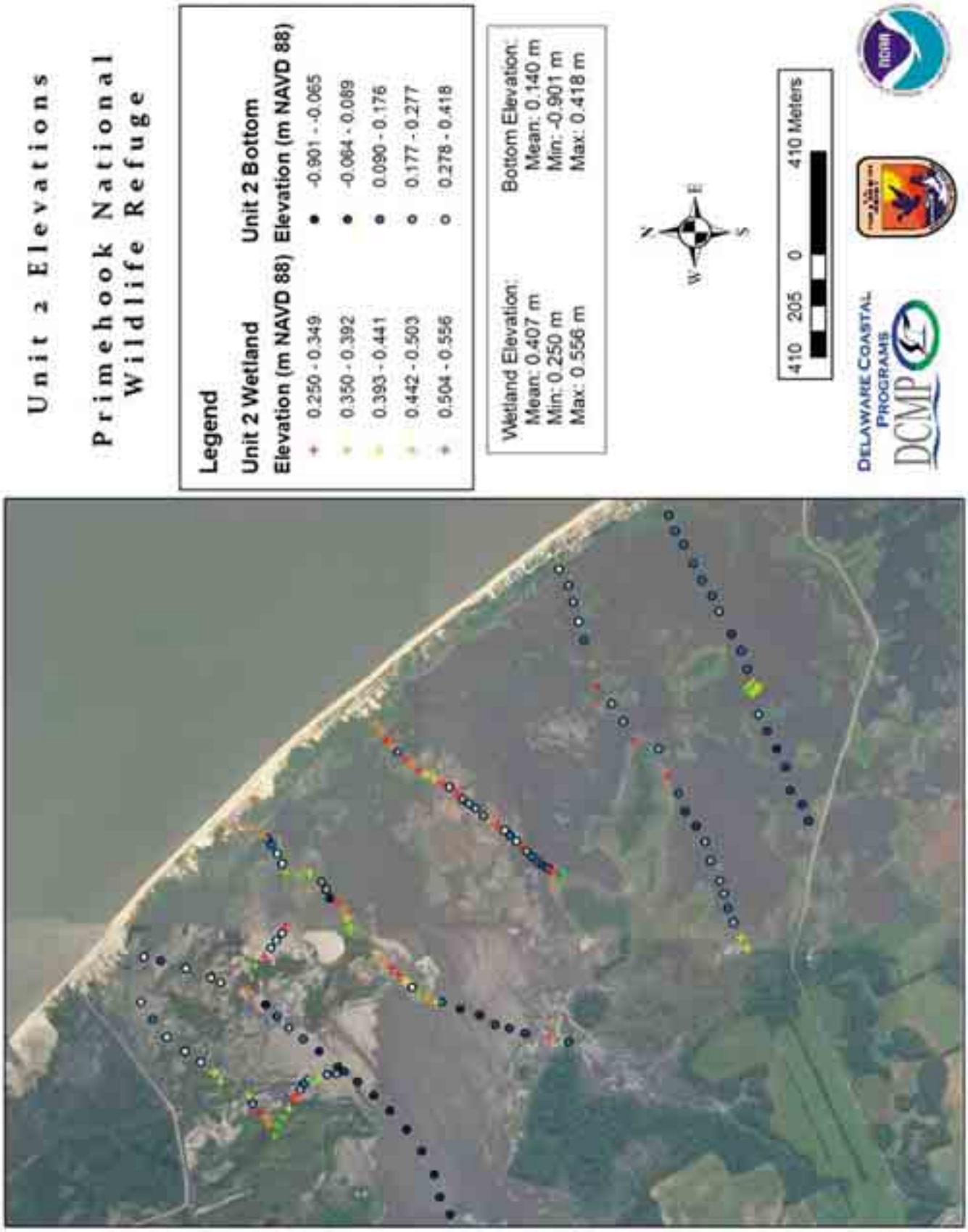
Top of O-Gate Openings

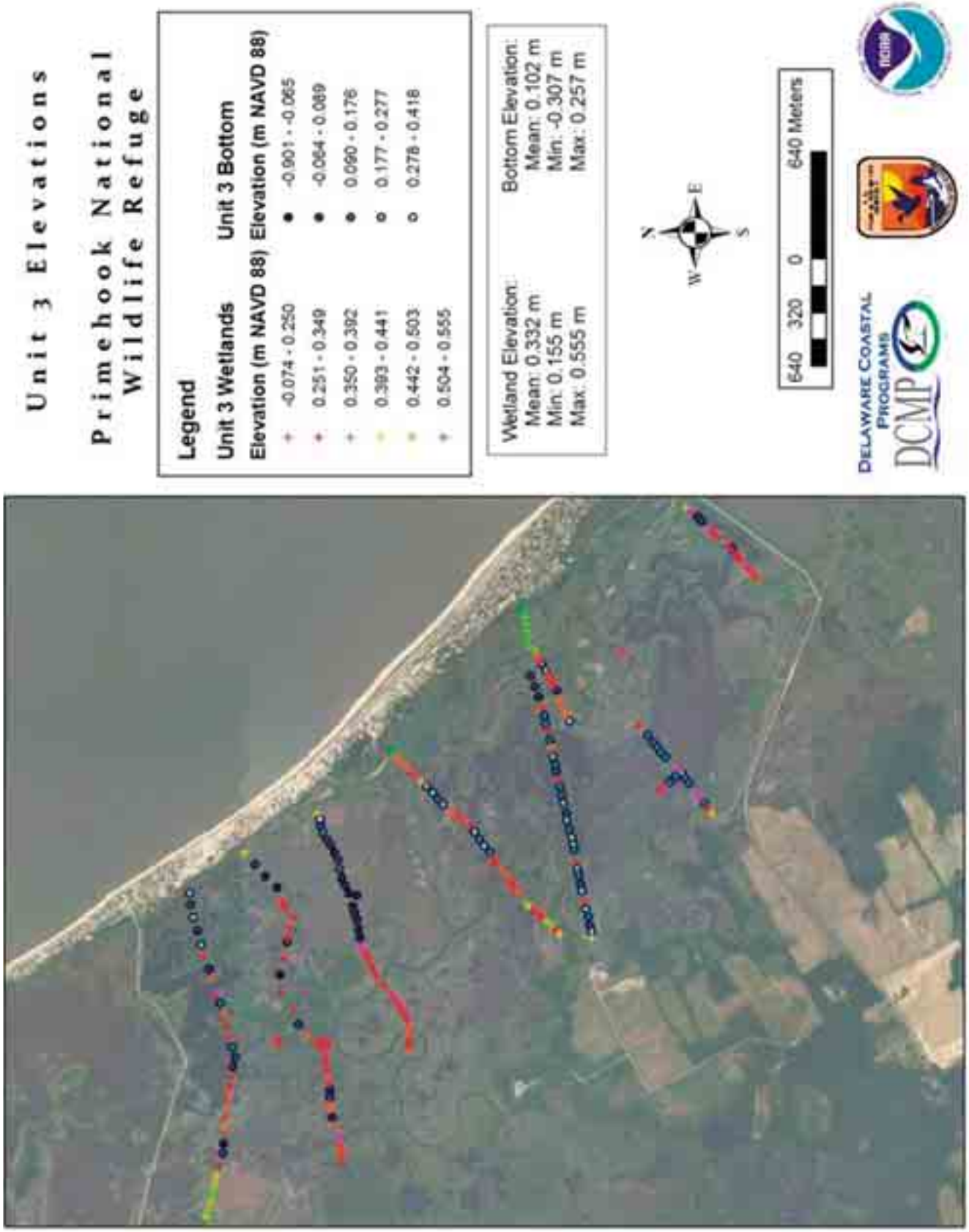
	OG1	OG2	OG3	OG4
Current Elevation (m NAVD 88; 06/07/10)	0.504 m HP 0.010 m VP 0.016 m	0.415 m HP 0.015 m VP 0.025 m	0.668 m HP 0.007 m VP 0.011 m	0.436 m HP 0.007 m VP 0.011 m

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)
0.025 - 0.236
0.237 - 0.345
0.346 - 0.415
0.416 - 0.517
0.518 - 0.703
0.704 - 1.000
Unit 1 Dune
Elevation (m NAVD 88)
0.635 - 0.872
0.873 - 1.177
1.178 - 1.432
1.433 - 1.949
1.950 - 2.425
Marsh Elevation:
Mean: 0.416 m
Min: 0.025 m
Max: 1.000 m
Dune Elevation:
Mean: 1.380 m
Min: 0.635 m
Max: 2.425 m
N
E
S
W
380 190 0 380 Meters
Delaware Coastal Programs
DCMP


Unit 2 Elevations
Primehook National Wildlife Refuge
Legend
Unit 2 Wetland
Elevation (m NAVD 88)
0.250 - 0.349
0.350 - 0.392
0.393 - 0.441
0.442 - 0.503
0.504 - 0.556
Unit 2 Bottom
Elevation (m NAVD 88)
-0.901 - -0.065
-0.064 - 0.089
0.090 - 0.176
0.177 - 0.277
0.278 - 0.418
Wetland Elevation:
Mean: 0.407 m
Min: 0.250 m
Max: 0.556 m
Bottom Elevation:
Mean: 0.140 m
Min: -0.901 m
Max: 0.418 m
N
E
S
W
410 205 0 410 Meters
Delaware Coastal Programs
DCMP


Unit 3 Elevations
Primehook National Wildlife Refuge
Legend
Unit 3 Wetlands
Unit 3 Bottom
Elevation (m NAVD 88)
Elevation (m NAVD 88)
-0.074 - 0.250
-0.001 - -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:
Mean: 0.332 m
Min: 0.155 m
Max: 0.555 m
Bottom Elevation:
Mean: 0.102 m
Min: -0.307 m
Max: 0.257 m
N
E
S
W
640 320 0 640 Meters
Delaware Coastal Programs
DCMP

References:

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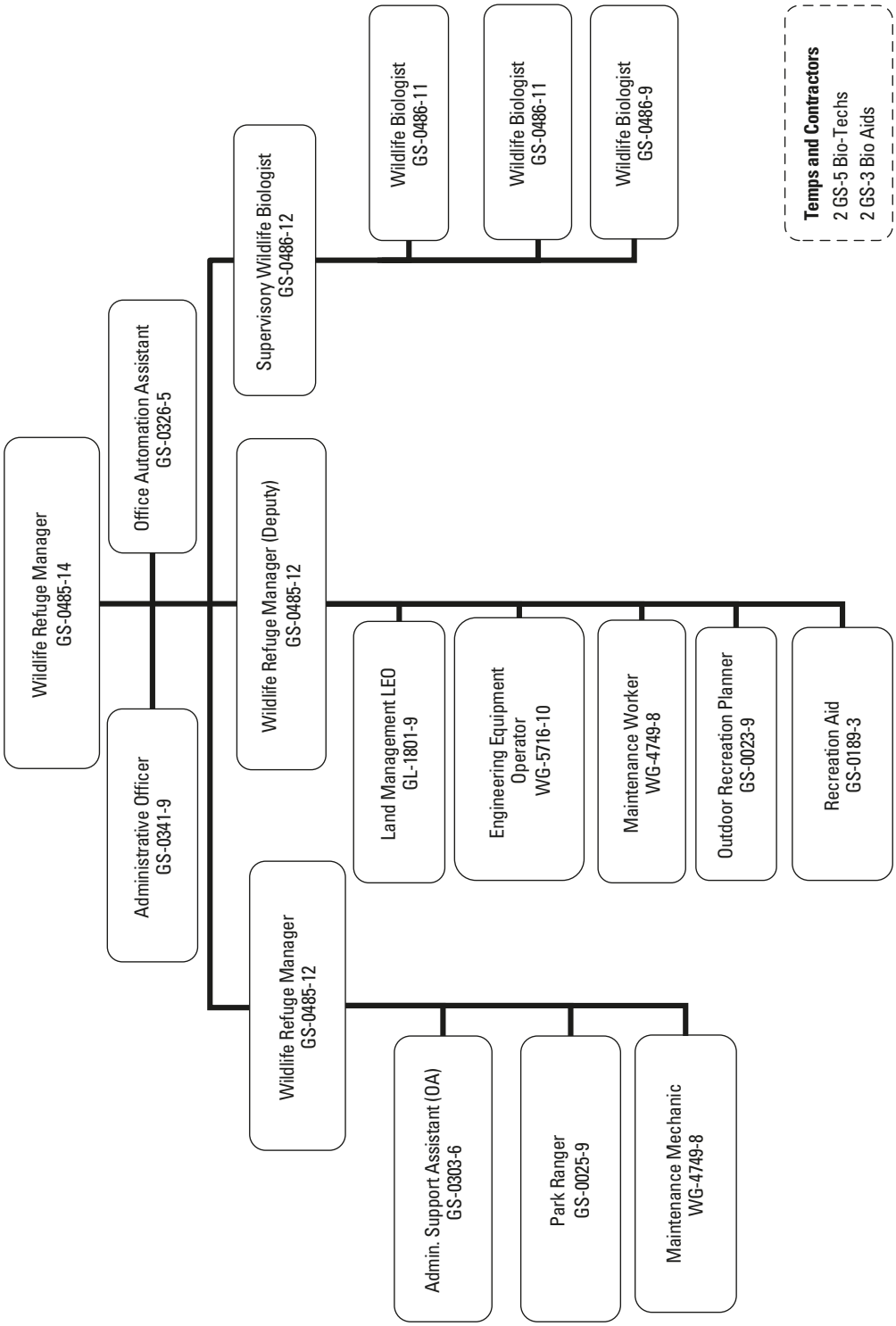
Appendix L

©Kevin Fleming

Female prairie-warbler

Staffing Chart

U.S. Fish and Wildlife Service
Northeast Region
Regional Chief, National Wildlife Refuge System
Coastal Delaware NWR Complex
(Bombay Hook and Prime Hook)



Appendix M

©Kevin Fleming

Short-billed dowitcher

Summary of Public Comments and Service Responses on the Draft Comprehensive Conservation Plan and Environmental Impact Statement for Prime Hook National Wildlife Refuge

Introduction

In May 2012, the U.S. Fish and Wildlife Service (Service, we, our) completed the draft comprehensive conservation plan and environmental impact assessment (draft CCP/EIS) for Prime Hook National Wildlife Refuge (NWR, the refuge). The draft CCP/EIS outlines three alternatives for managing the refuge. Alternative B is identified as the "Service-preferred alternative."

We initially released the draft CCP/EIS for 69 days of public review and comment from May 31, 2012 to August 6, 2012. In response to public requests, we extended that period another 20 days, to August 27, 2012. We also held 7 public meetings in Milford, Milton, and Lewes, Delaware. We evaluated all the letters and e-mails sent to us during that comment period, along with comments recorded at our public hearing. This document summarizes all of the substantive comments we received and provides our responses to them.

This document summarizes the public comments that raised issues and concerns within the scope of this final CCP/EIS and our responses to them. Based on our analysis in the draft CCP/EIS and our evaluation of those comments, we have modified alternative B, which remains our preferred alternative in the final CCP/EIS. Our modifications include additions, corrections, or clarifications of our preferred management actions. We have also determined that none of those modifications warrants our publishing a revised or amended draft before publishing the final CCP/EIS.

There are some important changes in the final:

- We clarified under alternative B, objectives 1.1 and 3.1 that we feel that dune restoration is a potential, and even likely, first step in our proposal to restore marsh habitat. We also reiterated that we would only plan to restore the dunes as part of the comprehensive marsh restoration, not as separate action.

- We revised the strategies under alternative B, objective 3.1 and our analysis in chapter 5 to provide some additional analysis of other shoreline modification and wave attenuation strategies, such as living shorelines and wave attenuation structures.

- We reduced, expanded, or modified different hunting strategies to be responsive to public concerns, be more consistent with state regulations, and eliminate confusion for hunters and non-hunters alike.

- We revised alternative B, objective 5.1a to no longer propose opening the refuge to white-tailed deer hunting on Prime Hook Creek.

- We revised alternative B, objective 5.1b to allow waterfowl hunting 4 days per week until 3:00 pm in all waterfowl hunting areas to be consistent with State hunting regulations.

- We modified our proposed waterfowl hunting areas under alternative B, objective 5.1b. Open areas now include:

  - Unit I (open to free-roam hunting)
  - Unit III (south of Prime Hook Road - open to free-roam hunting; lottery hunt area that now includes the area south of the Headquarters Ditch and six blind locations)
  - Unit IV (disabled blind only)

  Closed areas now include:

  - The area near Prime Hook Beach for disabled hunters is now closed and all disabled waterfowl hunting will be in the current wheelchair accessible blind in Unit IV.
  - Areas of free-roam hunting along the Broadkill River and hunting west of Foord's Landing on Prime Hook Creek are now closed.

- We revised alternative B, objective 5.1b to update information on the non-ambulatory waterfowl blinds on the Island Farm. We now propose to issue permits by preseason lottery drawing for first 2 days of each waterfowl season split; days thereafter will be first-come; first-serve.

- We removed the number of proposed waterfowl blinds sites under alternative B, objective 5.1b because the habitat is constantly changing. The number of blind sites will be a function of the habitat conditions when the CCP is implemented.

- We revised alternative B, objective 5.1 to permit snow goose conservation hunting in only wetland areas (no conservation order hunting in the uplands).

- We revised alternative B, objective 5.1d to allow turkey hunting until 1:00 pm on the refuge to be consistent with State hunting regulations.

- We revised alternative B, objective 5.1d to state that the number of turkey hunting numbers may be increased or decreased from the proposed five hunters based on trends in population data.

- We revised alternative B, objective 5.1 to require that all disabled hunters to have an assistant.

- We clarified our proposal for red fox hunting under alternative B, objective 5.1c. We propose to offer red fox hunting opportunities concurrent with deer hunting season. We will not allow chase hunting and will not permit centerfire and rimfire rifles.

- We revised alternative B, goal 5 to continue to allow year-round access to the western 4 miles of Prime Hook Creek for visitors engaged in uses such as wildlife observation, wildlife photography, and fishing.

- We updated the following information under alternative B, objective 5.2:

  - We updated the number and length of existing and proposed trails to 14 trails covering 9.9 miles.
  - We propose rerouting Slaughter Beach Trail due to changes in habitat, including adding a new parking area on the existing interior road and some minimal vegetation removal.

- We revised alternative B, objective 5.3 to allow fish and crabbing on the pull-offs along Prime Hook Road. We also clarified that the regulations for catch and release and use of barbless hooks will only occur west of Foord's Landing on Prime Hook Creek. These regulations may be revised as fishery population dynamics change.

- We have decided to permit the use of adulticides for mosquito control when there is a documented human disease threat, instead of only when a public health emergency is declared. We have modified a strategy under alternative B, objective 1.2 to state that we will allow the use of adulticides on the refuge once DMCS's surveillance program has detected a detected a mosquito-borne human health threat on the refuge or within the flight range of vector mosquitoes (approximately 5 miles from the refuge).

Our Regional Director will issue a final record of decision (ROD), after

- We provide the final CCP/EIS to interested or affected parties for a 30-day period of review, and

- Our Regional Director reaffirms that the final CCP supports the purpose and need for the CCP, achieves the purposes for which the refuge was established, helps fulfill the mission of the Refuge System, and complies with all legal and policy mandates.

Once she has signed and dated the ROD, we will publish a notice of the availability of the final documents in the *Federal Register*. That notice will complete the planning phase of the CCP process, and we can begin its implementation phase.

Summary of Comments Received

After the comment period ended, we compiled all of the comments we received, including all letters, e-mails, and comments recorded at public meetings. In total, we received 106 separate written responses and 18 oral comments from the public meetings. The separate written responses we received represent 150 different signatures. We also received 1,024 copies of a single form letter, as well as an online petition signed by 522 individuals.

We received a variety of letters from local, State, and Federal governmental agencies, including the following:

- Delaware Department of Agriculture
- Delaware Department of Natural Resources and Environmental Control (DNREC)
- Delaware Department of Transportation (DelDOT)
- DNREC - Division of Fish and Wildlife, Mosquito Control Section
- Delaware Historical and Cultural Affairs
- Delaware State Senator Gary Simpson
- Sussex County Councilwoman Joan Deaver
- Town of Slaughter Beach, Delaware
- U.S. Environmental Protection Agency (EPA)

We also received comments signed by representatives from the following organizations:

- Alliance of Bay Communities
- Broadkill Beach Preservation Association
- Canoe Cruisers Association of Greater Washington, D.C.
- The Center for Food Safety
- Defenders of Wildlife
- Delaware Audubon Society
- Delaware Chapter of the Sierra Club
- Delaware Riverkeeper Network
- Delaware Votes for Animals
- Delmarva Ornithological Society
- Ducks Unlimited
- The Humane Society of the United States
- The Pegasus Foundation
- Prime Hook Beach Organization
- Public Employees for Environmental Responsibility (PEER)

In the discussions below, we address and respond to every substantive comment we received. Substantive comments are those that suggest our analysis is flawed in a specific way. Generally, substantive comments meet at least one of the following criteria:

- Challenge the accuracy of information presented.
- Challenge the adequacy, methodology, or assumptions of the environmental or social analysis and supporting rationale.
- Present new information relevant to the analysis.
- Present reasonable alternatives, including mitigation, other than those presented in the document.

Our discussion does not include responses to non-substantive comments.

In order to facilitate our responses, we grouped similar comments together and organized them by subject heading. Directly beneath each subject heading, you will also see a list of unique letter identification (ID) numbers. Table X.1 at the end of this appendix relates each letter ID number to the name of the individual, agency, or organization that submitted the comment.

In several instances, we refer to specific text in the draft CCP/EIS and indicate how the final CCP/EIS was changed in response to comments. The full versions of both the draft CCP/EIS and the final CCP/EIS are available online at: *http://www.fws.gov/northeast/planning/Prime%20Hook/ccphome.html* (accessed December 2012). For a CD-ROM or a print copy, please contact staff at Prime Hook National Wildlife Refuge:

Prime Hook National Wildlife Refuge
11978 Turkle Pond Road
Milton, DE 19968
Phone: 302/684 8419

Service Responses to Comments by Subject

Comprehensive Conservation Planning and Process

Planning Process
(Letter ID#:25, 30, 45, 61, 69, 81, 105)

Comment: One individual felt that since the CCP process for Prime Hook NWR started in 2005, "arbitrary and capricious management actions have predominated and prevailed from 2005 to 2012 refuge management." Other commenters made similar comments.

> **Response**: The CCP process is forward looking, to guide future management. It is difficult to respond with specifics to this statement because it is so general in its criticism. Some of the approaches in management which occurred prior to 2005 are being considered for re-institution, examined as Alternative C. Some of the refuge's prior practices were challenged in court and led to changes in management, such as the cessation of the use of genetically modified seed, which is prohibited by national Service policy. Some former actions, such as restoring the dune separating Unit II from Delaware Bay, were attempted to be initiated, and after a court challenge, were allowed, only to fail within days in another storm. Some restoration of the dune is encompassed as a possible action under Alternative B, as a component of a major salt marsh restoration plan.
>
> Although NEPA applies to many Federal actions, there are also some types of activities to which it does not apply. Page 5-6 of the draft CCP/EIS describes some of the actions that would be "categorically excluded" from further NEPA analysis if independently proposed, such as recurring and routine habitat management actions and improvements, constructing small projects, or issuing new or revised management or public use plans when only minor changes are planned. Furthermore, page 4-4 of the draft CCP/EIS specifies "Actions Considered but Eliminated from Detailed Analysis", which include refuge boundary expansion, and specific engineering methods to stabilize the shoreline. The draft CCP/EIS does not complete the NEPA process, but is rather one part that continues the process through the Record of Decision.

Comment: A few individuals feel like the planning process for the CCP/EIS was incomplete because the document, "rather than define and describe the tactics by which the Fish and Wildlife expects to implement their preferred Alternative B, the CCP is replete with items that are such things as to develop more plans, initiate coordination, do more studies, build more models, etc. All of these things [should have been completed prior to releasing the draft CCP/EIS]."

Response: According to refuge planning policy, "the CCP is a document that describes the desired future conditions of a refuge or planning unit and provides long-range guidance and management direction to achieve the purposes of the refuge; helps fulfill the mission of the Refuge System; maintains and, where appropriate, restores the ecological integrity of each refuge and the Refuge System; helps achieve the goals of the National Wilderness Preservation System; and meets other mandates." In other words, it is designed to be a broad umbrella document that is supported by subsequent planning efforts that will adhere to the guidelines and vision set forth in the CCP. "Step-down management plans will provide additional details (strategies and implementation schedules) necessary to meet goals and objectives identified in the CCP."

Comment: A few individuals were interested in how much it cost to write the "1200 page CCP" and wondered if this money could have been better spent fixing the breaches. Several others were concerned about the length of time it took to prepare the draft CCP/EIS and the quality of the document.

Response: Typically it takes 3 years to produce a draft CCP. However, the Prime Hook plan was delayed several years for many reasons, including rapid habitat changes from storms and dune breaches, lawsuits against the Service for cooperative farming and dune repairs, and the complexity of issues requiring the thorough review of an environmental impact statement rather than an environmental assessment. Nationally, the costs to develop a CCP can range from $200,000 to $700,000 for an EA, and $500,000 to $1.5 million for an EIS. We estimate that the Prime Hook CCP has cost approximately $900,000, primarily for Regional Office planning and refuge staff. Some of the estimated total figure also includes funds for consultants, travel and printing. Although some people may believe that this amount of money would be better spent on other activities, we are nevertheless required by law to develop a CCP that meets all mandates.

Comment: The Sierra Club writes, "Given the scale of sea level rise that the CCP seeks to address, fifteen years is an inadequate time frame to consider the long-term wildlife and habitat needs. We encourage the U.S. Fish and Wildlife Service to look beyond the immediate concerns presented in the CCP and consider a long-term strategy to habitat and wildlife protection."

Response: Although the CCP is a long range plan that will guide management at the refuge over the next 15 years, we have seriously considered wildlife and habitat needs that extend beyond just the life span of the plan. As we state on page 1-2 of the draft CCP/EIS, "this CCP is designed to address management and protection of valuable natural resources into the future, a future where continued change is even more likely to occur." Furthermore, the Service is developing a framework, called Strategic Habitat Conservation, upon which future conservation efforts will be built. It is primarily a field-based approach for making management decisions about where and how to deliver conservation most efficiently to achieve specific biological outcomes. Through adaptive management, we will constantly reassess and improve our approaches.

Public Involvement
(Letter ID#: 6, 24, 25, 45, 58, 75, 81, 100, 104, S18)

Comment: A few individuals were concerned with the amount of time given for public review, considering the length of the draft CCP/EIS.

Response: Generally, a minimum of 45 days is required for an EIS. In practice, many Federal agencies enhance the opportunities for public and agency participation in the NEPA process by allowing longer review periods, such as 60 days. For the draft CCP/EIS, we extended the public comment period to a total of 89 days. We also made available a newsletter that summarized the draft CCP/EIS, and provided open house events to provide additional clarification of the document.

Comment: Many commented on the requirement for the Service to respond to substantive public comments. For example, the authors of one letter wrote, "We expect that the FWS will follow NEPA requirements concerning comments received on this [draft CCP/EIS]…."

> **Response**: This appendix includes our responses individually and collectively to comments received on the draft CCP/EIS. As many of the comments were very long and voluminous, we often summarized the substantive comments. Comments that are identical or very similar have been grouped. We follow NEPA requirements concerning all comments received on the draft CCP/EIS.

Comment: There was concern that the Service has already decided on its management direction and will ignore public input. One commenter writes, "it would appear to me that the term "draft" [CCP/EIS] is misleading. This is stated because it is likely that history will repeat itself with respect to ignoring public input regarding the "experts" proposal(s)…I'm going on record as suggesting that, unless input is consistent with the "preferred alternative"…said input will once again be ignored."

> **Response**: We have listened actively throughout this planning process, and will continue to do so even after we publish the final plan. We have considered many requests and, although we cannot satisfy every one of them, we have done our best to accommodate them when we could. For example, modifications to the hunting program between the draft and final plan came about largely from public comments. We want the public to feel that their voices have been heard in the modifications we have made. We recognize that increased outreach throughout the planning process might have alleviated some of the frustration voiced in the public comment period, and are committed to providing additional outreach in planning refuge activities in the future.

Document
(Letter ID#: 11, 24, 25, 27, 28, 65, 70, 80–Petition, 81, 104, 106, S5)

Comment: Several individuals pointed out statements in the draft CCP/EIS that they felt were inconsistent or incorrect:

(1) On page B-92 of the draft CCP/EIS, we stated that we would "permit that natural replenishment of sediments…to allow the marsh to keep pace with sea level rise." The authors of one letter felt this contradicted with other statements we made that "natural replenishment of sediments cannot occur at sufficient enough rates" and asked us to remove the sentence from page B-92.

(2) The authors of this letter also felt that discussion on overwash in the draft habitat management plan is not reasonable and is therefore questionable. They asked us to delete this section because it discusses people's feelings, which are not "germane" and are "prejudicial."

(3) The same authors felt that, "There is significant omissions in the CCP regarding the actions [the Service] will take in emergency situations. The CCP must be explicit as to the decision process [the Service] will employ in deciding when and what actions must be undertaken in cases of emergency … the refuge manager's authority to be exercised to undertake immediate repair of the breaches and mitigating the risk of further damage to the environment and public safety.."

(4) Another individual pointed out that our discussion on mosquito control activities was placed under the heading "Other Recreation" on page 4-179 of the draft CCP/EIS.

(5) Several commenters stated that the CCP is deficient because it does not address the impact of the visual changes and appearance changes resultant from the selection of each of the Alternatives.

(6) Several commenters noted that in several places throughout the draft CCP/EIS, the Service states that habitat management programs, which were conducted on the refuge for several decades, had been stopped in recent years either "for various reasons" or "for a variety of reasons". Not once does the Service articulate a single reason or provide any rationale for their actions (or in this case lack of action).

(7) One individual points out that the correct Latin name for the marbled underwing is *Catocala marmorata* (page B-35 of draft CCP/EIS) and for the beach dune tiger beetle is *Cicindella hirticollis* (page D-1).

(8) One letter pointed out that there is an inconsistency on page B-92, in the Habitat Management Plan in appendix B. It states that the use of "assisted accretion" may be appropriate where it is determined that natural replenishment of sediments is not sufficient. The commenter points out that this determination has already been made.

(9) One individual stated, "There is a contradiction on *Phragmites* control in comparing the last paragraph on this page with the 8th bullet on Pg 101. Pg B-98 indicates control is needed for *Phragmites,* while Pg 101 indicates it should stop being treated to allow faster accretion in the salt marshes."

(10) One individual points out that the draft CCP/EIS "incorrectly state[s] new trails in hunting areas are closed on Sundays. I think you meant to write 'except on Sundays' (example page 4-177)."

(11) One individual points out that several maps in the draft CCP/EIS "incorrectly imply that Petersfield Ditch and Headquarters Ditch are open (not closed) during hunting (example page 4-67).

(12) One individual feels that the CCP should include a spreadsheet or other chart showing the timing of actions proposed in the plan.

Response:

(1) We do not agree there is a contradiction. This is one of many proposed strategies that address climate change and sea level rise adaptation. It is immediately followed by the statement "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." In other words, reliance upon natural replenishment alone may not be enough under the current situation.

(2) We removed the referenced text from the Habitat Management Plan (HMP).

(3) The Service determined the dune repairs were not an emergency, and that NEPA review should be conducted prior to restoring the marsh system including the dunes. The CCP/EIS is a part of that process. The basis for this decision dates back to the repeated need over the years to conduct similar work along the beach. In addition, repairing the dunes alone will not eliminate future flooding of Prime Hook Road during extreme high tide and storm events, since sections of the road are 18 inches below spring high tides and floodwaters enter the road and parts of the community through locations other than the existing breaches. Also, the flooding of the public road to Prime Hook Beach is not a unique situation in that several other public roads providing primary access to communities in coastal Delaware routinely flood during high tide and storm events.

Several factors help to reduce the risk of personal injury, loss of life, and property damage should a flood emergency occur. These include the National Weather Service's warning system to provide residents advance warnings to take appropriate action before a major storm event and the availability of medi-vac helicopters services. The refuge's online monitoring system also provides information to help members of the public assess when the road may be threatened with flood waters.

(4) We removed the referenced text of mosquito control from "Other Recreation."

(5) In Chapter 4 "Developing Alternatives, Including the No Action Alternative" we explain the environmental baseline is difficult to fully access due to dramatic changes the refuge has and continues to go through. Alternative A serves as a baseline for comparing and contrasting Alternatives B and C. Although the draft CCP/EIS does not specifically mention the visual impacts, the document does address the loss of freshwater vegetation, stresses/dying trees, and other associated changes with the saltwater intrusion into the refuge. We have added appropriate text to chapter 5 of the final CCP/EIS "Wildlife Observation and Photography" sections to address potential visual and appearance effects.

(6) In every instance referenced, the phrase was used in an attempt to be brief when referring to multiple programs in one sentence, which were stopped for different reasons. The reasons for recent changes in each of the management programs in question were always explained elsewhere, where that program was being discussed specifically. For example, the changes associated with wetland management are explained on page 4-1, in the subsection titled "The environmental baseline," and again on in the introduction to Alternative C. The changes associated with the farming program are explained in detail in the introduction to Alternative C and also in the rationale for Objective 4.1 under Alternative C.

(7) Thank you. We have corrected these errors.

(8) This strategy bullet within the HMP has been clarified to indicate that it refers primarily to existing salt marsh in Unit I. In the last bullet for that objective, we address the expected creation of new salt marsh in Unit II and possibly Unit III, and direct the reader to Objective 3.1 for more details. Strategies in Objective 3.1 explain how refuge will pursue various strategies that will assist or accelerate accretion.

(9) There is no contradiction. Pg. B 78 refers to Phragmites control in forested wetlands while pg. 101 refers to *Phragmites* control in saltmarshes.

(10) Thank you. We made the change.

(11) Thank you. We updated the maps.

(12) We agree the proposed actions or timeline is often difficult to follow. While the objectives usually contain a time reference for implementation, many factors make it difficult if not nearly impossible to paint a fully accurate timeline. These factors include budgets, staffing, permitting, and adaptive management strategies.

Comment: One commenter states that the CCP has not integrated all new relevant knowledge and site conditions.

Response: Many portions of the CCP have been updated regularly throughout the CCP process, including during the final editing stage. All the most current data available regarding refuge programs and resources has been included and up-to-date research has been consulted.

Comment: One individual writes, "This CCP process began in 2005. Current management ([Alternative] A) baseline for impact analysis and environmental consequences should have been 2005."

Response: We explain on page 4-1 and 4-2 of the draft CCP/EIS our rationale for the required no action alternative. Due to the habitat changes that naturally occurred on the refuge during the prolonged planning process, we assumed the baseline for our analysis to be the condition of the refuge as of mid-2012.

Statutory Authority: Laws, Policies, and Executive and Secretarial Orders
(Letter ID#: 21, 24, 27, 36, 62, 64, 70, 71, 80–Petition, 81, 82, 104, 105, 106, S1, S5, S9, S18)

Comment: One individual feels that the refuge should have had to write an EIS for its decision to not repair breaches at Fowler's Beach, writing "It was the most significant environmental decision affecting the Refuge in its 50-year history, and yet, no environmental impact assessment was completed."

Response: Determining whether or not an EIS was appropriate for the referenced past action is beyond the scope of this planning process, and CCP/EIS. However, an environmental assessment was completed, and efforts to restore the dune line one more time while management and restoration plans could be developed were made by DNREC, in coordination with the refuge, in September 2011.

Comment: Several individuals and groups feel NEPA and the Refuge Improvement Act may have been violated by constructing new trails and expanding refuge uses without compatibility determinations or public review. For example, the Humane Society charge the following changes were made without NEPA compliance or compatibility determinations: changes in the types of species hunted, changes in the number of hunting days, commercial farming, the use of genetically modified organism crops, trail improvements, new boardwalks, photography blinds, and trash collection areas. Similarly, one individual writes, "New trails…totaling over 6 miles, were planned, built and opened without a new CD/EA and required public review…."

> **Response**: The Service recognizes that some trails, a public observation tower, and other facilities were constructed without following all compliance procedures a number of years ago. More recently, the Service tried to rectify this by the closing a boardwalk and tower, closing a deer hunting area, eliminating some duck blinds, and removing the recycling center. However, we respectfully disagree that we have not conducted an analysis of these programs during this planning process and the draft CCP/EIS. One purpose of the CCP process is to evaluate the environmental impact of facilities which may not have undergone earlier NEPA review and whether or not these facilities or activities are appropriate and compatible and whether or not, after evaluation, they should be constructed or opened, or removed or closed. Objectives and strategies can be found in Chapter 4, Objective 5 and the potential impacts are covered in the various sections of Chapter 5. Furthermore, compatibility determinations for *all proposed or existing uses* are updated and included as an appendix in this document.

Comment: The Humane Society of the United States, The Pegasus Foundation, and Delaware Votes for Animals feel that the draft CCP/EIS is inadequate because it fails to comply with Federal laws, including the National Environmental Policy Act and Council on Environmental Quality guidelines; the National Wildlife Refuge System Administration Act, as amended by the National Wildlife Refuge Improvement Act; and the Administrative Procedure Act. The reasons they cite include the following:

- The refuge has been pre-decisional and the draft CCP/EIS "seems designed to justify the decision that the [Service] has already decided to make…"
- The draft CCP/EIS fails to support the refuge's purpose to provide "an inviolate sanctuary for migratory birds, and ensure wildlife conservation."
- The draft CCP/EIS "fails to present viable alternatives to the increased or continued killing of wildlife and destruction of wildlife habitat…"
- The draft CCP/EIS "fails to comprehensively and candidly consider the impacts of the chosen alternative on refuge habitats or wildlife…"
- The draft CCP/EIS "fails to present required compatibility determinations for new or expanded potentially destructive uses of the PHNWR and fails to conduct the required analysis of the destruction and degradation that would occur to wildlife habitats and wildlife as a result of Alternative B."

> **Response**: The Service respectfully disagrees. The CCP/EIS presents viable alternatives in Chapter 4 and analyzes the impacts of those alternatives in Chapter 5. The compatibility determinations are located in Appendix E. More detailed responses to the above comments are found later in this appendix.

Comment: One commenter and the Town of Slaughter Beach noted "that the Refuge Improvement Act declares that all existing or proposed refuge uses must be 'compatible' with the refuge purpose and consistent with public safety… The plan fails to address public safety in critical areas."

> **Response**: Per Service policy 603 FW 2 a compatible use is defined as "A proposed or existing wildlife-dependent recreational use or any other use of a national wildlife refuge that, based on sound professional judgment, will not materially interfere with or detract from the fulfillment of the National Wildlife Refuge System mission or the purposes of the national wildlife refuge." Public safety is a primary concern for the refuge and is considered in our compatibility determinations.

Comment: Several commenters stated that the CCP is not compliant with Executive Order (EO) 11988 regarding floodplain management.

> **Response**: E0 11988 Floodplain Management requires federal agencies to avoid, to the extent possible, the long-and short-term adverse impacts associated with the occupancy and modifications of flood plains, and to avoid and indirect support of floodplain development where there is a practicable alternative. Under this order the federal agencies "shall take action to reduce the risk of flood loss, to minimize the impact of floods on human safety, health and welfare, and to restore and preserve the natural and beneficial values served by floodplains." The CCP is consistent with EO 11988 because the implementation of the preferred alternative would assist in restoring the natural ecological values of Prime Hook's barrier island and marsh system. Restoring the natural hydrological function of these units provides valuable ecosystem services such a storm surge protection and flood protection.

Comment: Several commenters stated that the CCP is not compliant with Executive Order (EO) 13352 regarding the facilitation of cooperative conservation.

> **Response**: EO 13352 seeks to ensure that laws relating to the environment are implemented "in a manner that promotes cooperative conservation, with an emphasis on appropriate inclusion of local participation in federal decision making." Throughout the CCP process the public has been provided many opportunities to participate and/or comment on our plans (refer to chapter 6 for more information). In addition, as stated above restoring the natural hydrological function of the impounded marshes provides valuable ecosystem services such as storm surge protection and flood protection, which minimize the impacts of floods on the communities.

Comment: Several commenters noted "The CCP failed to address applicable NEPA regulations concerning the impact of actions on surrounding communities. In particular 42 USC§4331 states that it is the continuing responsibility of the Federal Government to use all practicable means … to improve and coordinate Federal plans, functions, programs, and resources to the end that the Nation may ….attain the widest range of beneficial uses of the environment without degradation, risk to health or safety, or other undesirable and unintended consequences. The alternative A and, to an unknowable extent (depending on the efficacy of ill-defined drainage actions), the preferred alternative B, will lead to continued flooding of the Prime Hook community and the roads leading into it." Additional comments allege that the Service has an obligation to address public safety impacts due to coastal storms and flooding to development located on the barrier islands, with citations including 42 USC 4331 and other Executive Orders or policies.

> **Response**: Alternative A is the no action alternative required by NEPA regulations, and serves as a baseline for comparing and contrasting alternatives B and C. Alternative B includes continued coordination with DelDOT, the state agency which is responsible for the access roads to the Prime Hook community. Hurricanes Katrina, Sandy, and other storms have increased public awareness of the risks from coastal storms and climate change to construction located in low-lying coastal areas. This has generated some calls for changes to existing FEMA and state and local programs. The Service's mission charges it with protection and conservation of wildlife habitats and migratory birds; these other agencies are responsible for developing appropriate policies for existing development located on risky coastal areas such as barrier islands. We will continue to coordinate our habitat management with programs of other agencies. We believe that implementation of the preferred alternative would assist in restoring the natural ecological values of Prime Hook's barrier island and marsh system, and restoring the natural hydrological function of these units provides valuable ecosystem services such a storm surge protection and flood protection.

Some homes in the Prime Hook Beach community will continue to flood more than others due to a number of environmental factors that include the loss of water-absorbing marsh vegetation, the frequency and intensity of storm events, and sea level rise. Of the 140 homes recently surveyed at Prime Hook Beach, 40 percent were built below the 100-year floodplain as established by the State and the FEMA. In the long term, the Service's marsh restoration actions are expected to lessen, but not eliminate, the impact of sea level rise and storm events that contribute to flooding in the community. Impacts on health and safety are considered in the CCP/EIS as well as all compatibility determinations. We believe that the analysis presented in the CCP/EIS indicates that implementation of the preferred alternative would not result in any significant or negative human health or safety impacts.

Comment: "There is a significant omission in the CCP. The environmental impacts of non-actions by the FWS as well as actions must be fully addressed. The decision not to repair the breaches by the FWS is an example of an action/non-action by the FWS for which the full environmental impacts must be evaluated."

Response: The CCP/EIS outlines three alternatives and their associated impacts, of which one, Alternative A, the current condition or no action alternative is evaluated.

Comment: Several commenters pointed out that the FWS policy that requires that degraded environments be restored was not considered, and that this consideration influences the selection and support for tactics under the alternatives.

Response: We have integrated the principles and guidelines of the Service's biological integrity, diversity and environmental health (BIDEH) policy into all aspects of our comprehensive conservation planning and included them in crafting the alternatives, goals and habitat objectives in the CCP/EIS. We have especially focused on and considered the degraded environments and the lost and degraded elements of BIDEH of the refuge's various habitat types, especially of refuge wetlands. The foundation of our preferred alternative (B) is the proactive restoration of our degraded impounded wetland complex. This is completely consistent with the Service's BIDEH policy, which encourages that habitats be restored to environmental conditions prior to significant human intervention. We have based our analyses of restoring lost and degraded elements of our impounded wetland areas on refuge specific research data collected and a review of wetland health and restoration literature. We are continuing to collect more data and information to optimize the success of any specific restoration actions that we may conduct.

Comment: Several commenters noted that the Service's own policy of requiring staff to apply "adaptive management" protocols to the administration of its wildlife refuge resources as evidenced in this CCP should be graded "F" and stated that the Service needs to apply its own adaptive management standards to the draft CCP .

Response: There is no Service policy on adaptive management, but rather the Service functions under the Department of the Interior Policy regarding adaptive management (522 DM 1). Adaptive management is defined in the policy as "a decision process that promotes flexible decision making that can be adjusted in the face of uncertainties as outcomes from management actions and other events become better understood." This explicit definition has been clarified in the beginning of chapter 4, of the final CCP/EIS, under Actions Common to All Alternatives, where adaptive management is discussed.

We have applied the Service's adaptive resource management standards by identifying management strategies and coupling them with monitoring targets to evaluate the success of actions once implemented. In fact, the refuge's proposed shift from failed freshwater impoundment management to restoration of natural salt marsh represents adaptive management in action, as we recognize what has not worked, propose various strategies that we will employ to achieve the restoration, and explicit programs to monitor success of those strategies as we go so that we may adapt as needed. We will develop a new inventory and monitoring plan, also required by Service policy, as a step-down from the CCP. This plan will further detail the what, when, and how often we will monitor habitats, abiotic factors and wildlife species and how we will record and analyze the data, in order to evaluate management and adapt as needed.

Purpose and Need

Refuge Purposes, Refuge Establishment, and Land Acquisition History

(Letter ID#: 2, 10, 27, 33, 35, 39, 42, 46, 48, 49, 54, 55, 61, 64, 66, 70, 71, 78, 80–Petition, 81, 82, 86, 88, 98, 102, 105, 106, S2, S4)

Comment: Numerous individuals commented on two press releases made by Secretary of the Interior Udall in February 1963. For example, one writes, "The first one states that Service needs to stabilize and maintain the barrier beaches to prevent against storm tides to protect freshwater impoundments for waterfowl management. The second states that the Service must make sure that the water management plans for the refuge do not interfere with farming on private lands adjacent to the refuge. These two press releases were promised to the citizens of Delaware. The primary purpose of the government is to serve and protect its citizens." Similarly, the State of Delaware stated that the continued breach in the dunes is the result of management decisions, which are contrary to these press releases.

Overall, many felt that these press releases represent the original "purpose" and "vision" for establishing the refuge and constitute a "promise" to the citizens of Delaware. In general, they felt that not repairing the dune breach was contrary to the Secretary's letter because it does not protect surrounding communities or provide freshwater habitat for waterfowl. They also feel the refuge is obligated to continue to maintain freshwater impoundments and stabilize and maintain barrier beaches to protect against storms and coastal flooding.

> **Response**: The Service respectfully disagrees. In 1963 the Service did not understand sea level rise, climate change, the fact that barrier island roll-over/migration is how salt marshes maintain their storm attenuation functions to protect mainland areas, and what the adverse effects of trying to maintain freshwater wetlands would be in light of increasing sea levels. The goal of conservation of the resources of the refuge for present and future generation is stated clearly, so what the Service in 1963 was not contemplating is what would happen when changing conditions and decades of additional erosion made the maintenance of the barrier unsustainable. It's a well-intentioned statement in the context of incomplete knowledge and the very human inability to foresee the future. Policies guiding refuge management, such as the Refuge Improvement Act, obligate the refuge to make science-based management decisions that adapt to changing conditions and thus preserve natural processes.
>
> It would be neither responsible nor sustainable to attempt to maintain a static condition along this dynamic shoreline. We also respectfully disagree with the assertion that the continued breach in the dunes is a result of a management decision. On the contrary, we worked closely with DNREC to repair the dunes in 2011 to permit a more strategic planning process. That repair was delayed by litigation and ultimately was not successful because the amount of material available on-site for the repair was limited. The use of off-site material was not a viable option.

Comment: Several individuals point out that portions of the refuge were purchased with Federal Duck Stamp and Dingell-Roberts money and its purpose was to provide and improve impounded freshwater areas for waterfowl and shorebirds, as well as opportunities for hunting and fishing.

> **Response**: The purpose of the refuge is explained in chapter 1 of the draft CCP/EIS: Prime Hook NWR "… was established under the authority of the Migratory Bird Conservation Act (16 U.S.C. 715–715r), as amended, on August 21, 1963, *"for use as an inviolate sanctuary, or for any other management purpose, for migratory birds."* We later expanded the boundaries of the refuge to include 934 acres of land purchased with funding from 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: *"[land] 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 refuge has acquired 10,133 acres encompassing 100 tracts ranging in size from 0.4 acres to 1,600 acres from 73 landowners. Waterfowl species which concentrate in freshwater should continue to use the more brackish and freshwater portions of the refuge, although we do not know whether the same numbers will remain on site for as long. It will certainly continue to be a refuge for shorebirds, and the species of waterfowl which utilize marsh and open water areas may increase if the marsh restoration plans for Unit II are realized.

Comment: The Humane Society of the United States, The Pegasus Foundation, and Delaware Votes for Animals write, "There is no room in this instance for nuanced policy debate about the appropriate purpose of this refuge; Prime Hook NWR was established by statute expressly as an inviolate sanctuary for migratory birds… and the goal of protecting that specific refuge purpose trumps any conflicting activity. Yet, for many years, [this purpose]…has taken a back seat to various opposing commercial and recreational interests, all while statutory and regulatory mandates are consistently ignored." Similarly, PEER states that based to their reading of the Refuge Improvement Act, the overarching mission and use of the refuge is conservation and that any conflict between conservation and wildlife-dependent uses "must be resolved in favor of conservation and/or implementing Prime Hook's legislated purposes."

> **Response**: As noted in the response above, the purpose clearly states that not only was the refuge established as an inviolate sanctuary for migratory birds, but also *for any other management purpose* for migratory birds.

Alternatives

Alternatives - General

(Letter ID#: 2, 24, 27, 25, 45, 70, 80–Petition, 81)

Comment: One commenter speculates that any of the three alternatives will undoubtedly lead to protracted and expensive litigation.

> **Response**: We hope that the CCP/EIS is not challenged in court, because we are aware of how our limited staff are diverted from other initiatives when litigation arises. We believe that this document fully meets our NEPA and other statutory obligations. We also recognize that many people have different views about how the refuge should be managed, which is why we have solicited public comment, conducted so many public meetings, and extended the public comment period. We recognize that we will not be able to manage the refuge in a fashion which meets the views of everyone.

Comment: An individual noted that, "At the various public meetings, the staff indicated that the final plan could mix and match from the three [alternatives] presented. Won't this alter the analysis of the impacts listed in the CCP? Do you plan to rewrite the analysis of impacts and permit public review? If you mix and match among options, the cumulative impacts etc. will also change."

> **Response**: While engaging the public in dialog during our meetings, the staff encouraged the public to provide comments on what they liked and what they wanted changed on the various alternatives. This may include mix and matching strategies across the alternatives. If a strategy is added or deleted, then our impact analysis may change as well.

Alternative A

(Letter ID#: 2, 24, 33, 39, 42, 46, 48, 49, 66, 71, 81, 98, 107, S4)

Comment: The authors of one letter felt that key information about alterative A was missing from the draft CCP/EIS that "makes the basis of the CCP alternatives questionable." They write, "The Plant Communities discussion on page B-33 is misleading and does not appropriately characterize the significant negative aspects of Alternative A with regards to Plant Communities. So many trees and species were killed off by the saltwater intrusion from the beaches. The Alternative A approach does not allow for the reintroduction of many indigenous species." They also felt that this missing information is necessary to "make informed decisions" and provide the public "with a reasonable base of understanding." They ask that the Service provide "data as to how much habitat will be added [in the other two alternatives] above what will exist in Alternative A…Also, under alternative A, won't there be further losses in habitat over time?"

Response: The paragraph on plant communities has been clarified. This section of the HMP is not intended to address impacts of any particular alternative, but rather to simply describe refuge conditions. The vegetation map prepared for the refuge several years ago is still useful in many parts of the refuge, but not as much so in the wetlands. In this section, we do state that the summary of vegetation represents conditions present at the time of mapping, and it is acknowledged that this has changed. We have attempted to make this clearer. An effort is underway to work again with DNREC to update the vegetation map, but it will not be available before the Final CCP is completed.

Habitat changes resulting from each alternative have been estimated and quantified in numerous places throughout the draft and final CCP/EIS. For example, most of the CCP objectives under Goals 1 through 4 quantify the habitat changes expected under each alternative, and these are depicted in maps throughout the document. The potential for habitat loss under Alternative A, such as further conversion of wetlands to open water and the stress and loss of adjacent wetland forest habitat, is addressed in the Impacts to Vegetation section of Chapter 5.

Comment: Many individuals feel that alternative A is "a failure and should not be open for consideration" because of negative impacts on wildlife, refuge habitats, and surrounding agricultural and residential communities.

Response: Alternative A is the no action alternative required by NEPA regulations, and also serves as a baseline for comparing and contrasting alternatives B and C.

Comment: The State of Delaware writes, "Alternative A has a significant omission in that it must include continuing flooding of farm fields and septic systems, killing of trees and the development of an unstable salt water marsh system."

Response: Chapter 5, on Environmental Consequences, recognizes the continued potential impacts to farm fields, septic systems and vegetation under Alternative A. The Service is cognizant that flooding of some areas of adjacent farmland has been a long-term problem which pre-dates the initial 2006 overwash in Unit I. Salt water intrusion and flooding are common phenomena on many coastal Delaware farms. Barrier beach inlet formation can be inappropriately labeled as the only cause of flooding of private property during storm events, yet there are many other causes that contribute to coastal flooding. Physical forces that affect coastal beach flooding include increased storms and storm intensities, heavier precipitation patterns, extreme wind and wave conditions, extensive run-off from uplands, low elevation of roads and private properties with respect to local mean sea level, local geologic features, sediment supply, and human activities including subsidence exacerbated by two centuries of ground water withdrawals. These factors increase the level of complexity of coastal flooding seen at the refuge and adjacent private lands.

Comment: One individual writes, "How then is your Alternative A, "no action" status quo miraculously transformed into "no human interference"? … When and why did you abandon water level management in any of the impoundment without public notice? Was that legal?"

Response: The refuge has not abandoned water management. Water management has changed due the daily tidal influx of saltwater from the bay. Since we are still able to maintain some water management capability in Unit III, Alternative A, the "no action" alternative, continues this current activity, as long as feasible. Alternative C analyzes the infrastructure changes and environmental and fiscal costs of trying to return Unit II to pre-breach conditions. Alternative B recognizes that the efforts to artificially maintain a freshwater systems are unsustainable in light of 500 feet of shoreline loss over 80 years and a reasonable likelihood of greater rates of shoreline loss in the future, so it proposes to "fix the system once", i.e. to return it to a functioning salt marsh which can naturally adapt to sea level rise, and then to let that sustainable and natural habitat be. We believe the CCP/EIS does an adequate job analyzing the current situation and our proposed management direction as required by NEPA.

Comment: PEER stated that the draft CCP/EIS falsely characterizes freshwater impoundment management in Alternative A (current management) as No Human Intervention, when in fact there have been human management actions associated with the freshwater impounded wetlands from 2008 to 2011. Recent human actions to protect freshwater wetlands cannot be categorized as "historic management" of Alternative C because these actions have uniquely occurred as part of current management and we think that they will continue. These include filling in breaches in September of 2011 under the project justification of protecting freshwater impounded wetlands.

> **Response**: Alternative A portrays current management representing a "no action" alternative. Under NEPA, a "no action" alternative is one that prescribes no change to current management, not necessarily no action altogether. Under alternative A it does state that "natural ecological processes would be allowed to proceed with no human intervention." With regard to the impoundments, this specifically means that under alternative A, there would be no direct moist soil vegetation management of the impoundments as was historically conducted for the decades prior to formation of the breaches in 2009. As of the release of the draft CCP/EIS, there is no such management taking place in Unit II because it is not possible, and therefore this alternative is consistent with the assertion that it is "no action," no change to the current management. However, interventions such as adjustments to water control structures in response to heavy precipitation have taken place recently, and would continue under alternative A, to assist the refuge in complying with a 2.8 mean sea level water level deed restriction, so long as this capability remains in place. A strategy has been added to objective 3.1 under alternative A to clarify that such "storm water management" actions currently taking place now would continue.

Alternative B, the Service-preferred Alternative
(Letter ID#: 2, 8, 15, 18, 21, 25, 29, 33, 34, 35, 37, 39, 40, 41, 42, 45, 46, 48, 49, 53, 54, 62, 65, 66, 67, 68, 70, 72, 80–Petition, 81, 86, 89, 91, 100, 104, 105, 106, S2, S3, S4, S9)

Comment: Several individuals and organizations, including Duck Unlimited and the Canoe Cruisers Association, supported the Service's preferred alternative B. They cite the following reasons:

- Managing refuge habitats, including reforested portions of the refuge
- Allowing natural processes, such as along the shoreline.
- Restoring salt marsh habitats
- Expansion of hunting opportunities

> **Response**: We appreciate the support for our preferred alternative.

Comment: Many individuals did not support alternative B for the following reasons:

- Does not address public safety and impacts on surrounding communities and farms, such as saltwater intrusion and coastal flooding.
- Does not repair dune breaches and fails to restore freshwater marsh habitats for waterfowl and other wildlife species.
- Negatively impacts hunters because of losses in waterfowl habitat.
- Changes in hunting program, including free-roam hunting, hunting days and times, the hunting lottery, and impacts of hunting expansions on refuge habitats, waterfowl, and other wildlife.
- Changes in mosquito control.

Response: We respond to these concerns elsewhere throughout this appendix. Please see comments and response under "Local Communities," "Hunting," "Nuisance Species – Mosquito Control," "Dune Breach, Marsh Restoration, and Shoreline Stabilization." Also, based on the comments we received, we have made several changes to alternative B in the final CCP/EIS. We highlight these at the beginning of the appendix under "Introduction," as well as our specific responses to those concerns.

Comment: Several feel that alternative B is inadequate because it relies on using dredge sediments from the U.S. Army Corps of Engineers; even though these sediments have not been secured yet.

Response: Alternative B does not rely on dredge sediment. We agree that it is important to consider alternative strategies, because there is no guarantee that the refuge wetlands will be the selected beneficial use site for the Main Channel Deepening sediments. The strategies outlined under objective 3.1 under alternative B in the draft CCP/EIS included a number of options that do not rely on dredge materials. We also consider other sources of dredge material, other than the Main Channel Deepening project. For example, maintenance dredging is also conducted routinely in the Delaware Bay. In the final CCP/EIS, we have further developed several of these restoration strategies and have evaluated and added additional strategies based on the comments we received.

Comment: Delaware Audubon Society feels that alternative B is being considered only because of the surrounding community and that the single best alternative, absent that community, would be to let nature take its course and to move the refuge inland, upland, westward.

Response: The presence of the surrounding community has an influence on how management strategies can be implemented because it is a reality of the current condition. However, the Service stands by the conclusion that alternative B is the most appropriate course of action for the degraded impounded wetland complex, and that this decision is well supported by the scientific data outlined in the rationale for objective 3.1. Letting "nature take its course" is the preferred approach in wetland areas of the refuge that are not so extensively degraded, such as in Unit I. Given the history of altered hydrology and the collapse of the peat substrate due to decades of saltwater exclusion, purposeful restoration of wetlands in the impoundment complex is the most ecologically beneficial alternative.

Comment: One commenter noted that alternative B leaves issues of commercial development, permits, all contracts, etc, to sole discretion of refuge manager, with no oversight, permitting, or community input involved.

Response: The refuge manager does have broad discretionary authority over the day to day operations of the refuge. However, existing discretionary authority has oversight in policies. As examples, NEPA documents, compatibility determinations, and service and construction contracts receive Regional Office and in some cases Washington Office review and signatures. NEPA documents and compatibility determinations also require public involvement.

Comment: One individual was concerned with habitat diversity under alternative B. He writes, "Diversity of habitats will be lost as upland habitat areas are allowed to go to climax vegetation. This will result is less habitat diversity, and less wildlife diversity on the refuge."

Response: With alternative B of CCP/EIS the diversity of habitats will not be lost in upland areas because we will allow agricultural lands to revert to early successional grass, forbs and shrub-scrub plant communities. Proactive habitat management actions such as mowing, disking or using prescribed fire will be used in select fields to maintain and enhance natural early successional seral stages of upland areas. This is in addition to proactively managing existing forest and restore via reforestation of other select non-forested upland tracts to increase Delmarva fox squirrel population viability and also benefit forest interior dwelling birds. The specific habitat management actions described in upland management goals, objectives, rationales and habitat management strategies for alternative B as written in chapter 4 will result in enhancing upland habitat diversity on the refuge for a greater number of wildlife species.

More detailed upland habitat management strategies and prescriptions located in the Refuge Habitat Management Plan (Appendix B) explicitly describes how we propose to 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 upland habitats mixed with transitional forested areas. These upland habitat management plans and actions will conserve a greater diversity of migratory birds, breeding landbirds, and endangered species while maximizing benefits for other priority wildlife species that would result in an increase of wildlife and upland habitat diversity on the refuge.

Comment: Several individuals feel that the costs of alternative B must be examined in order to justify recommending it for implementation. One writes, "There is no discussion of costs whatever in the CCP. The strategies may in fact be very costly, perhaps comparable to those of alternative C cited on page 3-54. It is inappropriate to recommend that taxpayer dollars be allocated for an alternative with no knowledge of its overall costs."

Response: The Service agrees that the initial up-front planning costs associated with specific strategies of the preferred alternative B could be costly, and this amount will be more clearly defined once all monitoring data is collected. However, a cost of a self-sustaining salt marsh would be minimal when compared to the projected cost of continuous year-over-year maintenance required in alternative C. We believe that grant and cost sharing opportunities will become available through our partners and the Delaware Department of Natural Resources. It is also anticipated that the U.S. Army Corps of Engineers would become active partners, in addition to the traditional cost sharing partnerships, which allow and encourage those who benefit from the beneficial uses of dredge material. Appendix H (Refuge Operation Needs System (RONS) and Service Asset Maintenance Management System (SAMMS)), Appendix I (Regional Economic Impacts), and compatibility determinations do include estimated costs of alternative B. Please note that on the inside front cover of the document we also state that "… 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."

Comment: The EPA reviewed the draft CCP/EIS and rates the environmental impacts of the proposed action (Alternative B) as "Lack of Objections."

Response: Comment noted.

Alternative C
(Letter ID#: 2, 3, 8, 10, 23, 28, 33, 35, 37, 46, 47, 49, 52, 55, 59, 64, 66, 80–Petition,88, 97, 108–Form Letter, S4)

Comment: The form letter, online petition, many individuals, and organizations, including the town of Slaughter Beach and the Alliance of Bay Communities, supported alternative C or a modified version of alternative C that includes immediately repairing dune breaches. Individuals specifically mentioned supporting the following actions proposed under alternative C because in their view Alternative C:

- Supports the original intent of the refuge, as outlined in the 1963 press releases.
- Supports the National Wildlife Refuge System mission.
- Restores freshwater marshes to provide breeding and wintering habitat for migratory waterfowl.
- Reinstates cooperative farming to provide foraging habitat for migratory waterfowl.
- Reconstructs and maintains dunes along the Delaware Bay to protect surrounding communities and farms from flooding and saltwater intrusion.
- Restores marshes to freshwater to benefit migratory birds and other wildlife.

- Provides desirable ecotourism and recreational opportunities, such as those for anglers, hunters, and bird-watchers.
- Has a "proven track record" of being beneficial to wildlife.
- Continues existing mosquito control program.

> **Response**: We thank the respondents for their comments. We respond to these issues elsewhere throughout this appendix. Please see comments and response under "Local Communities," "Nuisance Species – Mosquito Control," "Dune Breach, Marsh Restoration, and Shoreline Stabilization," "Refuge Purposes, Refuge Establishment, and Land Acquisition History," and "Croplands and Cooperative Farming." Also, based on some of these comments, we have made several changes to alternative B in the final CCP/EIS, as well as to alternative C. We highlight the changes to alternative B at the beginning of the appendix under "Introduction," as well as our specific responses to those concerns. We also have clarified in the final CCP/EIS that we feel that dune restoration is a potential, and even likely, first step in our proposal to restore marsh habitat. We also reiterate that we would only plan to restore the dunes as part of the comprehensive marsh restoration, not as separate action.

Comment: One individual was opposed to alternative C, writing, "I believe it is the homeowners responsibility to bear the cost of relocation or protecting their property…It is not up to the taxpayers as a whole."

> **Response**: The Service is under no obligation to maintain private land. Decisions regarding the relocation of the homeowners are outside the scope of this CCP.

New Alternatives Proposed by Commenter
(Letter ID#: 24, 28, 64, 80–Petition, 82, 91)

Comment: One individual proposes Alternative D, "Best for All." Several others, including the Town of Slaughter Beach and the online petition, stated that they support this alternative and would like the Service to adopt it as the preferred alternative in the final CCP/EIS. The major components of the proposal are:

- Repair dune breaches immediately. Also, develop a long-range plan for beach replenishment and extend beach eastward.
- Restore refuge shoreline to 1962 conditions, all freshwater impoundments, and vegetation
- Repair all private property and roadways
- Ensure protection of all towns, farms, and residential areas.
- Acquire non-developed private beach properties.
- Continue existing mosquito control program.
- Continue existing hunting programs.
- Reinstate cooperative farming.

> **Response**: Shoreline stabilization and acquisition components referenced above are discussed in chapter 4 of the CCP/EIS section "Actions Considered but Eliminated from Detailed Analysis." Hard armoring was eliminated from further consideration due to adverse impacts, lack of sustainability, inconsistency with BIDEH policies, and high cost. The existing mosquito control program, hunting program, and cooperative farming program were all thoroughly evaluated, and determined to not meet the refuge purposes and vision and goals as well as the programs as described in alternative B.

Comment: One individual proposes Alternative E, "Delaware/Sussex County Takeover." This alternative is based on his proposed Alternative D, "Best for All." The major difference is that under alternative E the State of Delaware or Sussex County would "take possession" of the refuge. Other elements of the alternative include:

- Establish a new not-for-profit entity with a board of directors including wildlife experts, technical experts, and area communities.
- Petition the Governor to declare an immediate State of Emergency.
- A Federal grant to conduct repairs and restoration of shoreline and marshes.

> **Response**: Prime Hook NWR is land specifically set aside by Congress for conservation of wildlife, with the Service designated as the Federal agency responsible for conserving, protecting, and enhancing the fish and wildlife populations and their habitats. The proposal to turn operational and management functions over to another agency would undermine the values and legal obligations of the Refuge System. However, we will consider the use of Federal grants to assist with repairs and restoration of shorelines and marshes.

Comment: The authors of one letter propose Alternative R. The major components of this proposal are:

- Rebuild and maintain dunes to prevent flooding of roads, farms, and residences.
- Raise Fowler Beach Road or build a barrier or berm along road to prevent saltwater overwash.
- Manage Unit II and Unit III as freshwater marsh, if feasible, to protect adjacent landowners.
- Establish moist soil units in Units II and III.
- Use dredge materials from nearby sand bars or truck in sand.
- Develop a predator management plan to protect beach nesting birds.
- Continue existing mosquito control program.
- Continue existing hunting programs, with some minor expansions (including turkey hunting) and modifications.
- Reinstate cooperative farming, but convert some previously farmed areas to early successional habitat.

> **Response**: The existing mosquito control program, hunting program, and cooperative farming program were all thoroughly evaluated, and determined to not meet the refuge purposes and vision and goals as well as the programs as described in alternative B. Managing Units II and III as freshwater marsh is also evaluated as a component of alternative C

Comment: One individual proposes Alternative P, "People's Alternative." The major component of this proposal is the development and execution of a Memorandum of Understanding between the Department of Interior—U.S. Fish and Wildlife Service and the State of Delaware—Department of Natural Resources and Environmental Regulation that would provide for the joint administration and management of Prime Hook National Wildlife Refuge. A "Refuge Stakeholder's Advisory Consortium" would also be established to provide formal input into management decisions.

> **Response**: As stated earlier, Prime Hook NWR is land specifically set aside by Congress for conservation of wildlife, with the Service designated as the Federal agency responsible for conserving, protecting, and enhancing the fish and wildlife populations and their habitats. DNREC has not suggested any interest in joint management of Prime Hook NWR. The public already has the opportunity to provide input into management decisions through the CCP and compatibility determination process, and through NEPA.

Comment: One individual proposed a new alternative that essentially "mix and matches" aspects of the three alternatives in the draft CCP/EIS. Major highlights of his proposal are:

- Repairing dune breaches and restoring freshwater marsh in Units II and III to benefit waterfowl and protect refuge neighbors.
- Installing a "robust berm or levy" north of Fowler Beach Road.
- Adopting alternative B's proposed changes to the mosquito control program.
- Reinstating cooperative farming on 200 to 300 areas and developing "Food Plot Demonstration" areas.
- Continuing existing refuge hunt program, with some expansions including turkey hunting and handgun deer hunting.
- Expanding wildlife observation, interpretive, and environmental education programs.
- Better use and support of Friends Group and volunteers.

> **Response**: While engaging the public in dialog during our meetings, the staff encouraged the public to provide comments on what they liked and what they wanted changed on the various alternatives. This may include mix and matching strategies across the alternatives. If a strategy is added or deleted, then our impact analysis may change as well. However, continuing the existing refuge hunt program, reinstating cooperative farming, and restoring freshwater marshes have been evaluated, and determined to not meet the refuge purposes and vision and goals as well as the programs as described in alternative B.

Global Climate Change

General Comments

(Letter ID#: 28, 69, 96, 104)

Comment: The Delaware Audubon Society writes, "What is required for all the constituents around PHNWR is a long-term retreat from Delaware Bay. Alternative B, acted upon outside the context of a comprehensive solution, will only delay the inevitable: a necessary retreat from the coastline." Delaware Audubon requests the Service to address, quantify, and analyze each management option offered in the proposed CCP in terms of best return on investment associated with surviving a 100-year storm. In particular, for analytical purposes, apply the results of the storm that immediately preceded the creation of the refuge itself, the Storm of 1962.

> **Response**: It is outside the scope of the CCP to do a detailed quantified evaluation of specific storm magnitude impacts for each alternative. Hydrodynamic modeling underway will include modeling of a 20-year storm, which will help with the evaluation of several potential restoration scenarios. However, the Service stands by the assertion that alternative B, a restoration of natural salt and brackish marsh habitat and functions in the impounded wetland complex and along the refuge shoreline, will provide the most resiliency possible to the effects of future storms of any magnitude.

Comment: The Delaware Chapter of the Sierra Club writes, "Given the scale of sea level rise that the CCP seeks to address, 15 years is an inadequate time frame to consider the long-term wildlife and habitat needs…. They continue, "For example the CCP should include a strategy for acquiring additional lands in the refuge… to replace…habitat lost to sea level rise…the Service should prepare for facilitating a natural transition of ecosystem communities and a plan for landward transgression of protected forests and wetlands."

> **Response**: Through its recently released "Conserving the Future: Wildlife Refuges and the Next Generation" vision document, the Service has recognized the need to improve the CCP process in the future. Specifically, Recommendation 1 from this guiding document, regarding the next generation of conservation plans, states that the Service will "ensure these new plans view refuges in a landscape context and describe actions to project conservation benefits beyond refuge boundaries."

Comment: Defenders of Wildlife writes, "[Climate change] is an undeniably important issue for [Prime Hook Refuge]. Defenders developed criteria for evaluating how well climate change is incorporated into final CCPs. We recommend the planning staff refer to these criteria."

> **Response**: We have reviewed the climate change criteria, and have incorporated suggestions where appropriate. We will also consider these criteria in any future revisions to the CCP.

Sea Level Rise
(Letter ID#: 21, 24, 25, 27, 28, 33, 45, 64, 69, 70, 75, 76, 79, 80–Petition, 82, 83, 85, 87, S1, S3, S13)

Comment: Several commenters suggested that because the CCP is intended as a 15-year planning document, only 2 inches of sea level rise should be considered, based on recent local sea level rise estimates.

> **Response**: Sea level rise is not necessarily a linear process: therefore, it would be inappropriate to assume that only two inches of sea level rise will be experienced locally. It is not simply the rate of local sea level rise that the refuge is basing management decisions on, but rather the consequences of sea level rise and climate change on refuge shorelines. There are multiple synergistic effects associated with climate change include rising ocean temperatures, more frequent storm surges, increasingly higher spring tides, land subsidence, and annual local beach erosion rates. In particular, one manifestation of sea level rise which results in combination with other factors, such as increased storm intensity and frequency, is the rate of shoreline erosion on the refuge. Shoreline erosion has demonstrably increased, and has a direct impact on refuge management capability and options. Analysis of refuge shoreline position and erosion rate data has been incorporated into chapter 3 of the final CCP/EIS, in the section on "Climate Change Adaptation and Vulnerability Assessment of Refuge Wetland Impoundments." In the coming 15 years, even small amounts of sea level rise will increasingly impact low-lying coastal refuge areas in combination with more frequent storm surges. The refuge is obligated to respond to these locally documented changing conditions affecting the refuge.

Comment: One letter questioned why the confidence interval associated with the local sea level rate was not included.

> **Response**: The refuge relies specifically on the tidal data collected at the nearby Lewes NOAA tide gage. The margin of error associated with this local sea level rise rate was not initially included in the text of the CCP in order to simplify the presentation of the data, not in an attempt to hide the minor variability associated with the data. It was already included in the draft CCP/EIS in the heading of Figure 3-4. The final CCP/EIS has been updated to indicate the range of local sea level rise estimates (2.92 – 3.48 mm/year, 95% confidence interval).

Comment: Several commenters, including the town of Slaughter Beach, questioned why there was any reliance on global rather than local sea level rise rate information, why refuting information regarding global sea level rise was not included, or why the refuge cites a value of 1.3 feet in 100 years rather than the local rate of 1.05 in 100 years.

> **Response**: Although estimates of global sea level rise do vary, depending on the source, multiple widely-accepted peer-reviewed research papers are cited to set the stage for the discussion on climate change and related consequences experienced by the refuge. The Service stands by its conclusion that climate change poses a very real threat to the conservation and management of our trust resources. Ultimately, the data the refuge relies on most directly to guide refuge management decisions are that which are measured and collected locally, and are undeniable. The evidence of increasing local sea level rise and shoreline erosion are discussed in the "Influence of Climate Change on Physical Environment and Refuge Management" section of chapter 3 of the CCP/EIS, including updated information in the final CCP/EIS regarding local shoreline erosion rates, which is one manifestation of climate change. The refuge is obligated to respond to the documented changing conditions affecting the refuge. The dissenting evidence provided by commenters included opinion blogs, reports, website links, and news articles, which are not directly relevant to the local environment.

This reference to a sea level rise rate of 1.3 feet in 100 years in chapter 1 occurs in a description of the work undertaken by the U.S. Climate Change Science Program to examine sea level rise in the Mid-Atlantic in particular. In describing this work we explained that the researchers utilized 1.3 feet in 100 years as the "current rate" for their modeling, an average they view as applicable to the region. This was not labeled by the refuge as the "current rate." There is no place in the draft or final CCP/EIS where we are directly relying on a rate of 1.3 feet in 100 years as the local rate of relative sea level rise. On the contrary, we repeatedly cite the local sea level rise rate measured by NOAA in nearby Lewes as the data that we are relying on most directly for our evaluation of management options.

Comment: One set of comments was critical of the refuge's use of the Sea Level Affecting Marsh Model (SLAMM) results in evaluating management options and impacts. In particular, it was noted that a more recent version of the SLAMM model exists, that the refuge should not have used global rather than local sea level rise rates in the modeling, and that the draft CCP/EIS did not sufficiently acknowledge the limitations and assumptions associated with the SLAMM model results.

Response: The SLAMM analysis for the refuge was conducted before version 6.1 was developed. At the time, few SLAMM analyses utilized local elevation data, and in that manner the SLAMM analysis conducted for the refuge was more advanced than the SLAMM analysis otherwise available at that stage of planning. Its limitations are acknowledged in the Key Issues section of chapter 1, under the subsection on Sea Level Rise. Its limitations are also discussed in chapter 2 in the subsection of "Other Scientific Information Guiding the Project" devoted to SLAMM. Additional acknowledgment of SLAMM's limitations has been added to chapter 3 of the final CCP/EIS.

The sea level rise rates modeled within the SLAMM analysis incorporate a range of possible future scenarios based by default on IPCC scenarios, and do not attempt to predict with certainty which rate of sea level rise may occur. The lowest rate of rise modeled by the SLAMM analysis is 0.5 meters, which is 1.64 feet, and indeed substantially higher than the current rate of sea level rise. It may in fact be informative to utilize SLAMM to evaluate the impacts over time of the current rate of sea level rise, or about 1.05 feet in 100 years. However, for future evaluations of the impacts of climate change, the refuge intends to rely instead on data collected locally regarding rising water levels, retreating shoreline position, and insufficient wetland elevation, particularly as they are compiled into a local hydrological model.

The discussion on the SLAMM analysis in chapter 2 already acknowledged that modeling results should be "considered with caution" due to uncertainty. This has been revised to state that the uncertainty is "high." The final CCP/EIS also states that, although the SLAMM analysis results are one consideration, they are not the primary factor driving management decisions. We have ample local data and an upcoming site-specific hydrodynamic model to assist both now and in the future with refuge management decisions. Regardless of the exact amount of each various habitat class that the refuge has the potential to lose under these changing conditions, the refuge stands by its assertion that such modeling efforts signal a substantial potential impact to refuge habitats that we must prepare for, and indeed have already seen in portions of the refuge.

Comment: Commenters noted that SLAMM should not be referenced to make statements about hydrology because it is not a hydrological model.

Response: The referenced section in chapter 5 has been revised in the final CCP/EIS. That does not change the refuge's assertion that climate change has already had, and will continue to have, an impact on the refuge's coastal hydrology. We rely for now on the data collected thus far regarding current sea level rise, retreating shorelines, and insufficient wetland elevation to substantiate our expectation that an additional conversion to open water is likely. The refuge is working currently to develop a hydrodynamic model which will more accurately and closely model local hydrological behavior, and enable us to predict the outcome under various specific restoration scenarios. This modeling, and not SLAMM, would ultimately be used to further guide refuge management.

Comment: Several individuals felt that, "The alternatives in the CCP/EIS…insufficiently analyzed…optimal management response to sea level rise uncertainty." They suggest that, "The FWS should utilize the full range of likely sea-level rise projects and determine the outcomes and costs of the optimal strategy set under each scenario…The CCP should incorporate true anticipatory adaptive planning: undertake actions that stabilize current conditions, rather than the alternatives it proposes—which are irreversible actions that preclude adjustment and actively and aggressively monitor for more information, thus allowing for development of the correct response strategy, once better knowledge is available. This is better for the refuge and for the taxpayer. Due to the projected gradual onset, there will be time to make corrections as improved technology makes possible more scientific certainty…[The best alternative given the short time span of the CCP and the uncertainty of sea level rise projects] would be to undertake only a version of the CCP recommendation for the immediate future… on page 1-19: Fill inlets and fully reestablish dunes along Unit II…Undertake actions common to all alternatives as discussed beginning on page 4-8 couples with other monitoring, as needed…"

> **Response**: The CCP is a long range plan that will guide management at the refuge over the next 15 years. Nevertheless, we have seriously considered wildlife and habitat needs, and climate scenarios, that extend beyond just the life span of the plan. As stated on page 1-2 of the draft CCP/EIS, "this CCP is designed to address management and protection of valuable natural resources into the future, a future where continued change is even more likely to occur." Furthermore, the Service is developing a framework, called Strategic Habitat Conservation, upon which future conservation efforts will be built. It is primarily a field-based approach for making management decisions about where and how to deliver conservation most efficiently to achieve specific biological outcomes. Through adaptive management, we will constantly reassess and improve our approaches. Hydrodynamic modeling underway will also include modeling of a 20-year storm, which will help with the evaluation of several potential restoration scenarios.

Comment: The authors of one letter were concerned with the accuracy of information on climate change and sea level rise in the draft CCP/EIS. They write, "Sea level rise is [treated throughout the draft CCP/EIS] as a certainty and not as a topic over which there is considerable ongoing scientific debate. The only bibliographic sources given are those that support the FWS's premise. There are many scientific reports that refute the FWS premises…" They also provide several bibliographic references. Similarly, another individual feels that "early 'scientific observations and measurements' [of sea level rise and climate change] were politically motivated towards indicting man as the primary culprit. Newer data has exploded many of these theories."

> **Response**: We believe the information in the CCP/EIS to be accurate and supported by current scientific research. Although estimates of global sea level rise do vary, depending on the source, multiple widely-accepted peer-reviewed research papers are cited to set the stage for the discussion on climate change and related consequences experienced by the refuge. The Service stands by its conclusion that climate change poses a very real threat to the conservation and management of our trust resources. Ultimately, the data the refuge relies on most directly to guide refuge management decisions are that which are measured and collected locally, and are undeniable. The evidence of increasing local sea level rise and shoreline erosion are discussed in the "Influence of Climate Change on Physical Environment and Refuge Management" section of chapter 3 of the CCP/EIS, including updated information in the final CCP/EIS regarding local shoreline erosion rates, which is one manifestation of climate change. The refuge is obligated to respond to the documented changing conditions affecting the refuge. The dissenting evidence provided by commenters included opinion blogs, reports, website links, and news articles, which are not directly relevant to the local environment, or have suspicious and unsupported claims.

Comment: Several commenters state that the draft CCP/EIS failed to acknowledge "the actual growth (vs. loss) of the beachfront on Broadkill from the section designated as North Shores 2 at California Avenue, northward past the area designated as Back Bay Cove."

> **Response**: The commenter is referring to private land/beach associated with the Broadkill community and the private subdivision, Back Bay Cove. It is beyond the scope of this CCP to analyze the shoreline of these communities. The Service acknowledges some areas along the shoreline are accreting sand. Barrier islands are dynamic by nature. Losses in one area may mean gains in another. However, the overall trend is the landward migration of the shoreline.

Comment: One individual writes, "The CCP does not acknowledge that the ongoing destruction to private communities and farmland is resulting from coastal-storm caused unrepaired breaches in the dune line at Fowler Beach on Prime Hook National Wildlife Refuge proper and not from sea level rise…there is no stated evidence linking these storms to climate change and therefore no reason to question the premise of relatively stable sea level over the shorter term."

> **Response**: The storms, dune breaches and flooding that have led to adverse impacts to farmland and private properties have also adversely impacted the refuge. We do believe that there is clear linkage between the frequency and intensity of storms and global climate change, and that sea levels are in fact rising. We worked closely with DNREC to repair the dunes in 2011 to permit a more strategic planning process. That repair was delayed by litigation and ultimately was not successful because the amount of material available on-site for the repair was limited. The use of off-site material was not a viable option.

Refuge Administration

General

(Letter ID#: 24, 28, 97, 99)

Comment: One individual commented on communications, writing "Due to communication problems and bad cell phone coverage, the FWS should do a complete overhaul of all field communications equipment ensuring all cars [and] boats have dependable radios for emergency [and] weather info. Portable units should be required. Also, work with local cell providers to improve transponders so the refuge with have better cell signal.

> **Response**: The Service believes our communication equipment is adequate. The refuge does have portable units that can be utilized in vehicles or in the field.

Comment: One individual urges the refuge to pursue access to the refuge property on the east side of Unit III. He writes, "The refuge is supposed to have access via N. Bay Shore Dr. to these lands, but [it] has been denied… This item needs to be resolved [with the Back Bay Cove Trust] to ensure refuge staff access.

> **Response**: Legal issues with private landowners are beyond the scope of this CCP. However, the Service continues to work towards a successful conclusion to access issues.

Budgets and Costs

(Letter ID#: 21, 28, 97, 104, 108–Form Letter)

Comment: One individual writes, "Management is poor due to 80% of the annual operating budget being spent on employee salaries, leaving only $100,000 to maintain the refuge…The priority should be on the best managed property and the wildlife it benefits."

> **Response**: The Service has tried to assure that national wildlife refuges have sufficient funds for management activities, above and beyond the funds needed to pay for permanent salaries. Today, most refuges in the country have 75 to 80% of their operating budgets dedicated to staff salaries. This is not due to poor management, but to the economic realities faced by governmental agencies to reduce waste and trim costs where possible.

Comment: One individual asks, "What is the source and availability of funding? The Plan proposes adding seven (7) employees to the staff. These will more than double annual operating costs. With the current federal emphasis on reducing costs and the House Appropriations Committee trying to slash the Fiscal '13 Refuge Budget by 10%, where is the money coming from to support additional staffing of seven folks?"

Response: Staffing levels for core refuge activities (core staffing), measured in full-time employees (FTEs) which includes operations, maintenance, and fire management, is derived from the President's budget allocation from the resource management appropriation for each fiscal year. The preferred alternative B addition of five FTEs is contingent upon an increase in appropriations for the refuge. Beyond receiving financial resources, refuges also can receive in-kind donations from nonprofit groups, for-profit companies, and other organizations and reprioritize refuge funding to ensure the completion of required conservation plans.

Comment: One individual felt that the CCP should include estimated costs for proposed actions. Another individual and the Delaware Audubon Society feel that the refuge should analyze and compare the overall costs, benefits, and risks of each of the three proposed alternatives in the draft CCP/EIS.

Response: Appendix H (Refuge Operation Needs System (RONS) and Service Asset Maintenance Management System (SAMMS)), Appendix I (Regional Economic Impacts), and compatibility determinations do include estimated costs of alternative B. Please note that on the inside front cover of the document we also state that "… 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." Initial up-front planning costs associated with specific strategies of the alternatives B and C could be costly. However, a cost of a self-sustaining salt marsh would be minimal when compared to the projected cost of continuous year-over-year maintenance required in alternative C. We believe that grant and cost sharing opportunities will become available through our partners and the Delaware Department of Natural Resources. It is also anticipated that the U.S. Army Corps of Engineers would become active partners, in addition to the traditional cost sharing partnerships, which allow and encourage those who benefit from the beneficial uses of dredge material. Outside of relative costs, we have also evaluated and compared the various impacts, benefits, and risks of each of the proposed alternatives in chapter 5 of the CCP/EIS.

Staffing
(Letter ID#: 13, 28, 36, 81, 98)

Comment: We received several comments on law enforcement, and what appears to be a lack of law enforcement on the refuge. One individual asks, "Where is the law enforcement" when birdwatchers are blocking the gate to Island Farm, people sneak into Island Farm, and rabbit hunters are hunting in closed areas. The State also suggests, "If Fowler Beach is opened to night fishing, a provision should be made for increased enforcement presence during that time." Another suggests that law enforcement efforts be increased during hunting season to remind hunters to follow safety rules, wear proper clothing, and follow State and refuge regulations.

Response: Law enforcement staff is essential. Currently, the refuge has no authorized law enforcement staff, but is scheduled to receive a full-time officer. The law enforcement position at Bombay Hook NWR currently covers Prime Hook. Delaware Division of Fish and Wildlife Law Enforcement and Service law enforcement staff continue to work together to provide law enforcement needs for the refuge. Also, we agree with the State that we should increase law enforcement if night fishing is allowed.

Comment: One individual was concerned by reductions in staff at Prime Hook National Wildlife Refuge. He writes, "[If the CCP is so important,] why then did the regional office of [the U.S. Fish and Wildlife Service] reduce the refuge staff by 4 positions…immediately after filing the [notice of intent to prepare the CCP]." He continues, "Another self-inflicted problem was the Service's decision to remove three personnel who could have been key to getting the CCP finished in less than seven years.

Response: In 2007, the need to implement a workforce plan was due to the nationwide budget decline in the National Wildlife Refuge System which continued to erode field station management capability. These declines have limited the ability for stations to complete mission critical projects, and with the institution of base budgets and continually declining budgets, refuges would not have the ability to pay staff salaries. At the Regional level, it was clear that we would no longer be able to continue the practice of making every field station "whole" at the beginning of each year, based on the permanent staff they had on board.

The Northeast Region implemented a plan to effectively and responsibly manage natural, financial and human resources with declining federal budgets.

During that period the Service took a hard look at the future budget for refuges in Region 5. We stressed the need to do less with less; we emphasized the need to focus on high priorities only; we informed stations that we will be going to base budgets; and finally, we developed our list of refuges that will stay strong and a list that might go into preservation status.

By proposing a 75/25 funding split for salary and operational dollars, we have been able to manage through this dilemma. While developing the downsizing plan, we analyzed the planned FTE loss and salary savings, and accounted for savings from stations placed in preservation status, which was the first step in achieving a 75/25 budget ratio. This plan identified a reduction of approximately 22 field positions throughout Region 5, which was the first step/phase in facilitating the move to base and providing our field stations with the capability to manage through the budget decline. The Director supported this plan.

Comment: One individual wanted to know what the job duties of the proposed additional public use staff.

Response: To meet the increasing demand for outdoor recreational experiences in this area for environmental education and interpretation and their connection with other priority public uses such as wildlife observation, photography, hunting, and fishing, the final CCP/EIS supports the addition of public use personnel if appropriated funds become available.

Volunteers and Friends Group
(Letter ID#: 24, 28)

Comment: One individual and the authors of another letter suggest the following, "Work hand in hand with Friends group on the development of a refuge volunteer plan and handbook."

Response: The development of a refuge volunteer plan and handbook is discussed as a strategy to fulfill Objective 6.3 in Alternative B. The Friends of Prime Hook NWR will play an important role in the strategies to achieve many of the objectives outlined in the CCP as discussed in "Actions Common to All Alternatives" in Chapter 4.

Comment: One individual writes that "The Friends Store storage pace should also be increased to accommodate more visitors and display space."

Response: A project to expand the office is included in our databases. Hopefully, future renovations would include additional space for the Friends store and storage.

Comment: One individual feels that refuge management need to put more of the Friends Group resources to use and should continue to recognize volunteers through the volunteer banquet and cookout, as well as seeking other ways to reward and recognize the important work of volunteers.

Response: The refuge recognizes the outstanding support the Friends group and the volunteers have provided over the years. The refuge recognizes their contributions annually at the volunteer banquet.

Partnerships and Community Outreach
(Letter ID#: 27, 28, 33, 39, 42, 46, 48, 49, 64, 66, 72, 80–Petition, 82, 91, 98, 104)

Comment: Several commenters recommend establishing a formal public-private partnership among Prime Hook NWR and the communities of Prime Hook Beach, Slaughter Beach, Broadkill Beach, impacted farms, and other key stakeholders. Another individual felt that "a collaborative relationship with stakeholders will also help address the CCP comments that detail a lack of public trust with the FWS."

Response: An informal advisory partnership with numerous academic professionals and representatives of other agencies was expanded this past spring to include representatives of the Alliance for Bay Beach Communities (ABC), the Prime Hook Beach Organization (PHBO), and the local farming community, who were included in a wetland restoration workshop. As described in the strategies associated with Objective 3-1, we envision that we will continue to gather these partners in some combination, along with members of the public, again after the CCP is finalized to discuss the next steps in wetland management and restoration. As also described, we intend to host public forums to share restoration plans as they are developed, in order to seek public feedback and involvement. In addition, the refuge has recently taken steps to expand its formal partnerships beyond the successful partnership it has maintained with the DNREC Coastal Program, responsible for considerable monitoring and data collection that has been pivotal for guiding management decisions and contributing to upcoming modeling efforts. As now described in the rationale and strategies associated with Objective 3.1 in the Preferred Alternative of the Final CCP/EIS, efforts are underway to formally partner with the Partnership for the Delaware Estuary (PDE) regarding the potential application of living shoreline techniques in appropriate areas of the wetland complex. Regarding a formal private-public partnership between the refuges and the neighboring communities directly, the purpose, structure, and mechanism for a formal partnership between the refuge and private community entities would need to be examined with the assistance of our Solicitor and other partnership experts within USFWS. However, this is an option that could be explored further following finalization of the CCP.

Comment: One letter states, "What needs to happen is a coordination of efforts across government agencies, involving FEMA: *http://www.fema.gov/pre-disaster-mitigation-grant-program.* Through programs like the Pre-Disaster Mitigation program linked above, the community of Prime Hook may be able to benefit from a program that analyzes the probability of disaster and quantifies the risks to the community. It is clear that even if USFWS is successful with implementing Option B, this community will continue to be at great risk for five-year storm events, let alone 100-year storm events. The hazards the community currently experiences during each flood event are well documented."

Response: Comment noted. The refuge has included community representatives and several state agencies in recent discussions regarding wetland restoration and management, and will continue to do so after the CCP is finalized and the next steps of CCP implementation begin to take shape. The Pre-Disaster Mitigation program is targeted toward state, tribal, and local communities, and the community of Prime Hook Beach is welcome to pursue such funding opportunities. Although we would be willing to partner with them on such an effort, that would be entirely independent of the refuge's CCP.

Comment: Several commenters believe the Service should recognize in the final CCP the relevance and importance of these complimentary state activities, such as the 10-year Bay Beach Management Plan and the Bay Beach Work Group, and ratchet up the level of collaboration and resource sharing with these endeavors, for example, the ongoing hydrology and drainage studies and economic analysis and utilize and integrate all relevant data and findings.

Response: The Delaware Bay Beach Work Group was formed for examining issues such as beach erosion, marsh drainage in the Delaware Bay Beach communities, resulting in recommendations for how the governmental agencies might address these issues. The Service currently is a member of this work group. The Service continues to utilize any relevant data and continues to collaborate with its partners and academia.

The analysis conducted as part of the 10 year Bay Beach Management Plan, did not include the undeveloped portions of the Bay. Although this information provides valuable information for the communities, it provides limited utility for the refuge.

Comment: The Alliance of Bay Communities, Sussex County, and several individuals asked the refuge to fully participate in the Delaware Bayshore Initiative. They write, "We believe the recently launched Delaware Bayshore Initiative -a federal-state partnership, serves to reiterate [the] promises [from the 1963 press releases] and the necessity for responsible stewardship of the beaches, marshes, lands, and wetlands that comprise the PHNWR and impact the surrounding communities that proves to be mutually beneficial to all parties.

Response: The Service is proud to be a part of the Delaware Bayshore Initiative, and looks forward to a productive partnership that addresses responsible stewardship of the natural resources found in the state.

Comment: Several individuals and the Prime Hook Beach Organization suggest additional partnership opportunities, including partnering with the following organizations and agencies:

- U.S. Army Corps of Engineers to obtain suitable sediment for shoreline and marsh restoration.
- U.S. Army Corps of Engineers and the EPA to obtain Section 404 permits.
- Governor Markell's Sea Level Rise Advisory Committee to develop adaptation strategies for coastal Delaware.
- Other State, Federal, and local agencies—such as DNREC, DelDOT, Delaware Emergency Management Agency—to help implement the plan and conduct adaptive management.

Response: The Service reiterates Goal 6 of the CCP/EIS: "Collaborate with the local community and partners to complement habitat and visitor service programs on the refuge and the surrounding landscape." Furthermore, we have already been working closely with these entities to evaluate marsh management and restoration options, as outlined under Objective 3.1 of the CCP.

Comment: The Prime Hook Beach Organization writes, "The National Wildlife Refuge System Improvement Act of 1997 [states in Section 6. Compatibility Standards and Procedures that] the Secretary shall not initiate or permit a new use of the refuge or expand, renew, or extend an existing use of the refuge, unless…[that use is consistent with public safety.] … the refuge manager's failure to fix the dune breaches, which the refuge has done in the past, results in a new use, i.e., an ongoing tidal flooding of salt water that did not exist before the breaches and is incompatible with public safety … . Furthermore, the context of the CCP statement ignores its role of "community partnership" and its "stewardship ethic" as stated in the Refuge's vision statement.

Response: Per Service Policy 603 FW 3 a compatible use is defined as "A proposed or existing wildlife-dependent recreational use or any other use of a national wildlife refuge that, based on sound professional judgment, will 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 breaches and subsequent changes to the marsh do not constitute a use as defined by policy.

Comment: The authors of one letter write, "The refuge has not been in compliance with Federal Law … which requires the federal government to use all practicable means to create and maintain conditions under which man and nature can exist in productive harmony. Section 102 requires federal agencies to incorporate environmental considerations in their planning and decision-making through a systematic interdisciplinary approach. Specifically, all federal agencies are to prepare detailed statements assessing the environmental impact of and alternatives to major federal actions significantly affecting the environment.

Response: Among other things, NEPA requires that Federal agencies "Utilize a systematic, interdisciplinary approach… in planning and decision-making…" and "… insure that presently unquantified environmental amenities and values… [are]… given appropriate consideration in decision-making along with economic and technical considerations…" Prior to making a decision to undertake a proposed action, agencies are to consider a range of reasonable alternatives and the effects of their implementation. We have prepared this CCP and environmental impact statement in compliance with NEPA.

Comment: One individual suggests using an outside consultant of university group to conduct an evaluation of the effectiveness of current outreach techniques because outside groups "tend to look at the broader picture and will include local observations and thoughts."

Response: The extensive scoping process, public involvement and use of an interdisciplinary planning team all allow for a broad look at the refuge and the issues it faces, and includes local observations and thoughts into the plan.

Comment: One individual proposes a Bayshore Initiative Partnership project called the "Fowler Beach Demonstration Project." He feels that this proposal will protect neighboring communities and benefit wildlife. The major components of the proposal are:

- An agreement between the Service and private shoreline owners
- A memorandum of agreement between the Service, DNREC, DelDOT, the Army Corps of Engineers, and the University of Delaware to address road maintenance, dune maintenance, shoreline management and monitoring, and to conduct pilot study projects on "fortifying the shoreline" with dunes, engineered solutions, or living shoreline techniques.
- Funding for dune restoration, restoration of Fowler Road, parking lots, observation areas, appropriate signage, and the shoreline fortification project.

Response: The Delaware Bayshore Initiative builds on existing partnerships to conserve, protect, and restore critical wildlife habitat and waterways, and provide world-class low-impact outdoor experiences, while inspiring generations of Delawarean's to take pride in Delaware's wild side.

DBI is comprised of a three-part strategy:

(1) Conservation, restoration, and protection of critical native habitats and waterways, including landscape-scale preservation through acquisition or easements of unprotected lands

(2) Recreation and connectivity within and among urban and rural areas by enhancing access to Bayshore sites and promoting low-impact recreation including hunting, fishing, wildlife observation, photography, hiking/walking, biking, canoeing, kayaking, and other recreation opportunities

(3) Engagement and marketing of the region by, promoting local economic development, encouraging volunteerism, environmental education, improving key facilities, and engaging residents, businesses, community groups, schools, and civic organizations to instill a sense of local stewardship.

The Service continues to work with its partners (DNREC, DelDOT, U.S. Army Corps of Engineers, Partnership for the Delaware Estuary, etc.). The Service and its partners are looking into restoration options for the Prime Hook marshes to include living shoreline techniques, potential dune restoration, road and culvert issues. We are always looking out for potential funding opportunities. It should be noted that the Service's alternatives do not include shoreline fortication (hard armoring) or restoration of Fowler Beach Road. DelDOT has authority over Fowler Beach Road.

Facilities – Roads and Culverts
(Letter ID#: 24, 28, 62, 65, 70, 71, 80–Petition, 81, 104, 108–Form Letter)

Comment: The form letter states, "Prime Hook Beach Road can be rebuilt. It was built 65 years ago on nothing more than marsh land. It has had only minimum maintenance which any county road would get in Sussex County. Fowlers Beach Road was probably built the same way many years before Prime Hook Road. Both roads have never had more than the minimal maintenance until the breaches in the barrier beach at Fowlers broke through. Rebuilding the barrier beach would stop the salt water from entering Unit II. A lower water table could be held; therefore both roads could be rebuilt."

Response: DelDOT has maintenance authority over the road. Per DelDOT, the marsh substrate the road rests on cannot support addition elevation (weight). Actually, adding additional material may result in a loss of elevation through subsidence.

Comment: One commenter stated that the elimination of Fowler Beach Road further exposes Unit I to adverse impacts.

Response: The potential elimination of Fowler Beach Road is simply one strategy and scenario we may use to restore the hydrological connection between Unit I and a restored salt marsh in Unit II. For example, removing the physical obstacle of the road between the units would likely improve water circulation and drainage in Unit I and divert more sand and other sediments into Unit II that currently accumulates on top of Fowler Beach Road. Sand on top of the road is lost to a back-barrier marsh system that is currently sediment starved and could use more sediment transport dropping sand into the marsh instead of on top of the road. The Service would not advocate for this step unless our modeling work and restoration monitoring indicated that it would be beneficial, and this caveat has been clarified in the final CCP/EIS. Similarly, we would not encourage the removal of the road if we have concerns about the timing of such a step. However, ultimately the fate of Fowler Beach Road rests with DelDOT, which has authority over its maintenance.

Comment: PEER writes, "Other wetland-road management actions related to road maintenance of Fowler Beach or Prime Hook Roads taken in 2008 and 2009 were and still are directly linked to refuge wetland management and/or have direct impacts to the conservation of refuge wetlands. The characterization or labeling of the DelDOT maintenance actions of 2008 and 2009 as "No Human Intervention" related to freshwater wetland management on these two roads is simply not accurate. Adverse direct, indirect and cumulative hydrological impacts of wetland-road maintenance actions of 2008 and 2009 to the biological integrity, diversity and environmental health of the then existing refuge freshwater impoundments were never considered or analyzed or even remotely connected to the federal actions taken by the Service that supposedly had to occur "to protect freshwater impounded wetlands" [Dune EA (2010)]."

Response: DelDOT, not the refuge, has authority to maintain the road. These actions are not considered refuge actions, and therefore are not labeled in the CCP as direct refuge management strategies under any of the alternatives, including Alternative A. Rather, we routinely include strategies to continue working with DelDOT to encourage road maintenance decisions that will not interfere with the conservation and management of refuge habitats and resources. Furthermore, road maintenance actions taken by DelDOT in 2008 did not hinder successful management of the freshwater impoundments in spring and summer of 2009, as documented by vegetation response, and thus are not viewed as primary factors in the hydrological changes the wetland system experienced following the formation of large inlets in the fall of 2009.

Comment: PEER writes, "Road maintenance occurred in the past and will continue in the future, so why does the CCP/DEIS fail to adequately discuss the full ramifications of road maintenance actions and conduct a full environmental consequences analysis in the CCP/DEIS?" Another individual writes, "DelDOT efforts to fix the road are minimal and short term—the CCP needs to address a longer term effort and how to deal with this in the meantime."

Response: DelDOT, not the refuge, has responsibility for maintaining the roads. We cannot predict what actions they will decide to take on any particular road that crosses the refuge, and therefore cannot evaluate impacts from road maintenance actions explicitly for any alternative in the CCP. The CCP addresses actions to be taken by the refuge. As stated in several places in the CCP, we will continue to work with DelDOT to encourage road maintenance decisions that will not interfere with the conservation and management of refuge habitats and resources. We have some opportunity for minor environmental review through state permit process, such as for culvert additions, but not for most road work like hauling gravel for the shoulders. They have the authority to conduct road maintenance under the conditions of an easement established prior to refuge acquisition of the land.

Comment: PEER writes, "PHNWR has presided over the rapidly destruction of the health and integrity of national wildlife refuge freshwater wetland habitats by failing to mitigate adverse impacts and find more wetland friendly road maintenance solutions."

> **Response**: As explained in the Key Issues and Concerns section of Chapter 1 of the CCP, the Service attempted to mitigate the impact of sudden saltwater intrusion into the impounded wetland complex by working with DNREC on a temporary, though ultimately unsuccessful, repair of the breaches that formed in 2009. Because road maintenance is the responsibility of DelDOT, it is not within the authority of the USFWS to "find… road maintenance solutions." We have been in communication with DelDOT about possible future options, but they maintain the authority to conduct road maintenance as they deem necessary to meet their mandates.

Comment: One individual writes, "How do you justify the compatibility of maintaining BIDEH of refuge wetlands that culverts on a maintenance-easement has already in the past and will continue to with very significant adverse impact on wetland health and integrity and refuge wetland management capability?"

> **Response**: The culverts did not result in the adverse impact to the impoundments. The saltwater intrusion from the Bay, because of the breaches, has resulted in the loss of the freshwater integrity of the impoundments. A list of potential restoration scenarios that would be evaluated through a modeling effort can be located under Objective 3.1. Various restoration experts and state officials have suggested both reduced and increased flow under Prime Hook Rd. as potential strategies for wetland management, and so both are listed in the referenced statement as scenarios to be evaluated in the modeling exercise.

Comment: One individual suggests, "In accordance with your plans summarized on page 4-167, wouldn't it be more logical to place the culverts under Fowler Beach Road and drain the water that direction? This would permit salvage of the Unit III impoundment as a freshwater impoundment."

> **Response**: We respectfully disagree. The low road elevation and lack of drainage to the north may have detrimental impacts to Unit I. The topography of Unit II will always allow for southerly flow through the culverts under Prime Hook Rd. Historically Slaughter Creek flowed to the south and entered the Bay just north of Prime Hook Road.

Comment: One individual writes, "If FWS and the state intend to rebuild the dunes to reduce flooding, why would there be a need for additional, larger PHB culverts? The two actions are very connected environmentally. Do you intend to do an EA/compatibility review and public review of this project? Or do you and the state intend to hide the work as repair and replace of existing structures? Larger PHB culverts are not replacing existing structures."

> **Response**: We have always stated that dune work/breach closure was a possible, and indeed likely, first step toward restoration of the salt marsh in order to attenuate water velocities and sustain the sediment while marsh plants are becoming established. However, repairing the dunes alone will not eliminate future flooding of roads and agricultural lands during extreme high tide and storm events, since floodwaters can enter these areas through locations other than the existing breaches. Rather, restoring the natural hydrological function of historic refuge salt marshes has many different strategies; this may include larger culverts under Prime Hook Rd. As stated earlier the marsh restoration planning may require additional environmental assessments as the modeling and other data become available. We continue to work with DelDOT, DNREC, and the communities to strive for a positive outcome for all parties.

Comment: One individual writes, "Additionally, recent news articles have reported that the state (DelDOT) has received $640,000 to replace culverts under Prime Hook Road. Where is this discussed in the CCP? This project will have serious negative impacts on the refuge by degrading and destroying the BIDEH of Unit III. It will make any return of Unit III to some semblance of a healthy marsh, or even parts of the unit to freshwater impossible."

> **Response**: You are correct in stating DELDOT received a grant to replace the culverts under Prime Hook Rd. We listed this as a potential strategy under Objective 3.1 of Alternative B. Hydrodynamic modeling underway will include impacts of replacing the existing culverts with larger culverts (increased flow). We further state in Objective 3.1 that the marsh restoration planning may require additional environmental assessments as the data becomes available. However, the Service stands by the assertion that Alternative B, a restoration of natural salt and brackish marsh habitat and functions in the impounded wetland complex and along the refuge shoreline, will provide the most resiliencies possible and restore BIDEH of the Unit.

Comment: PEER writes, "The increased water flows and significant volumes of water from Unit I culverts entering Unit II from re-established culverts along with other temporary alterations to hydrology from digging drainage ditches at Fowler Beach Road were major contributing hydrological factors that aided in punching out new breaches in Unit II during the November Nor'easter."

> **Response**: We find this comment to be pure speculation. There is no way to claim with any certainty that maintenance along Fowler Beach Rd. was a factor in the formation of shoreline breaches during a storm event that caused flooding all along the Delaware Bayshore. Road maintenance actions taken by DelDOT in 2008 did not hinder successful management of the freshwater impoundments in spring and summer of 2009, as documented by vegetation response, and thus are not viewed as primary factors in the hydrological changes the wetland system experienced following the formation of large inlets in the fall of 2009.

Comment: One individual writes, "The existing culvert could have been fitted with flap gates to keep "most" salt water in Unit II. The marsh elevation could be helped to recover by conducting a project similar to what Blackwater NWR did – place hay bales in the open water areas to collect silts etc. as well as clean the marsh channels (drains) and pump the water slurry inside the area with hay, thus raising the elevation of the Unit III marsh and restoring healthy freshwater wetland habitats for migrating and wintering waterfowl and other wildlife is completely ignored in proposal B."

> **Response**: Retrofitting flap gates and/or stop logs structures on the culverts elevating water levels in Unit II was never evaluated in the 1980's. The EAs developed in the 1980's acknowledged the hydrological connection between Units II and III. It is unclear whether restricting the flow may have negative impacts to upland habitats, the road, and the Prime Hook community and if the purpose of such a project is to return the unit to a freshwater marsh, as soon as the next large storm inundates these structures, the freshwater vegetation would be killed again, which is why trying to maintain a freshwater system is unsustainable.
>
> Objective 3.1 lays out many short-term strategies including living shoreline techniques such coconut logs or hay bales for salt marsh restoration. We question the use of such a technique for freshwater wetland restoration, since the larger issues of sustainability still arise. The refuge acknowledges that the best management for Unit III is not yet clear, as it has always had higher freshwater inputs. The overarching objective is for it to be more sustainable for the long-term. Clearly, it cannot continue to be managed in exactly the current manner, which has left it vulnerable to subsidence and wetland collapse in large portions. Without the results of hydrodynamic modeling currently in development, and other further analysis, it is difficult to know yet if salt marsh restoration would succeed, or if a return to impoundment management is even feasible given the many factors involved.

Comment: One individual writes, "The Prime Hook Road, which carries traffic, presents a different problem. This road has no significant base, is low and continues to sink. The alternates are: elevate the low sections and add a water control structure, elevate the road and incorporate a water control structure, or build a berm or levy on the north side, with appropriate water controls. Probably adjustments will be required on the Petersfield Ditch structure and the Prime Hook Creek structure as well."

> **Response**: Comment noted and the Service agrees. We recognize that community safety is important to all concerned. We will continue to work with the State of Delaware on any road improvements that will alleviate flooding while ensuring that Refuge resources are not significantly impacted. Prime Hook Beach Road is maintained by the Delaware Department of Transportation (DelDOT). Maintaining the road to adequately function during storm events is a DelDOT responsibility, and the refuge will continue to work with DelDOT to address the situation.

Comment: A commenter noted that page B-101 of the draft CCP/EIS states, "Work with DelDot on abandonment and removal of Fowler Beach Rd to improve tidal flow between Units I and II." The respondent writes, "Unless there is better drainage out of Unit I, the result will be that additional water will flow into Units II and III, leading to greater need for drainage along both Primehook Rd as well as Broadkill Rd. The COE's assistance is needed to repair the Mispillion jetty (which is currently silting in) that would then speed drainage of Unit I. Despite the jetty being off-Refuge, it is having a very adverse impact in overall drainage of Unit I."

> **Response**: The commenter likely oversimplifies the necessary resolution to the problem. Marshes of a given acreage require inlets and outlets of sufficient capacity to move all water coming off the land and from the bay within a tidal cycle or two. A myriad of man-made factors contribute in varying degrees to reduced drainage of the PHNWR marsh, including numerous jetty's designed to stabilize shorelines and inlets running from Slaughter Creek to Lewes, roads (with or without culverts) crossing the marsh that serve as dikes, and permanent closure of the main channel of Prime Hook Creek to the Bay. Retaining the existing infrastructure, or adding more highly engineered impediments to the free-flow of lunar tides and overland runoff, may serve as a short-term solution at best.

Comment: Several commenters requested that we take actions on either Prime Hook Road, Fowler Beach Road, or both, such as more culverts, road raising or replacement, conversion to floating roads, or berms along the roads. Failure to include such specific strategies is regarded as a significant omission in the CCP.

> **Response**: As stated in the strategies associated with alternative B, objective 3-1, we will continue to work with DelDOT to explore options, which address road flooding concerns in a manner consistent with refuge management objectives. The impact of road changes on local hydrology will be evaluated in ongoing hydrodynamic modeling. DelDOT has indicated that the marsh substrate Prime Hook Road rests on cannot support addition elevation (weight) and that adding additional material may result in a loss of elevation through subsidence. DelDOT has proposed replacement of culverts along Prime Hook Road, and we are working with them to ensure that any work they do would not have a detrimental impact on refuge resources and that their work may benefit from our hydrodynamic modeling. However, DelDOT ultimately has maintenance authority over both roads and it is outside the jurisdiction of the USFWS to propose or conduct management strategies involving changes to state roads, such as culvert replacement or raising of the roads. DelDOT has not expressed any interest in or intention to raise or otherwise improve Fowler Beach Road.

Comment: One letter pointed out that a statement on page 4-100 of the draft CCP/EIS regarding closing the Prime Hook Road culverts is inconsistent with other parts of the CCP, which call for additional flow of water under Prime Hook Road.

> **Response**: The statement referenced included a list of potential restoration scenarios that would be evaluated through a modeling effort; this list was not intended to describe definite plans. Various restoration experts and state officials have suggested both reduced and increased flow under Prime Hook Road as potential strategies for wetland management, and so both are listed in the referenced statement as scenarios to be evaluated in the modeling exercise.

Comment: The Delaware Audubon Society and one individual were concerned about activities conducted by DelDOT on or along refuge property. The individual writes, "DelDOT only has a [50]-foot easement to 'maintain [Prime Hook and Fowler Beach Roads].' How is they were allowed to dig ditches…on Service lands and in fragile salt marsh, without a permit/CD or environmental review?" The Audubon Society concurs, writing, "Shouldn't there have been an EA or CD on whether or not these culverts were in the best interests [of the refuge]?"

Response: DelDOT obtained a 50' easement for a road prior to refuge establishment. The easement states "…A permanent easement and right to grade and slope the lands and premises hereinafter described for the purpose of relocating, constructing, widening, improving, and maintaining the existing State Highway… for the grading an sloping of said land and, the right to grant a public utility permit franchise or easement to install and maintain its facilities or permitting a public utility to install and maintain its facilities in, on, over, or across said lands and premises." DelDOT, through the easement, has the right to maintain the road. Although past mistakes were made in their routine management (such as depositing spoils from a ditch clean out on the wetland), DelDOT has acknowledged that such approaches should not be repeated. DelDOT, DNREC, the Service, and the Corps of Engineers worked together to insure that the situation was rectified. Although we cannot undo the past, lessons learned have improved communications and sound management practices by and among all parties.

Road maintenance and culvert replacement for Fowler Beach and Prime Hook Roads do not require a compatibility determination. Service policy 603 FW 2(B)(1) states "Exceptions may apply when there are rights or interests imparted by a treaty or other legally binding agreement, where primary jurisdiction of refuge lands fall to an agency other than us, or where legal mandates supersede those requiring compatibility. Where reserved rights or legal mandates provide that we must allow certain activities, we should not prepare a compatibility determination." However, these activities may require further environmental review such as wetland permits. The Service, DNREC, and DelDOT continue to work together during these review processes when they arise.

In 1990 the Service and DelDOT entered into a memorandum of agreement (MOA), which states "whereas, it is desirable for both parties to establish a cooperative agreement for replacement of these culverts…" The Service and DelDOT have worked cooperatively in the past and will continue to look for the best solutions for Prime Hook Rd. and the refuge's marshes. Should the modeling work determine that replacement of the culverts is an appropriate and refuge-compatible project, the Service can issue a limited special use permit for the work to be performed if it is necessary for it to encompass more than the 50 foot easement.

Comment: One organization questioned why the Service did not address adverse impacts that would impede and interfere with the refuge's capacity to conduct water level management and continue to protect the freshwater integrity of an established wetland system, referring specifically to the summer of 2008 and claiming that the Service made the choice to not maintain the freshwater integrity of Unit II impounded wetlands by allowing the re-establishment of the culverts under roads crossing the refuge wetlands.

Similarly, another individual writes, "FWS completely ignores a thorough environmental analysis of impacts that PHB culverts has on critical factors that adversely impacts BIDEH of current and future wetland condition and management of Unit III. How is this possible? Not very credible in CCP and violates BIDEH policy. FWS present a credible 15 year plan and HMP with zero discussion about immediate and cumulative impacts that PHB culverts has already had and will continue to have on Unit III. Bigger culverts will materially interfere with the refuge wetland management capability of Unit III endorsing the current refuge position to permanently degrade Unit III marshes."

Response: We respectfully disagree with your conclusions. In 2008, the dunes were repaired and the Units were restored to freshwater. Restoring the dunes reduced the flow of saltwater from the bay, hence lowering salinity levels. In 2009, we had excellent production of moist soil vegetation, which has been well-documented. It was during the Veteran's Day storm of November 2009 that dunes were overwashed again. The overwashing of the dunes and erosion of the shoreline are primary factors contributing to the loss of the man-made freshwater impoundments.

The breach immediately north and south of Fowler Beach Road has formed inlets in the past few years. Those inlets flooded the managed freshwater impoundments with saline bay water. That saline bay water flows through the culverts and periodically over the roads. According to past annual refuge management plans, salinity levels can range from 0 to 12 ppt. With salinities regularly above zero, the system cannot be a true freshwater system. Salinity has always been a factor in the management of these manmade freshwater units. The inlets, as seen today, continue to provide daily tidal exchange of saline bay waters. Although culverts influence the hydrology, they, alone, are not responsible for the current situation the marsh faces.

It is true roads, ditches, and culverts have an impact on the hydrology of an area. Many of these impacts occurred prior to refuge ownership and continue to influence the hydrology of the marshes today. DelDOT obtained an easement for a road prior to refuge establishment. The easement states "…A permanent easement and right to grade and slope the lands and premises hereinafter described for the purpose of relocating, constructing, widening, improving, and maintaining the existing State Highway… for the grading an sloping of said land and, the right to grant a public utility permit franchise or easement to install and maintain its facilities or permitting a public utility to install and maintain its facilities in, on, over, or across said lands and premises." DelDOT, through the easement, has the right to maintain the road which includes culvert replacement. In 2008 DelDOT replaced the existing culverts. Although past mistakes were made in their management of the culverts, such as depositing spoils from a ditch clean out in the wetland, DelDOT has acknowledged that such approaches should not be repeated. DelDOT, DNREC, the Service, and the Corps of Engineers worked together to insure that situation was rectified. Although we cannot undo the past, lessons learned have improved communication and sound management practices by and among all parties.

Road maintenance and culvert replacement within the 50 foot right of way for Fowler Beach and Prime Hook Roads are not actions that the Service is in a position to "allow" or "deny" and therefore they do not require a compatibility determination. Service policy 603 FW 2(B)(1) states "Exceptions may apply when there are rights or interests imparted by a treaty or other legally binding agreement, where primary jurisdiction of refuge lands fall to an agency other than us, or where legal mandates supersede those requiring compatibility. Where reserved rights or legal mandates provide that we must allow certain activities, we should not prepare a compatibility determination." However, these activities may require further environmental review, such as wetland permits. The Service, DNREC, and DelDOT continue to work together during these review processes when they arise.

Land Protection and Acquisition
(Letter ID#: 54, 104)

Comment: Multiple organizations urge the Service to continue and possibly expand the use of land acquisition from willing sellers to protect existing habitats and to provide future habitats for wetland migration.

Response: Expansion of the refuge's acquisition boundary is a necessary future step to meet habitat needs for trust species such as migratory waterfowl, shorebirds, and neotropical migrants, and to contribute to the network of conservation lands and wildlife resources in the regional landscape. However, with input we received from the public during scoping, coupled with reduced land acquisition funding, we are not planning any major refuge boundary expansion as part of this CCP/EIS. Approval to explore refuge boundary expansion comes from the Service's Director, and then expansion requires development of a Land Protection Plan (LPP). We will continue to consider minor acquisitions adjacent to the refuge from willing sellers if the lands are determined to be biologically important, or provide connections with other protected lands. As sea level rise inevitably continues, should owners of surrounding farmlands determine that their lands are too soggy or salty for productive farming, the Service will certainly remain open to willing sale purchases as such lands may hold wildlife value as well as providing an ecological transition protecting lands farther inland. Land protection efforts that emerge outside of this planning process will include significant public involvement in decision making, involve partners in the protection effort, and will utilize the full range of protection methods, including management agreements, conservation easements, and fee acquisition.

Historic and Cultural Resources

General

(Letter ID#: 44, 108)

Comment: The Delaware Nation inquired whether a cultural resource survey or archaeological assessment was included in the draft CCP/EIS for Prime Hook NWR.

> **Response**: We did complete a thorough "Archeological, Historical, and Geomorphological Study of Prime Hook National Wildlife Refuge" in December 2004 (through a contract with Tetra Tech FW, Inc.) at the beginning of our planning process, and reference it throughout the CCP. The primary sections of the draft CCP/EIS document that pertain specifically to cultural or archeological resources can be found in Chapter 3 (page 3-20), Chapter 4 (page 4-34), and Chapter 5 (page 5-15). We did not include the Tetra Tech report in the public draft of the CCP due to the sensitive nature of the resources. Copies of the report were shared with the Delaware Nation and the State Historic Preservation Office.

Comment: The State of Delaware Historical and Cultural Affairs office appreciates the "spirit of stewardship" for historic, archaeological, and cultural resources in the draft CCP/EIS. They look forward to continue to consult with the Service on cultural and historic resources once the Service selects an alternative for implementation. They also suggest the following cultural and historic resource protection strategies:

- Due to anticipated impacts on cultural resources from climate change, please consider the protection of archaeological sites when planning countermeasures to storm events and saltwater intrusion. Conduct evaluation testing on archaeological sites that might be affected. Some sites may be regionally or nationally significant and eligible for the National Register of Historic Places; such sites may need to be protected or documented through excavations.

- Consider conducting systematic auger core testing to identify the presence or absence of Native American sites in refuge wetlands.

- Arrange site visits with the State of Delaware Historical and Cultural Affairs office to known archaeological sites on the refuge.

> **Response**: We look forward to cooperating with the State of Delaware Historical and Cultural Affairs office when we develop the step-down Cultural Resource Management Plan to determine how sites will be treated as they are inundated in the future, and how much survey we will do for new sites that might be inundated. The Service will continue to value the Historical and Cultural Affairs office's review and advice during the planning of specific cultural resource undertakings at the refuge, and subsequent consultation with the office under Section 106 of National Historic Preservation Act.

Socioeconomics and Local Community

Socioeconomics

(Letter ID#:21, 39, 47, 55, 63, 64, 68, 80–Petition, 81, 82)

Comment: Several individuals feel that the draft CCP/EIS fails to adequately address the economic losses to local communities in its economic analysis, including economic losses to local farmers, landowners, retail shops, builders, wholesale suppliers, and other businesses from coastal flooding, saltwater intrusion, damage to beaches, and changes in habitat. For example, one local farmer writes, "The financial impact today and the potential impact of tomorrow on my family's farm can only be described as devastating. I have completely lost over 40 acres to salt contamination with another 40 to 80 acres negatively impacted by cutting crop yields in half. I calculated a value of ten thousand dollars per acre." Another writes, "The assumptions and social and financial impacts [discussed in Appendix I of the draft CCP/EIS] address only positive revenue enhancements to the local community [from the refuge]. Conspicuously absent…are those costs that can be…attributed to flooding in the surrounding communities." Several also suggest that the refuge refer to DNREC's draft economic analysis published on May 11, 2012 for additional information.

Response: We refer the commenter to the recent economic analysis conducted by DNREC for the Bay Beach communities. Some commenters may have misinterpreted the recent findings. The analysis included four different scenarios or alternatives, including no action, beach nourishment, and two strategic retreat options. The risk of flooding remains under all alternatives, as flood waters can enter the system from other sources such as the Broadkill and Mispillion Rivers. By their nature, barrier islands are dynamic and they move through the forces of sea level rise, storms, and erosion. Overwashes and inlets (breaches) are continually being created and closed due to these forces, as illustrated along the Delaware Bay shoreline in appendix J. Aside from the physical damage to the built environment which was shown so dramatically by Hurricane Sandy, sea level rise entails the inevitable landward expansion of wetter and saltier conditions in soils located near the coast. 500 feet of shoreline retreat since 1926 does not automatically translate into changes of upland areas 500 feet inland, as the rates of subsidence from ground water pumping and hydrological conditions also affect local conditions.

The Service believes restoration of the marshes provides the best solution for long-term sustainability in the face of changing environmental conditions.

Comment: One individual feels that economic losses to local homeowners from flooding (e.g., frequent repairs from flooding, severely decreased home values, difficultly selling homes, damage to septic systems) since the dune breaches constitutes an economic "takings" by the government. He writes, "This cost burden placed on homeowners by the management decision of the Refuge should be considered a "taking" requiring compensation to homeowners. Prime Hook Beach Organization echoes this sentiment, writing, "There has been no responsibility taken for the financially-compensable emotional toll on residents of adjoining communities…[There has been no] attempt to negotiate financial compensation with those who have been adversely affected."

Response: The Service is concerned about the increase in flooding as it impacts the refuge as well as the communities and other neighboring landowners. However, as stated above the alternatives being considered in the economic analysis and the CCP/EIS will not reduce the risk of coastal flooding. The Service is attempting to develop sound ecological strategies to reduce the adverse impacts from such events by restoring the habitats which naturally buffer inland areas. The conundrum facing property owners on Prime Hook beach and other areas is that their houses are built on a very low-lying barrier island which has been eroding for decades. The risk to structures built in such environments was dramatically illustrated by Hurricane Sandy. Since barrier islands naturally "roll over", i.e. migrate landward, as sea levels rise, structures placed on such ephemeral features are subject to substantial risk. We empathize with the stressful and difficult situation owners are confronting now. It is very appropriate for such homeowners to consider their options, but the Service is not the agency designated by Congress to address flood risk, so we urge homeowners to confer with their insurance carriers and FEMA.

Comment: One individual feels the CCP does not adequately address economic losses to the community from the expanded hunting program. In particular, he feels that hunting conflicts with other uses such as canoeing and kayaking and closures due to hunting will hurt local businesses that cater to non-consumptive refuge users.

Response: The Service does not believe there will be any economic losses to the community. On the contrary we believe there will be gains under our preferred alternative due to proposed increases in opportunities for all wildlife-dependent recreation including wildlife observation and photography. Canoeing, kayaking, and fishing on the western portion of Prime Hook Creek will continue to be permitted year round, which is discussed in the "Introduction" as a change from the draft version. Areas where various hunts would be expanded do not include trails that cater to non-consumptive users currently.

Local Community
(Letter ID#: 12, 20, 24, 27, 28, 33, 39, 42, 46, 47, 48, 49, 56, 59, 61, 63, 64, 65, 66, 70, 75, 76, 79, 80–Petition, 81, 82, 83, 85, 87, 94, 102, 104, S1, S2, S3, S8, S9, S19)

Comment: Several individuals felt that Service negatively portrayed local landowners, farmers, communities, showed a lack of concern for adjacent landowners, and blamed local communities for human disturbances to wildlife and habitats. For example, one person commented on the following text on page B-54 of the draft CCP/EIS: "development of homes and cottages are a threat to Refuge species because of residents build structures, desire artificial dune replenishment, increase pedestrian traffic, and let dogs run at large." The person writes, "The fact is that nearly all residents are responsible stewards of the beach, participate in numerous conservation activities, and clean the beach of harmful debris." Similarly, Delaware Audubon writes, "The statement implies that the homes and cottages themselves are causing damage to the habitat protection that is the refuge's mission. As such, analysis of the future costs to the refuge in maintaining homes in this dangerous area is warranted."

Another writes, "Many of these homes predate the refuge and we, the human disturbances, have tried to be good neighbors to the refuge and its wildlife preservation mission." Another feels like the draft CCP/EIS, "Instead of addressing the problem, the plan actually blames property owners in what it calls 'flood prone and vulnerable locations'…the insulting attitude and lack of concern expressed by a federal agency…is a breach of public trust."

> **Response**: We do appreciate the endeavors that local residents have made to assist the refuge and conscientiously maintain their own environment. We did not intend to cast aspersions upon them. The referenced statement was comparing current habitat conditions to those that existed historically prior to European colonization of the area. We describe the presence of neighboring development, most of which occurred before refuge establishment, as one of many human-associated factors that influence the ecology of refuge habitats. We evaluated the impacts of these factors because they are part of the current environmental conditions. However, it is not within our jurisdiction to make decisions about private properties and land-use decisions. Private landowners and local governments retain the right to make decisions regarding development that is adjacent to, but not on, refuge lands.

Comment: One commenter noted that page 2-9 of the draft CCP/EIS "the plan identifies that managing human population growth (more than 11 million) while maintaining functional natural ecosystems is the greatest conservation challenge in Area 44" and suggests that the USFWS views this as a motivation for eliminating towns adjacent to the refuge.

> **Response**: The plan this statement is referring to is not the CCP/EIS, but rather the Partners in Flight (PIF) Plan for the Mid-Atlantic Coastal Plain Physiographic Region (also referred to as PIF Area 44). This plan was developed through a cooperative effort involving Federal, state, and local government agencies, non-profit institutions, professional organizations, the academic community, and interested private individuals. The plan acknowledges a number of large-scale conservation challenges, such as human development and population growth. This challenge is outside the scope of the CCP, and we do not address this challenge directly or indirectly in the CCP and do not wish to eliminate the towns and communities adjacent to the refuge.

Comment: The Town of Slaughter Beach commented on the town's Comprehensive Land Use Plan and the importance of local farms in preserving and protecting the town. They write that "14 farms…adjacent to the refuge voluntarily participate in Delaware's Farmland Preservation Program. The Town fully supports this program and its participating farmers. The two main goals of the Program are aimed at preserving croplands, forests and open space and providing farmers with an opportunity to preserve their land and avoid development pressures and decreasing commodity values. Failure to protect these farms from flooding and salt water intrusion contravenes the intentions of the Town's [Comprehensive Land Use Plan] and the State's Farmland Preservation Program.

Response: We understand local communities' concerns about flooding and salt water intrusion. We believe that our proposal to restore refuge impoundments to healthy, brackish marsh and salt marsh, as identified under our Service-preferred alternative B, will encourage the conditions most resilient to sea level rise, while 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 reducing wave energy. Wave heights are reduced by 60% within the first twenty feet of the marsh, which in turn also 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 below-ground 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) and serve as 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.

We would also like to note that barrier beach inlet is not the only cause of flooding of private property during storm events. There are many other extenuating causes and effects involved, such as increased storms and storm intensities, heavier precipitation patterns, extreme wind and wave conditions, extensive run-off from uplands, low elevation of roads and private properties with respect to local mean sea level, local geologic features, sediment supply, and human activities. These factors increase the level of complexity of coastal flooding seen at the refuge and adjacent private lands.

The opening and closing of overwashes is a natural part of salt marsh systems. The shoreline along Unit I has breached and closed repeatedly over past decades (figure 1-1). This process likely accounts for the adequate vertical accretion that Unit I has experienced, keeping pace with sea level rise. As such, permitting overwashes is the best way to ensure the salt marsh remains able to provide a buffer for storms and flooding. In the time immediately after the 2006 Unit I breach formed, but before the Unit II breaches formed, the salt marsh in Unit I was thriving. We may consider closing this breach if needed for marsh restoration in Unit II. Breaches, in time are likely to close, but without more geomorphological investigations, we cannot predict how soon this might occur. Any additional stress experienced by Unit I is related to the fact that the wetlands in Unit II are degraded and unable to absorb the quantity of water from the Unit II breaches. The best solution for Unit I is ultimately the restoration of a healthy marsh within Unit II. The flow of water in this part of the wetland complex has been well documented, and is from Unit II into Unit I, not the other way around. We believe restoring the marshes would provide the best solution for long-term sustainability.

Comment: The Delaware Audubon Society asks, "For each alternative offered, A, B, and C, would there be any difference in decision recommendations if the homes of Prime Hook were removed and the homeowners relocated? In other words, would USFWS continue to recommend [Alternative] B and the costs thereof if there were no humans along the barrier island?"

Response: The purpose of the draft CCP/EIS is to analyze reasonable alternatives for managing the refuge over the next 15 years given current and foreseeable future conditions. Therefore, we did not consider or evaluate any alternatives based on extreme hypothetical circumstances that are not currently present. Whether or not the alternatives or decisions would be any different if the homes were not present along the barrier island is not relevant to the evaluation of proposed alternatives. Rather, we evaluate the impacts of the alternatives on the current condition, which includes the presence of neighboring communities. However, we do refer the commenter to the recent economic analysis conducted by DNREC for the Bay Beach communities.

Comment: The Delaware Audubon Society writes, "If USFWS is charged with putting forward a CCP in light of the constituents and communities around PHNWR, shouldn't a true long-term plan consider the financial analysis of an optimal solution for the area, including home relocation? There is no option that addresses this issue."

Response: It is outside the scope of the CCP, and beyond the Service's authority, to propose any alternative which would recommend the relocation or removal of private homes adjacent to the refuge or to conduct a detailed economic analysis of such options. However, we feel that it is entirely appropriate for the Service to evaluate management options within the capability of the refuge to implement. Alternative B has the most potential to enhance habitats which provide better storm buffering protection to upland areas than current conditions, and if we can expand the extent of healthy salt marsh this will be beneficial to neighboring landowners.

Comment: Several commenters write "that a de facto determination by the FWS in the CCP/EIS has been made that in effect finds - by exclusion in the CCP from the list of designated compatible uses – that the Prime Hook Beach community and any other NWR-adjoining community (Broadkill Beach and the Town of Slaughter Beach) do not constitute 'compatible uses' in the NWR as defined in 16 U.S.C. 668dd-668ee. Accordingly, we request that this issue be forthrightly addressed in the final CCP. If hunting, fishing, and trapping are fully compatible uses within refuges under the statute, communities residing in peaceful harmony next to a refuge also must be deemed compatible."

Response: While community members regularly use the refuge, the existence of the neighboring community itself is not a refuge use as defined by policy. According to Service Policy (603 FW 3) a compatible use is defined as "A proposed or existing wildlife-dependent recreational use or any other use of a national wildlife refuge that, based on sound professional judgment, will not materially interfere with or detract from the fulfillment of the National Wildlife Refuge System mission or the purposes of the national wildlife refuge." This policy only applies to uses occurring on refuges and is not intended to apply to neighboring communities or uses on lands adjacent to the refuge.

Comment: The authors of one letter write, "In selecting alternatives or management strategies that could put human habitats such as Prime Hook Beach at possible catastrophic risk or subject them to extreme public safety hazards and property damage, the Service somehow chooses to define "community" as hunters and fishers, birders, photographers, recreational visitors, and incorporated municipalities e.g., Milton and Milford - places far removed from the impacts of the CCP."

Response: The commenters are referring to the use of the word "community" as defined by the U.S. Geological Survey (USGS) for their survey of refuge visitors and the local community. For the survey, USGS interviewed visitors to the refuge and individuals living in the communities surrounding the refuge in 2004 and 2005 to determine visitor and community attitudes and preferences about the refuge. Surveys were randomly distributed to both consumptive and non-consumptive-use visitors and to a stratified random sample of "community" members in adjacent and surrounding areas which included Slaughter Beach, Broadkill Beach, Prime Hook Beach, Milton, Lewes, Milford, and surrounding communities.

Comment: Several individuals question why other beaches in Delaware have been restored and replenished with sand, but not the beaches at Prime Hook Refuge. One writes, "Broadkill and Slaughter Beach are being replenished…You are neglecting some residents and not others?"

Response: The Prime Hook Beach community is currently a private beach community and is not participating in the State's beach replenishment program. The refuge and State have never replenished any of the undeveloped areas in Delaware Bay.

Refuge Habitats and Vegetation

General

(Letter ID#: 70, 80–Petition, S16)

Comment: One commenter noted that the CCP is direct conflict with stated refuge goals because it does not protect the "dynamic beach island."

Response: We believe that restoration of healthy shoreline and salt marsh processes will allow the beach island to function in the dynamic manner that is natural. A dynamic barrier beach island is exactly that, dynamic, with the formation and natural closure of breaches and inlets. This has been evident along the refuge shoreline for decades (figure 1-1 and Appendix J). Protecting this habitat does not necessarily imply continuous dune construction and manipulation to maintain a static shoreline condition, but rather allowing natural processes to occur without interference and, if natural conditions have been altered by human actions, intervening only to restore the system to a more natural condition.

Comment: One individual suggested that the refuge use the following management techniques to improve wildlife habitat on the refuge: food plots, early successional management, timber stand improvement, freshwater impoundment management, and moist soil units.

Response: (See also comments and responses under "Early Successional Habitats, Including Grasslands and Shrublands," Croplands and Cooperative Farming," and "Impoundments"). We believe our objectives and strategies under our preferred alternative include many of these techniques mentioned above.

Forested Habitats
(Letter ID#: 22, 98, 107)

Comment: One individual asks that the refuge cease active forest management, stating that, "It [is] very expensive for all those vegetative tree treatments…It is best to let the trees fall naturally…They need to be left in place and they are used by wildlife." She also feels that commercial forest management is not a compatible use of the refuge, writing, "keep and save the trees which are necessary for bird and wildlife homes."

Response: We respectfully disagree. Active management is needed to strive to meet the desired forest conditions and our migratory bird and endangered species objectives.

Comment: The State of Delaware writes that it "in general supports the Service's timber practices, but recommends that the Service amend the CCP to include a statement identifying a range of dates that encompasses the breeding season for the largest majority of birds occurring on the Refuge, such as April 1 through July 31, and preclude forest alteration practices during this time of year restriction."

Response: Thank you. We added this as a strategy under objective 2.1 in the final CCP/EIS.

Early Successional Habitats, Including Grasslands and Shrublands
(Letter ID#: 22, 65, 80–Petition, 81, 93, 107, S18)

Comment: One individual was concerned about the potential impacts of prescribed burning to maintain early successional habitat on wildlife. In particular, she felt that prescribed burning during the springtime could kill young birds and other animals.

Response: Many early successional habitats are fire-dependent communities. Fire rejuvenates desired vegetation communities and eliminates undesirable plant communities. It also releases valuable nutrients back into the soil. It is true some wildlife may be injured or killed if they are unable to get out of the fire's path. However, the refuge works closely with Service fire program staff to carefully plan all prescribed burns on the refuge to minimize impacts on wildlife (e.g., only burning at certain times of year to protect nesting areas and animals) and to ensure public and fire staff safety.

Comment: One individual writes, "Under "Prescribed Burning," [on page B-115 of the draft CCP/EA] it seems likely that unless greater emphasis is placed on removal of all the dead and dying vegetation, both trees and shrubs, there will be so much additional fuel for fires that the risk of performing prescribed burning getting out of control would be greatly increased under Alternatives A and B.

Response: Experts in fire management have developed fire models incorporating fuel load, fuel type, fuel moisture, ambient humidity and other factors to determine whether a prescribed fire would fall within safety limits. Sometimes other methods of reducing fuels are conducted alone, or in concert with prescribed fire, such as mowing, chopping, or removal of woody vegetation.

Comment: One individual urged the refuge not allow the upland fields along the refuge entrance road to transition to shrubland or forest, writing, "These fields are valuable for grassland wildlife species and provide a diversity of habitat. What about security of your office and shop complex? If they are hidden from view, vandalism is more likely."

Response: We agree that managing for early successional shrubland habitat may provide greater biological diversity and biological integrity. As outlined under the Service's preferred alternative, objectives 4.1 and 4.2, we propose to continue to manage several fields (approximately 120 acres), including those referred to in the comment, as early successional habitat. However, we have decided to allow some other fields transition to shrubland and forest because we believe these habitat types will provide higher quality habitat for refuge wildlife. As outlined in chapter 3, the grassland bird study conducted by the refuge resulted in some of the lowest abundance of grassland birds and the lowest relative contributions of obligate grassland birds in these fallow fields. Prime Hook NWR showed some of the lowest densities, much less than Midwestern habitats or other refuges in the region.

Comment: Several commenters asked that the refuge manage early successional habitats for migratory birds. A representative for the Humane Society of the United States stated that the refuge should manage for a variety of habitats and species, including early successional species. The Delmarva Ornithological Society asked that the refuge retain most of the former agriculture lands as early successional habitat over the long term to benefit declining bird species including "American woodcock, northern bobwhite quail, brown thrasher, eastern towhee, yellow-breasted chat, field sparrow, grasshopper sparrow, and eastern meadowlark." They stated that the refuge manager informed them that only a portion of these agricultural fields are going to be maintained as early successional habitat, even though the table for alternative B in the draft CCP/EIS said this entire area was going to be early successional habitat. Similarly, the Delaware Division of Fish and Wildlife also "encourages the Service to develop and maintain early successional habitat" in formerly farmed fields. Although they agree that reforestation of portions of former farmed lands will benefit some migratory birds, "early successional habitats… are fragile habitat components important to many rare species" including "eastern meadowlark, grasshopper sparrow, American kestrel, and possibly Henslow's sparrow."

Response: As mentioned in our previous response, under our preferred alternative, we propose to continue to manage 120 acres of grassland on the refuge. We discuss this in more detail in the Habitat Management Plan (HMP) in appendix B of the draft CCP/EIS. We also propose to actively manage additional fields as shrublands, permitted to revert to shrub cover naturally, or expected to provide shrub habitat during the successional process as forest cover develops. The objective prescribes early successional management for at least 200 acres on the refuge at any time. The HMP also explains how we identified priority focal species for early successional habitats, including Henslow's sparrow.

Comment: A commenter noted on our discussion on page B-70 of the draft CCP/EIS. He writes, "in order to manage the grassland bird species, habitats at the Refuge have to support a diversity of terrestrial insect species from grasshoppers to beetles and caterpillars, which in turn are prey for bird populations. Also, the grassland species require food such as mice, voles, shrews, rabbits, groundhogs and snakes for predators listed in Table 13. Mostly, these prey species would become far scarcer as the salt marsh expands, which would occur under alternatives A and B."

Response: We project, that over the 15-year life of the CCP, our restoration of former agricultural fields will increase these species abundance on the refuge. However, we agree that, as sea levels rise over time, the refuge's terrestrial habitats will diminish in size and quality.

Wetlands
(Letter ID#: 24, 70, 80–Petition, 81)

Comment: One commenter noted that the CCP is direct conflict with stated refuge goals because it does not maintain the "wetland impoundment complex."

> **Response**: A wetland can be part of an "impounded wetland complex" without being a freshwater impoundment. In fact, most managed impoundments in Delaware are brackish, rather than freshwater. As explained in the rationale for objective 3-1 under alternative B in the draft CCP/EIS, the presence of the roads and associated water control structures and culverts mean that portions of the refuge wetlands will always be impounded or semi-impounded. This is the wetland impoundment complex referenced in the refuge goal.

Comment: One commenter claimed that the CCP states "Marsh management techniques may increase the amount of open water on the refuge" and expresses concern that open water does not provide the same level of flood protection and wildlife benefits that marsh does.

> **Response**: We feel that alternative A is the only alternative in the CCP/EIS that would likely lead to an increase in open water over the long term. The Service's preferred alternative, alternative B, would actively restore marsh and would not increase the amount of open water over current conditions. Given the SLAMM and other models, transition to open water may occur across wide areas of the refuge simply due to sea level rise, and it is uncertain whether Alternative C—relying upon natural processes to provide sufficient sediments to "catch-up"--will be effective within the timeframe of the CCP.

Comment: The authors of one letter write, "The CCP draws conclusions without a proper basis. The CCP does not contain a wetland restoration plan. How can the Alternatives be fairly evaluated if it is not clear as to what FWS will do to provide for this wetlands restoration?

> **Response**: The CCP guides the refuge management in a broad and long term framework, and the details of a particular restoration plan were outside the scope of the CCP process. Detailed restoration plans of comparable scope elsewhere in the country have routinely taken years to develop; accounting for the time needed to collect data, model habitat conditions, evaluate restoration options, and prepare the plan. Admittedly, most restoration plans are prepared with the benefit of a stable situation, rather than in a reactionary context. We did not want to delay the release of the entire CCP until a detailed restoration plan could be developed. As the commenters noted, many restoration concepts would need to be developed further by engineers for more detailed analysis, a process that is time-consuming and requires rigorous data. The partnership to move such plans forward and the necessary analysis to further develop options have already started. Furthermore, the final CCP/EIS does incorporate additional details about strategies that we will be poised to act upon once the CCP is completed. The Service acknowledges it does not have all the information collect yet to develop a restoration plan. We continue to work with our partners in collecting the appropriate data. The hydrodynamic modeling is one component needed for the restoration plan. The Service also recognizes additional environmental analysis and permitting will be needed.

Comment: One individual writes, "This CCP falls far short of planning how to manage this refuge's wetlands for the next 15 years. One of the refuge staff, at an open house, stated that we need freshwater wetlands, but in the middle of the state. He chose not to address if the impoundments at Bombay Hook should also be allowed to revert to salt marsh. There is a larger issue here that the CCP ignores. What is causing the sudden rapid loss of beach from Kitts Hummock in the north to Broadkill Beach in the south? You need to know and understand the bigger picture of what is causing the accelerated erosion from Mispillion Inlet down to Cape Henlopen before you can meaningful fix any problem on the refuge."

> **Response**: DNREC has done some modeling work in Delaware Bay and may have some of the answers to these questions. We, along with our partners continue to look at these issues at a landscape scale. However, we acknowledge that there are existing information gaps that can be further addressed.

Dune Breach, Marsh Restoration, and Shoreline Stabilization
(Letter ID#: 1, 2, 4, 8, 15, 18, 21, 23, 24, 25, 27, 28, 29, 33, 34, 38, 39, 40, 41, 42, 43, 45, 46, 47, 48, 49, 50, 52, 54, 55, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 74, 75, 76, 78, 79, 80–Petition, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 94, 95, 96, 98, 100, 101, 102, 104, 107, 108–Form letter, S1, S2, S3, S4, S8, S10, S13, S16, S17)

Comment: Numerous commenters asked that the refuge close the dune breaches and restore freshwater marshes to protect neighboring communities and farms from salt water intrusion and coastal flooding and to provide freshwater impoundments for waterfowl and other wildlife. Of these comments, many wished to see the breaches closed immediately. For example, the State of Delaware reiterated their position that the breaches "must be closed in the short-term to allow a managed and phased approach to achieve long-term marsh restoration, as well as mitigate the impacts on neighboring farmland and homes, and preserve them as closed until a functioning, self-sustaining tidal marsh can be established in Unit II, [and consider marsh restoration options for Unit III that will provide quality and diverse habitat (addressed below)]. Our goal of closing the breaches has been frustrated by a number of factors over the last few years, but the state is prepared again to contribute toward a solution." Several other commenters agree, stating that given the length of time likely for finalization of the CCP, the FWS needs to affect a temporary solution to close the breaches immediately to preserve all options, protect the health and safety of neighboring persons as well as farmlands.

> **Response**: It was our intent to maintain short-term stability for Unit II by reestablishing the dunes, as explained in the November 2010 Dune EA and FONSI. However, the site conditions have changed dramatically and there is no longer enough sand on site to reestablish the dunes. That EA also evaluated the use of off-site sediment, but the costs of this approach would have to be borne by the State or others. We did not specifically exclude filling the breaches under alternative B. Rather, any work we conduct along the shoreline will be part of a more comprehensive marsh restoration; as the means to an end, not as the end goal itself. We believe restoring the marshes would provide the best solution for long-term sustainability. We have always stated that dune work/breach closure was a possible, and indeed likely, first step toward restoring the salt marsh. We have reworded a strategy in the draft CCP/EIS to state this more clearly. In the strategies under Objective 3.1 of alternative B in the draft CCP/EIS, we outlined many short-term strategies that we may use to restore the marsh and hopefully reduce the flooding. We have also recognized that during the marsh restoration process there may be a need to close the breaches while affecting restoration. By their nature, barrier islands are dynamic and they move through the forces of sea level rise, storms, and erosion. Overwashes and inlets (breaches) are continually being created and closed due to these forces, as illustrated along the Delaware Bay shoreline in appendix J.
>
> We also acknowledge that State assistance in finding material to complete marsh restoration will be critical, and greatly appreciate their offer to contribute to a solution.

Comment: One individual writes, "The time required to develop plans, resolve uncertainty in their effectiveness and determine costs, the truly best alternative for the taxpayer would be to undertake only a version of the CCP recommendation for the immediate future laid out on page 1-19: fill inlets and fully re-establish dunes along Unit II as needed to allow for time to ascertain what site-specific workable and effective plans for marsh restoration can be developed, and determine their costs."

> **Response**: Recently, the Service started collecting data to understand marsh transition to help make science-based management decisions. The results indicate the need for a detailed marsh restoration planning effort, which will outline strategies to rebuild a resilient mix of salt marsh (dominated by *Spartina alterniflora* with significant areas of *Spartina patens*), brackish marsh, and freshwater marsh. This approach is the appropriate sustainable option to help the refuge adapt to the realities of sea-level rise and the changing estuary environment. Prior studies in similar estuary systems suggest that a firm understanding of the hydrodynamic characteristics is essential to making restoration and management decisions.

Filling the breaches along Unit II is identified as a possible strategy under Objective 3.1 of Alternative B. However, we only plan to fill the breaches if we determine that such a step would support our salt marsh restoration objective. As mentioned in our previous response, we do feel that filling the breaches is likely a potential first step in comprehensive marsh restoration. For example, the construction of a dune may be necessary to prevent bay waters from entering the restoration site during project implementation. We will base our decision on whether to filling the breaches on hydrodynamic modeling that is underway and by further consultation with the State and wetland experts.

Comment: Several commenters fell that the breach north of Fowler Beach Road in Unit I poses a threat to the stability of the adjacent salt marsh, and suggest that the refuge consider closing that breach in all of the alternatives. Form letter says, "Rebuild the barrier dune both north and south of Fowlers Beach Road. This would reduce the amount of salt water entering the refuge in Unit II. This would leave only Slaughter Canal where water would enter from the north end as it has done for 100 years. Prime Hook Creek and Peterfield Ditch would still be the main outlets to the south and east in Unit III…." The form letter then continues, "Rebuilding the barrier beach would not only save the beach communities, the agricultural land to the west and restore the freshwater marshes, it would protect the natural area for the horseshoe crabs to lay their eggs and the shore birds to feed on them." Several individuals state that man-made, engineered projects have successfully protected shorelines elsewhere and would work to protect Prime Hook Refuge habitats and adjacent landowners.

Response: The opening and closing of overwashes is a natural part of salt marsh systems. The shoreline along Unit I has breached and closed repeatedly over past decades (figure 1-1). This process likely accounts for the adequate vertical accretion that Unit I has experienced, keeping pace with sea level rise. As such, permitting overwashes is the best way to ensure the salt marsh remains able to provide a buffer for storms and flooding. In the time immediately after the 2006 Unit I breach formed, but before the Unit II breaches formed, the salt marsh in Unit I was thriving. We may consider closing this breach if needed for marsh restoration in Unit II. Breaches, in time generally close if there is an adequate sediment supply, as it is a natural function. Any additional stress experienced by Unit I is related to the fact that the wetlands in Unit II are degraded and unable to absorb the quantity of water from the Unit II breaches. The best solution for Unit I is ultimately the restoration of a healthy marsh within Unit II. The flow of water in this part of the wetland complex has been well documented, and is from Unit II into Unit I, not the other way around.

Comment: Several commenters expressed concern that no short-term or "shovel ready" strategies are included in the CCP/EIS, and that restoration appears to focus only on the long-term with no regard for short-term marsh stabilization.

Response: As stated in the list of strategies for Objective 1-1 and Objective 3-1 in Alternative B of the draft CCP/EIS, we recognize that short-term shoreline stabilization may likely be the first step of comprehensive marsh restoration. We have reworded this section in the draft CCP/EIS to state this more clearly. Again, we would only conduct shoreline stabilization as part of a more comprehensive marsh restoration. We feel that, without further salt marsh restoration efforts, the refuge's wetland ecosystem of the refuge would continue to suffer. We also feel that the duneline would continue to be vulnerable due to the elevation deficit and the presence of only open water or unvegetated mudflat behind it.

Several strategies under objective 3-1 under Alternative B could be implemented as soon as the CCP is finalized and the necessary resources secured. We apologize for this confusion, but acknowledge that it was presented in a manner that suggested they may not be pursued immediately.. The final CCP/EIS clarifies that we intend to initiate appropriate, short-term restoration projects within the first year of (perhaps within months of) CCP finalization, and that we have already started conducting site evaluations and building partnerships to facilitate these projects. Although we do not expect these short-term strategies to achieve large-scale restoration, we believe they would provide incremental improvement and benefits. We have provided additional details on these strategies in the final CCP/EIS, and also evaluated additional strategies recommended by commenters.

Comment: One individual writes, "I question if [the U.S. Army Corps of Engineers] sand is used why Alternative C would be cost-prohibitive?

> **Response**: Alternative C would be cost prohibitive due to the costs of perpetual maintenance as sea level continues to rise.

Comment: One individual writes, "The refuge manager, and others, recently, while this CCP is under review, has stated that in the near future, sand (from the Delaware River Project?) will be brought in to rebuild the dunes/breaches. Where is that discussed in the CCP? What will the impact be on your preferred option? Is this secret project covered by the dune repair EA? If so, once again, whatever happened to Option B?"

> **Response**: We presented information on this proposal under objective 3.1 of Alternative B in the draft CCP/EIS and analyzed the impacts of this proposal in Chapter 5 in the draft CCP/EIS.

Comment: Several commenters expressed concern that the refuge and the Service were not working proactively enough with DNREC and the Army Corps of Engineers regarding the potential use of dredge material, such as from the Main Channel Dredge Deepening project, for wetland restoration, or had not clearly prioritized restoration at Prime Hook NWR over the Kelly Island project. The Service is accused of "waiting for permission rather than working for a more immediate response and compromise." Another writes, "Without DNREC's agreement, [this proposal] is mostly meaningless."

> **Response**: We respectfully disagree and have been communicating with both the U.S. Army Corps of Engineers (Army Corps) and DNREC about the use of these dredge spoils. In June 2011, we communicated directly to the Army Corps about our concerns regarding the Kelly Island project, as it had been previously proposed and approved. By letter, Project Leader Michael Stroeh explained that there would be better uses for the material on the Coastal Delaware NWR Complex and asked the Army Corps to consider those alternatives. Throughout fall 2011, we met with staff from DNREC and the Army Corps to discuss Kelly Island and alternative projects. The Army Corps requested summaries of alternate sites statewide, an effort to be led by DNREC. We promptly sent a summary of the proposed Prime Hook NWR project to DNREC. At DNREC's request, we later submitted an updated summary of the proposed Unit II marsh restoration for them to submit to the Army Corps for further consideration.
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> As we have explained in the CCP and in public forums, it is the State of Delaware, through DNREC, that has the task of prioritizing the list of projects in the state and coordinating the decision process with the Army Corps. From an early time, we have repeatedly expressed interest in using these materials for marsh restoration. We have also proactively incorporated using these materials into the CCP to help fulfill NEPA requirements, and we continue to take steps to prepare to make use of the material if we can get it (e.g., through our hydrological modeling work). However, we cannot force DNREC or the State of Delaware to prioritize Prime Hook NWR marsh restoration as a beneficial use project for the Main Channel Deepening project, or any other sediments, dredged from the bay. DNREC and other officials within the State of Delaware will make a decision about the placement of sediment from bay dredging projects, such as the Main Channel Deepening project, based on many factors. We believe we will be well positioned with regard to NEPA requirements and the modeling and data necessary to move the project forward.

Comment: Some noted that there is no alternative tactic provided if sediment from the Main Channel Deepening project is not available. Several also suggest dredging from sandbars and/or trucking in sediment from an inland source.

Response: We agree that it is important to consider alternative strategies, because there is no guarantee that the refuge wetlands will be the selected beneficial use site for the Main Channel Deepening sediments. The strategies outlined under objective 3.1 under alternative B in the draft CCP/EIS included a number of options that do not rely on dredge materials. We also consider other sources of dredge material, other than the Main Channel Deepening project. For example, maintenance dredging is also conducted routinely in the Delaware Bay. In the final CCP/EIS, we have further developed several of these restoration strategies and have evaluated and added additional strategies based on the comments we received.

As far as trucking sand from an inland source, DelDOT has told us that the road to Fowler Beach cannot accommodate the quantity of truck-hauled material that would be necessary for sufficient dune repair work. Because of this, we do not consider trucking in sand a viable option.

Comment: Several commenters stated that filling the breaches should not require an EIS, since the Service had previously written an EA and FONSI for filling breaches. Additionally, several commenters stated that the use of spoils from the dredging of the channel offshore of the Slaughter, Fowler, and Prime Hook Beaches should not require an EIS since the Army Corps of Engineers has already done this EIS and are ready to move forward with this dredging.

Response: The EA and FONSI we wrote in November 2010 (USFWS 20120) only assessed the impacts of truck hauling sand and scraping sand from the landward side of the dunes. It did not examine the impacts of using dredge material on Prime Hook's shoreline and marshes. Similarly, the U.S. Army Corps' of Engineers EIS for the main channel-deepening project only examined the impacts of the dredging the main channel on the Bay, the Broadkill Beach renourishment project, and the proposed Kelly Island project. The EIS did not consider the impacts of marsh or shoreline restoration on Prime Hook NWR. We will still need to complete an additional EIS that evaluates the use of this dredge material and assesses the impacts of marsh restoration to comply with NEPA. However, that document can tier from these other documents and incorporate much of the information contained in this EIS into that one. So, the scope of the other document may be able to be reduced.

Comment: The Delaware Riverkeeper Network is concerned about the use of spoils dredged from the main channel of the Delaware River by the U.S. Army Corps of Engineers to restore dunes and/or dikes at Prime Hook Refuge. They write, "Disposing of soils from the deepening project is unwise due to the contaminants known to be present within those spoils…" They also state that if the refuge considers using these spoils, they would need to draft a much more rigorous and complete EIS and that the U.S. Army Corps of Engineers would also have to update their EIS for the 45' Main Channel Deepening Project before the refuge could accept those soils.

Response: The Service has reviewed the Corps' documentation regarding contaminants. From the data we have received for Reach E there are no contamination issues. The Service will continue to work with the Corps of Engineers to make sure no contamination will occur from the dredge material. As stated earlier the marsh restoration planning may require additional environmental assessments as the modeling and other data become available.

Comment: Several commenters stated that it is their understanding that Kelly Island as a depository for channel dredging spoils is not favored by the USFWS, and that therefore, there should be no question as to the placement priority, as indicated by the Fish and Wildlife Service for the dredge spoils offshore of the Slaughter, Fowler, and Prime Hook Beaches should be made available for Impoundment II.

Response: It is true we have concerns with the proposed Kelly Island project. We, along with DNREC, have expressed those concerns to the Army Corps in writing and in person at several meetings. Because of our concerns, we have also recommended using the material originally intended for Kelly Island on Prime Hook NWR instead. Although all parties were receptive to the idea, many areas along the Bayshore are in need of sand and sediment. The decision regarding the use of dredged material for restoration rests with DNREC. We remain hopeful that if the Main Channel Deepening project proceeds as planned, the refuge will receive some sand and/or sediment from the project.

Comment: One individual writes, "Far greater emphasis on drainage outlets needs to be addressed in…the CCP."

> **Response**: We agree that specific information on drainage is an important component of our proposed marsh restoration. We will include specific information about drainage when we develop a final marsh restoration plan.

Comment: One individual writes, "How and where are lowered water tables anticipated? It seems unclear that only freshwater water tables are being discussed."

> **Response**: We discuss restoration of fresh water table in prior converted wetlands via filling ditches. We also discuss lowering of salt/brackish interstitial water in saltmarsh via creating ditches in chapters 3, 4 and 5 of the CCP/EIS.

Comment: One individual writes, "On Pg 4-49, the CCP sets the goal of keeping water levels at Unit III at or below 2.8 feet mean sea level from October to March 10. Without adequate drainage of all of the Units, it is difficult to see how this goal would be attained."

> **Response**: We agree. Restoring the natural hydrology is critical to meeting our restoration objectives.

Comment: Numerous individuals and organizations commented on the impacts of the dune breaches on neighboring communities and farmlands. They specifically mentioned the following: damage to houses and roads from flooding, damage to farm fields from saltwater intrusion, public safety concerns due to flooded roads, and pollution from overflowing septic systems.

> **Response**: We understand local communities' concerns about flooding and salt water intrusion. We believe that our proposal to restore refuge impoundments to healthy, brackish marsh and salt marsh, as identified under our Service-preferred alternative B, will encourage the conditions most resilient to sea level rise, while 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 reducing wave energy. Wave heights are reduced by 60% within the first twenty feet of the marsh, which in turn also 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 below-ground 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) and serve as 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.
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> We would also like to note that barrier beach inlet is not the only cause of flooding of private property during storm events. There are many other extenuating causes and effects involved, such as increased storms and storm intensities, heavier precipitation patterns, extreme wind and wave conditions, extensive run-off from uplands, low elevation of roads and private properties with respect to local mean sea level, local geologic features, sediment supply, and human activities. These factors increase the level of complexity of coastal flooding seen at the refuge and adjacent private lands.

Comment: The State of Delaware Department of Agriculture contends that by not closing the breaches and allowing salt water intrusion to continue, the Refuge is operating counter to its own recommendations associated with forging new community partnerships and strengthening existing ones.

Response: This past spring, we expanded an informal advisory partnership with numerous academic professionals and representatives of other agencies to include representatives of the Alliance for Bay Beach Communities (ABC), the Prime Hook Beach Organization (PHBO), and the local farming community. We also included all of these groups in a wetland restoration workshop. As described in the strategies for objective 3-1 under alternative B in the CCP/EIS, we envision that we will continue to work with these partners, along with members of the public, once the CCP is finalized to discuss the next steps in wetland management and restoration. We also intend to host public forums to share restoration plans as they are developed, in order to seek public feedback and involvement. In addition, we have recently taken steps to expand its formal partnerships. We also plan to continue our successful partnership with the DNREC Coastal Program, which has been responsible for considerable monitoring and data collection that has been pivotal for guiding management decisions and contributing to upcoming modeling efforts. As further described in the rationale and strategies associated with Objective 3.1 in the preferred alternative of the final CCP/EIS, efforts are underway to formally partner with the Partnership for the Delaware Estuary (PDE) regarding the potential application of living shoreline techniques in appropriate areas of the wetland complex. Regarding a formal private-public partnership between the refuges and the neighboring communities, the purpose, structure, and mechanism for a formal partnership between the refuge and private community entities would need to be examined. However, this is an option that could be explored further following finalization of the CCP.

Comment: The State of Delaware Department of Agriculture stated that the continued breach in the dunes is the result of management decisions which negatively impacts private farmland and facilitates expansion of salt water intrusion.

Response: We recognize the negative impacts of coastal flooding and salt water intrusion on local communities and farmlands. We acknowledge the impacts of tidal flow through the breaches in various sections of chapter 5 of the draft CCP/EIS. Barrier islands are naturally dynamic and are shaped by the forces of sea level rise, storms, and erosion. Overwashes and inlets (breaches) are continually being created and closed due to these forces, and there is a demonstrated history of this along the refuge shoreline (appendix J). We respectfully disagree with the assertion that the continued breach in the dunes is a result of a management decision. On the contrary, we worked closely with DNREC to repair the dunes in 2011. That repair was delayed by litigation and ultimately was not successful because the amount of material available on-site for the repair was limited. The use of off-site material was not a viable option as the roads cannot support heavy truck traffic.

We have always stated that dune work/breach closure was a possible, and indeed likely, first step toward restoration of the salt marsh. However, repairing the dunes alone will not eliminate future flooding of roads and agricultural lands during extreme high tide and storm events, since floodwaters can enter these areas through locations other than the existing breaches. Rather, restoring the natural hydrological function of historic refuge salt marshes would provide valuable ecosystem services such as storm surge protection and flood protection, which minimize the impacts of floods. In addition, the flooding of roads and agricultural lands is not unique to the Prime Hook NWR area, several other areas in coastal Delaware routinely flood during high tide and storm events.

Comment: The State of Delaware stated that the continued breach in the dunes causes ditches to act as a conduit bringing salt water further inland.

Response: We agree that these ditches act as conduits for salt water intrusion. These ditches were originally created to drain agricultural land, and they can now provide a conduit for saltwater intrusion and flooding as sea levels rise. In order to prevent this from occurring, landowners may need to install flood control devices in the future. Such adaptations have been necessary on coastal agricultural land elsewhere.

Comment: Several commented on the negative impacts of the dune breach (including conversion of freshwater impoundments to brackish water) on wildlife, such as waterfowl, fish, horseshoe crabs, reptiles and amphibians, and invertebrates. One writes, "Has the service considered the negative impact on wintering waterfowl numbers over the entire refuge area since the loss of freshwater impoundments? If so, what benefits will returning the entire marsh to saltwater incur on wintering waterfowl numbers? "

> **Response**: Yes, the Service has acknowledged the potential reduction in waterfowl numbers. Actually BIDEH policy recognizes that at times we may be sacrificing biological diversity at the local scale for biological diversity and biological integrity at the landscape scale.

Comment: One individual writes, "Brackish tidal creek shrub swamp is a good habitat for target ROCS: the prairie warbler, the short-eared owl, the sedge wren, and the coastal plain swamp sparrow. Heavy tidal flooding associated with storm surges is the most likely cause of heavy damage to this habitat and its associated species."

> **Response**: Potentially true, however restoration of former agricultural fields may offset the conversion of habitats to brackish-saline types. Short-eared owls would readily use high saltmarsh if not dominated by *Phragmites*.

Comment: The authors of one letter write, "The lack of strong control for the waters flowing in and out of these breaches caused the FWS to fail to both accomplish its stated mission as well as meet its guiding principles. Will the FWS modify the [preferred] alternatives…to provide for a means by which the water levels in the impoundments will be controlled to both sustain and protect wildlife?"

> **Response**: The Service's preferred alternative B proposes to allow natural processes, including inlet formation, sand migration, and overwash development, to change and shape barrier beach habitat on the refuge. These natural processes will continually shape the structure and functioning of coastal landforms and habitats (including sandy beach, overwash tidal flats, dune and grasslands, and mudflats) along nearly 3.5 miles of shoreline in all refuge management units. Both the Delaware State Wildlife Action Plan and the BCR 30 Plan identify the dune habitat system, with overwashing and ephemeral inlets, as a key wildlife habitat of special conservation concern. Wildlife species that benefit from this habitat type include spawning horseshoe crabs, nesting American oystercatcher, other State- and federally listed beach nesting bird species, and foraging and staging sanderlings, whimbrel, and other migratory shorebirds. Because of the benefits to species of conservation concern, we feel that our proposal is consistent with the Service's stated mission and meets its guiding principles.

Comment: One respondent felt that the draft CCP/EIS failed to acknowledge the dramatic degradation of the refuge habitats and BIDEH (biological integrity, diversity, and environmental health) from saltwater intrusion through breaches on uninhabited shoreline that the refuge now mostly controls.

> **Response**: We acknowledge how the breaches change and impact wetland habitat throughout the "Influence of Climate Change on Physical Environment and Refuge Management" section of Chapter 3 of the draft CCP/EIS, as well as in the "Impacts of Alternative A" sections of Chapter 5 devoted to Vegetation, Hydrology, and Soils/Sediment. We summarized the steps the refuge took to partner with DNREC to fill the breaches and strop the influx of saltwater under the discussion on "Soft Engineering Methods to Stabilize Shoreline" under "Actions Considered but Eliminated from Detailed Analysis" in Chapter 4. The 2011 breach closure effort included an attempt to fill the breaches on both refuge and private land with the only available sediment, that which was onsite. Although the refuge now owns additional tracts along the affected shoreline, this has only been the case for a few months. The juxtaposition of the remaining private land along the refuge-owned shoreline will continue to be a factor in shoreline management decisions.

Comment: One individual was concerned about the impacts on wildlife and refuge habitats under alternatives A and B from the dune breaches and associated salt water intrusion and permanent open water. He states the following:

- Permanent open water under alternative A in Units II and III will result in decreasing terrestrial, marine, and freshwater insect species populations.

- Saltwater intrusion will decrease plant diversity under alternatives A and B, which in turn will lead to decreased insect abundance and diversity, including the following species: golden beach heather, little glassy wing, Delaware skipper, and their host plant eastern red cedar; marbled underwing , little wife underwing, and their host plant swamp cottonwood; bronze copper; common firefly; sedges, rushes, and blue irises; little wife underwing and its host plant southern bayberry; and great purple hairstreak.

- Alternatives A and B could greatly reduce the number of pollinators on the refuge due to habitat loss.

- Salt water intrusion will have greater than minor negative impacts on reptiles and amphibians, including the carpenter frog.

- Permanent open water under alternative A will attract increasing snow geese populations which are destructive for marsh development.

- The refuge's overall BIDEH will be impaired under alterative B because of the potential for huge losses in overall diversity of species, including reptiles, amphibians, and terrestrial and freshwater aquatic invertebrates.

Response: In response to concerns about invertebrates and their host plants, we acknowledge that the refuge's insect and plant communities under alternatives A and B are likely to shift as habitats change: from species characteristic of native freshwater marshes to species that live in native brackish marsh and salt marsh. We recognize this in the draft CCP/EIS, writing "This could include changes in the abundance, distribution, or composition of local terrestrial wildlife populations." We also recognize the following in the draft CCP/EIS that "Allowing passive conversion to salt marsh and open water in refuge coastal wetland habitats as proposed in alternative A or proactive salt marsh restoration as proposed in alternative B will both result in drastic changes in emergent wetland vegetation communities as freshwater plants are replaced by halophytic marsh plants. As relatively few plant species are halophytes (less than 2 percent of all plant species) the transition from freshwater to brackish and salt water salinity regimes across the refuge's wetlands will also result in a decrease of wetland plant diversity." However, although insect and plant diversity may decrease in the refuge's coastal wetland habitats, under alternative B the conversion of hundreds of acres of row-cropped agricultural fields to native plant communities will increase the overall invertebrate community diversity refuge-wide.

In response to specific species concerns, southern bayberry will withstand a certain degree of intermittent tidal flooding. A properly designed marsh restoration should have limited impact especially if the bayberry component of the marsh/upland habitat is allowed to migrate landward with rising sea levels. However, the current use of adulticides under Alternative C within and adjacent to the Delaware Bay communities may account for the limited records of the little wife underwing moth in these areas.

Also, in terms of pollinators, we feel several of our proposals under alternative B will positively impact pollinators, including reducing adulticide use for mosquito control and restoring native plant communities in hundreds of acres of row-cropped agricultural fields.

In response to the comment on snow geese, there appears to be limited correlation between the extent of open water and snow goose feeding habits. Snow geese on Prime Hook NWR, as well as Bombay Hook and Forsythe NWRS, have created large open water areas through overgrazing. In most cases, these open water areas were associated with a sanctuary affect (i.e. lack of hunting pressure that permitted excessive grazing in relatively confined areas of habitat).

In response to concerns about impacts on amphibians and reptiles, we weighed the benefits to reptiles and amphibians against adverse impacts on the refuge landscape as a whole. We weighed the restoration of row-cropped farmland, increased connectivity between once isolated habitats, and improving surface water quality against habitat losses due higher salinities in Unit II and the lower reaches of Unit III. Overall, we consider the impacts to reptiles and amphibians minor to moderate.

In response to concerns about BIDEH, the Service's BIDEH does not strive for maximum species diversity, but rather a sustainable native ecosystem. BIDEH policy states, "The highest measure of biological integrity, diversity, and environmental health is viewed as those intact and self-sustaining habitats and wildlife populations that existed during historic conditions." Historic conditions are generally considered to be pre-European settlement. As recently as the 1950s, much of Units 2 and 3 were dominated by brackish marsh and salt marsh, as indicated by vegetation surveys conducted by DNREC. The freshwater marshes located in Unit 2 and the eastern portions of Unit 3 have been artificially maintained since the 1980s. Prime Hook Creek historically flowed to the bay, allowing for tidal exchange in its lower reaches. We have no reason to believe the populations of several species mentioned by the commenter (e.g., little wife underwing moth, southern bayberry, beach heather, carpenter frog, and great purple hairstreak) did not exist prior to impoundment construction in the 1980s so they may persist if capable of shifting upstream with the salinity gradient.

We feel that the refuge's overall BIDEH will be enhanced under alternative B because the salt marsh and natural hydrological restoration actions proposed in alternative B will repair hydrological and coastal geomorphological functioning to Units II and III by restoring severely degraded wetland integrity and health within impounded areas, consistent with our BIDEH policy. We feel that this restore these areas to close to their historical conditions and support a wide range of native species. Under alternative B, we also propose to improve BIDEH by restoring hundreds of acres formerly farmed areas from nonnative croplands to native plant communities.

Comment: One individual asks, "Has the service studied any alternative methods to return area III to a freshwater impoundment other than perpetual repair of the dunes?

Response: During our wetland restoration workshop, we consulted a wide array of wetland restoration and management experts. We were openly seeking alternate ideas for management of Unit III and the consensus was generally that it is going to be very difficult to maintain Unit III as a freshwater impoundment given the presence of Prime Hook Road and limited options for modifying that road. We are still evaluating the most effective means to manage Unit III sustainably, and have not ruled out any specific strategies yet. These discussions are ongoing. However, we feel that we need to make changes to our current management of the marsh because salt marsh areas subjected to long-term fresh water inundation and then returned to saline conditions are vulnerable to marsh collapse and degradation due to the loss of the peat layer. Please also see the comment and response below regarding Unit III.

Comment: Several individuals point out that beach nourishment, dune rebuilding, and other engineered shoreline protection projects are used throughout the world and appear to be successful elsewhere. They suggest the refuge should include these types of projects in its preferred alternative.

Response: We still propose shoreline work only in conjunction with stabilizing conditions for the purposes of marsh restoration, not as a temporary or permanent measure on its own. Without restoration of the marsh behind the dunes, any dune work would remain vulnerable to future overwash due to the elevation deficit, and routine supplementation would continue to be necessary. There are no quick, inexpensive, short-term solutions to deal with the magnitude of wave dissipation needed along the shoreline itself. The use of off-site dredged sediment was already included as a potential strategy for short-term shoreline stabilization in conjunction with marsh restoration. In response to these comments, several options that could be considered are described in the final CCP/EIS. For example, we have further evaluated other engineered wave attenuation solutions designed specifically for such applications (rather than the use of jersey barriers, which are not designed for the purposes of wave attenuation). This discussion has been added to alternative B Objective 3-1 and in appropriate portions of Chapter 5 on Impacts.

As the commenters noted themselves, the determination of which specific strategies may work best under the conditions present in the wetland complex require additional expert analysis. Both engineering firms we have discussed the refuge's situation with agree that hydrodynamic modeling is the first step before making substantial restoration recommendations or shoreline alterations. This analysis has already begun so that we may be poised to move forward on appropriate actions pending finalization of the CCP, but this would have taken too long to complete without a delay to the CCP release. Additional research and discussions with restoration experts about the likely sufficiency and success of the strategies suggested above have been incorporated into the final CCP under alternative B Objective 3-1.

Comment: One individual commented on the following statement on page B-101 of the draft CCP/EIS: "Evaluate the option of deepening and widening the existing inlets in Unit II." He writes, "Unless some hard engineering work, such as electrically controlled gates, is done to control what tidal surges are allowed to enter the new salt marsh, the further expansion of this salt marsh would seem to be practically guaranteed. The COE is needed not only to provide dredging material to support areas adjacent to the breaches, but also to install gates that could control water flow in and out of the marsh."

Response: Hardening of refuge shorelines does not support the objectives and goals under alternative B or the draft Habitat Management Plan because periodic tidal surges are necessary to sustain healthy salt marsh habitat. Coastal zone management and restoration experts have proposed deepening or widening the inlets to help facilitate marsh drainage at low tides and/or transport sediment into the marsh. Regardless of what plan we adopt, assuming that the substrate is at the appropriate elevation, salt marsh will ultimately expand on the refuge due to sea level rise, as well as elsewhere along the Atlantic Coast. As sea levels rise, inland salt marsh migration and saltwater intrusion will continue. If the substrate is not at the necessary elevation, then the former marshes will convert to open water conditions.

Comment: One individual writes, "With the dune breaches being plugged, the Fowler Beach Road and the Prime Hook Beach Road flooding events will be reduced. Because Unit I will remain a salt marsh, open to storm intrusion, constructing a robust levy or berm on the north side of the road will stop flood waters from running into Unit II. Appropriate adjustments to the water control structure at Fowler Beach will prevent back flow into Unit II."

Response: Barrier beach islands and coastal salt marsh habitats are priority conservation habitat types within the Delaware Bay and the mid-Atlantic coastal region. Unit I represents one of the remaining undeveloped coastal saltwater wetlands in Delaware and supports 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. Installing a berm on the north side of Fowler Beach Road would disrupt natural hydrologic function within the unit, potentially jeopardizing the function and value of the wetland.

The water control system as originally conceived in the 1980s included a one-way flap gate system which closed to prevent incoming water from Unit I. It still functions to drain Unit II when water levels are high enough that waters flow into Unit II over Fowler Beach Road, via Slaughter Canal, or through the breaches. It is unclear at this time whether or not the State or landowners north of the refuge will install flap gates or take other measures to reduce the flow and salt water intrusion via Slaughter Canal, but, as explained elsewhere, the most sustainable approach to reducing flood impacts on surrounding uplands is to have a robust salt marsh in Unit II.

Comment: A number of commenters recommended that the refuge use materials and structures such as geotubes, biologs, cocoa mats, and jersey barriers to temporarily fill the breaches or otherwise assist with marsh restoration. One letter specifically recommends a modified Service-preferred alternative that incorporates "living shorelines" on the bay coast at the breaches as well as along the interior marsh borders and roads and other accepted approaches.

Response: We identified some of these living shoreline strategies under objective 3.1 of the alternative B in the draft CCP/EIS and evaluated their potential impacts. We added some further evaluate these strategies in the final CCP/EIS, as well as describing our discussions with the Partnership for the Delaware Estuary (PDE) regarding potential implementation of living shoreline projects.

However, we only proposed these types of projects as potential short-term restoration strategies for inland wetlands, such as along the road and along the interior marsh interface. We do not consider these long-term solutions for the shoreline because it is well-established by restoration professionals that living shoreline techniques are not appropriate for the high energy dynamics of the bay shoreline. We still propose shoreline work only in conjunction with stabilizing conditions for the purposes of marsh restoration, not as a temporary or permanent measure on its own. Without restoration of the marsh behind the dunes, any dune work would remain vulnerable to future overwash due to the elevation deficit, and routine supplementation would continue to be necessary. There are no quick, inexpensive, short-term solutions to deal with the magnitude of wave dissipation needed along the shoreline itself. The use of off-site dredged sediment was already included as a potential strategy for short-term shoreline stabilization in conjunction with marsh restoration. In response to these comments, we consider and describe several options in the final CCP/EIS. For example, we have further evaluated other engineered wave attenuation solutions designed specifically for such applications (rather than the use of jersey barriers, which are not designed for the purposes of wave attenuation). This discussion has been added to alternative B, objective 3.1 and in appropriate portions of chapter 5.

As the commenters noted themselves, the determination of which specific strategies may work best under the conditions present in the wetland complex require additional expert analysis. Both engineering firms we have discussed the refuge's situation with agree that hydrodynamic modeling is the first step before making substantial restoration recommendations or shoreline alterations. This analysis has already begun so that we may be poised to move forward on appropriate actions pending finalization of the CCP, but this would have taken too long to complete without a delay to the CCP release. Additional research and discussions with restoration experts about the likely sufficiency and success of the strategies suggested above have been incorporated into the final CCP under alternative B, objective 3.1.

Comment: One individual suggests the following: "For Unit II, construct and maintain a robust dune of sufficient height and depth to withstand most of the Nor'easter type storms. This includes adding a levy or similar structure on the north side of Fowler Beach Road and elevating, hardening Fowler Beach Road and protecting adjacent farming interests. Convert this unit back to a freshwater marsh. Provide a levy or similar structure on the north side of Prime Hook Beach Road, with water control capabilities as required." He continues, "For Unit III, convert this unit back to freshwater marsh. Repair/modify and or replace water control structures as required…[to fulfill refuge mission because] waterfowl counts indicate that a freshwater marsh is much more productive than a saltwater marsh…[and] assuming an increase in sea level rise, they will provide critical habitat for wading birds, dipping ducks, geese and shorebirds. They will be [a] buffer for storms and help hold storm runoff water, filter pollutants and are a highly productive nursery."

Response: We have always stated that dune work/breach closure was a possible, and indeed likely, first step toward restoration of the salt marsh. However, repairing the dunes alone will not eliminate future flooding of roads and agricultural lands during extreme high tide and storm events, since floodwaters can enter these areas through locations other than the existing breaches. Rather, restoring the natural hydrological function of historic refuge salt marshes would provide valuable ecosystem services such as storm surge protection and flood protection, which minimize the impacts of floods. In addition, the flooding of roads and agricultural lands is not a unique situation in that several other areas in coastal Delaware routinely flood during high tide and storm events. It was our intent to maintain short-term stability for Unit II by reestablishing the dunes as was explained in the November 2010 Dune EA and FONSI. However, the site conditions have changed dramatically and there is no longer enough sand to reestablish the dunes. Filling of breaches is not specifically excluded from Alternative B. Rather, any work along the shoreline would be conducted in the context of comprehensive marsh restoration, as the

means to an end, not as the end goal itself. The Service believes restoration of the marshes provides the best solution for long-term sustainability. We have always stated that dune work/breach closure was a possible, and indeed likely, first step toward restoration of the salt marsh and have reworded a strategy to specifically acknowledge the potential and likely first step of closing the breaches to complete marsh restoration. Installing a berm on the north side of Fowler Beach Road would disrupt natural hydrologic function within the unit, potentially jeopardizing the function and value of the wetland. In addition, if a "berm of sufficient height and depth to withstand most of the Nor'easter type storms" were constructed, this would need to be a very large engineered dune, likely far higher and wider than the elevation and width of the Prime Hook community or other portions of the current barrier system. To the extent that such a dune system might deflect flood and tide waters, it could focus storm activity to other land. Many artificial shore protection measures cause other adverse impacts to adjacent or downdrift areas.

The refuge acknowledges that the best management for Unit III is not yet clear. The overarching objective is for it to be more sustainable for the long-term. Clearly, it cannot continue to be managed in exactly the current manner, which has left it vulnerable to subsidence and wetland collapse in large portions. Without the results of hydrodynamic modeling currently in development, and other further analysis, it is difficult to know yet if salt marsh restoration would succeed, or if a return to impoundment management is even feasible given the many factors involved.

Comment: The State of Delaware stated that the continued breach in the dunes is contrary to the letter of February 20, 1963 by then Department of Interior Secretary.

Response: We respectfully disagree. The letter states that the goal of the refuge is to conserve refuge resources for present and future generations. However, in 1963, the Service did not understand the mechanics and impacts of climate change and sea level rise. In particular, they did not know that it would be unsustainable to maintain coastal freshwater wetlands in the face of decades of coastal erosion and changing conditions due to climate change. The Service also did not fully understand the ecology of coastal habitats, including that salt marshes provide storm attenuation functions that protect mainland areas and are maintained by barrier island rollover and migration. Although, the letter was well-intentioned, at the time the Service had incomplete knowledge and was unable to foresee the future. Management decisions made in the 1960's were based on the science and knowledge of the times, which did not account for the increasing rate of erosion, rising of water levels in the Delaware Bay, or increases in coastal storms that have created the current management challenge. Also, the refuge's management is now guided by more up-to-date Service polices and new laws, such as the policy on biological integrity, diversity, and environmental health and the Refuge Improvement Act. These require the refuge to make science-based management decisions that adapt to changing conditions and thus preserve natural processes. Because of these changes— changes in the refuge environment, better science, and these new policies—we feel it would be neither sustainable or responsible to attempt to maintain a static condition along this dynamic shoreline.

Comment: The State of Delaware suggest isolating Unit III to maintain it as a freshwater complex as they believe it has sufficient base flow to maintain it as a freshwater/slightly brackish wetland, its management infrastructure has not been as compromised, and the management capabilities are still somewhat intact unlike the other units within the refuge.

Response: Our overarching objective for Unit III is for it to be more sustainable for the long-term. Clearly, we cannot continue to manage it exactly as we have, which has left it vulnerable to subsidence and wetland collapse in large portions. Without the results of hydrodynamic modeling (currently in development) and other further analysis, it is difficult to know yet if salt marsh restoration would succeed, or if a return to impoundment management is feasible given the many factors involved. We respectfully disagree with the assertion that the management infrastructure is not very compromised, because Prime Hook Road is at such a low elevation and has free-flowing culverts that connect it with Unit II, and because we have found the elevation of water control structures along Broadkill Beach Road to be well below their designed elevations.

Comment: The authors of one letter request that the refuge close the breach in that area north of Fowler Beach Road because it is threatening Unit I and Unit II and could negatively impact horseshoe crabs and nesting birds. They suggest, "There are many engineering options to do this that the CCP should consider, such as an interior dike or berm."

> **Response**: The opening and closing of overwashes in a healthy salt marsh is a natural part of the system. The shoreline along Unit I has breached and closed repeatedly over past decades (see figure 1-1 in the draft and final CCP/EIS). This process likely accounts for the adequate vertical accretion that Unit I has experienced, keeping pace with sea level rise. As such, permitting overwashes is the best way to ensure the salt marsh remains able to provide a buffer for storms and flooding. In the time immediately after the 2006 Unit I breach formed, but before the Unit II breaches formed, the salt marsh in Unit I was thriving. Closing this breach may be considered, if needed for marsh restoration in Unit II. Breaches, in time generally close, as it is a natural function if there is sufficient sediment in the system. Any additional stress experienced by Unit I is related to the fact that the wetlands in Unit II are degraded and unable to absorb the quantity of water from the Unit II breaches. The best solution for Unit I is ultimately the restoration of a healthy marsh within Unit II. The flow of water in this part of the wetland complex has been well documented, and is from Unit II into Unit I, not the other way around. . Installing a berm may disrupt natural hydrologic function within the units, potentially jeopardizing the function and value of the wetland.

Comment: Several individuals suggest the following:

- Removing the dike parallel to Route 16 if the breaches at Fowler's Beach are not closed and/or the impoundment in Unit III remains as salt marsh. They suggest using the materials from this dike to help restore the marsh stating that "The material for this dike was trucked in [and therefore] must be eco-friendly."

- Removing water control structures from Unit III if the breaches at Fowler's Beach are not closed and/or the impoundment [in Area III] remains as salt marsh, because they were installed "only to capture and hold freshwater. If there is no freshwater marsh…then there is no reason to hold any water in that section."

- Re-examining groundwater levels, which are much higher than they were prior to installing the dike and water control structures, and how they impact refuge neighbors. They write, "This has had an impact [on] sewage systems and building lots on Broadkill."

- Regardless of the decision about closing the breaches, opening or expanding culverts along Route 16 to allow incoming water from the north to drain more readily. They write, "The refuge has demonstrated a great capacity to capture and retain water, [but] almost no capacity to remove or drain it [causing flooding].

> **Response**: As stated in the strategies associated with alternative B, Objective 3-1, we will continue to work with DelDOT to explore options, which address road flooding concerns in a manner consistent with refuge management objectives. The impact of road changes on local hydrology will be evaluated in ongoing hydrodynamic modeling. Alternative B includes active restoration (e.g., improving wetland elevation and increasing historic flow and hydrology within refuge impounded wetlands) to ameliorate damage and facilitate the healthy succession to a brackish/salt marsh. A functioning salt marsh results from the interactions of salt marsh plants species diversity that flourish in response to specific patterns of tidal flooding. The ability of these systems to thrive is dependent upon the salt marsh's link to the bay. Many factors influence groundwater levels, seas level rise, precipitation, irrigation, etc. Currently, the Service is not proposing to remove the water control structures.

Comment: One individual writes, "If you close the breaches, where will the water come from to support a salt marsh? If the water will come from removing the water control structure and removing the [Fowler Beach Road] roadbed, why not just leave the breaches alone and build up [Fowler Beach Road] as a dike? Have you thought about the impact that removing the roadbed will have on public use? Impacts on new surf fishing? Impacts on wildlife observation?"

Response: Unit I and Unit IV have received water from the Mispillion and Broadkill Rivers during lunar tides and storm surges. The Service is not currently proposing to remove the water control structures. Installing a berm on the north side of Fowler Beach Road would disrupt natural hydrologic function within the unit, potentially jeopardizing the function and value of the wetland. Adaptive management is necessary if Fowler Beach Road, from Slaughter Canal to its terminus at the Delaware Bay, is abandoned by DELDOT and donated to the Service. If, upon DelDOT's removal of the existing layer of asphalt overlying unconsolidated fill, the walking trail will serve its purpose of public use until marsh vegetation and hydrologic function reclaim the trail and the formally bisected habitat (Units I & II) function as one unit. When conditions are deemed unsafe, access will not be permitted to Fowler Beach for public use opportunities such as wildlife observation, wildlife photography, and fishing.

Comment: One individual writes, "Regarding the breaches in the dunes and the impoundments, I support an approach that recognizes the dynamic nature of the beach/dune interface, and recognizes that sea level rise is occurring. It would be pointless to attempt to close the breaches and attempt to restore the impoundments to a non-tidal condition. The impoundments should be restored to tidal marsh habitat, subjected to regular tidal exchange. I realize this is a difficult thing to achieve, given the low elevations of the former impoundments, the erosive energy caused by the dune breaches, and the limited sediment supply. I would recommend that the Service work with the State of Delaware to explore the possible installation of artificial reef/wave attenuation structures that will reduce wave energy and promote accretion of sand, which will help to buy time and be complementary to efforts to build a tidal marsh."

Response: Thank you for your support. The Service continues to work with all our partners to achieve the desired outcome.

Comment: A number of commenters expressed concern that the CCP/EIS did not contain sufficient detail regarding the marsh restoration strategies, or a specific restoration plan, and that the lack of detail prevents fair or complete evaluation of the alternatives. For example, one letter states, "The strategies to be undertaken within impoundment II for the preferred alternative B are too incompletely developed to justify the recommendation that this alternative be chosen—in fact they are not developed at all. The overarching strategy is to restore impoundment II to tidal brackish/salt marsh, through improving wetland elevation by the addition of dredged sediment, and increasing historical flow and hydrology (among other strategies, see table 4.5 and discussion objective 3-1). Yet there is no plan put forward as to how to achieve the three components of this strategy. [1.] There is no discussion of how much sediment is needed for sufficient elevation, and extent to which the "dredged" sediment (a reference to sediment potentially obtained from ACE dredging of the Delaware River channel) will suffice, or the source of additional sediment, if needed. [2.] There is no discussion of how to achieve the drainage, which would lead to stability necessary to realize the flood protection benefits claimed on page 4-97. [3.] Further, mention is made of the fact that flood protection benefits may be needed to assist in restoration, yet without discussion of types and costs. Indeed, the identified strategies (beginning page 4-99) cite "working with an advisory team" to develop restoration plans and further studies. It is wholly inappropriate to propose expending taxpayer dollars on vague overarching strategies without known plans."

Response: The CCP provides the "big-picture" of refuge management, and the details of a restoration plan were outside the scope of the CCP process. Similar marsh restoration plans of comparable scope and detail elsewhere in the country have routinely taken years to develop; accounting for the time needed to collect data, model habitat conditions, evaluate restoration options, and prepare the plan. Admittedly, most restoration plans are prepared with the benefit of a stable situation, rather than in a reactionary context. We did not want to delay the release of the entire CCP until we could develop a detailed restoration plan. As the commenters noted, many restoration concepts would need to be developed further by engineers for more detailed analysis, a process that is time-consuming and requires rigorous data. The partnership to move such plans forward and the necessary analysis to further develop options have already started. Furthermore, the final CCP/EIS does incorporate additional details about strategies that we will be poised to act upon once the CCP is completed.

Additionally, the Service has recently begun to collect data to understand current marsh transitions in order to make science-based management decisions. Results indicate the need for a detailed marsh restoration planning effort, which will outline strategies to rebuild a resilient mix of salt (dominated by *Spartina alterniflora* with significant areas of *Spartina patens*), brackish, and freshwater marsh.

In order to return the Unit II wetlands to a diverse, resilient, and dynamic ecosystem, the proposed wetland restoration project within Unit II being studied by the refuge and a private consulting firm stressed in the CCP the importance of restoring inherent ecological processes, improving sustainability and resiliency to adapt to climate change and other environmental changes. A better understanding of the potential impacts of climate change (e.g., sea level rise and possible changes to extreme precipitation events) on the Unit's wetlands will help accomplish this objective. The study's models will simulate the hydrologic conditions in a watershed model including the hydraulic conditions of the wetlands. These models are applied under various climate change scenarios to existing wetland conditions and proposed wetland restoration alternatives. The results of the models, along with supporting references, are used to improve understanding of the potential climate change impacts to habitats under different restoration scenarios and aid in helping the refuge select the optimal restoration design. Once all the data is collected, the refuge will prepare additional Environmental Assessments for the proposed work that includes a detailed discussion of how much sediment is needed for sufficient elevation, flood protection benefits, shoreline protection and cost.

Comment: Several individuals were concerned that the draft CCP/EIS did not address what would occur if the strategies under alternative B failed. One writes, "The uncertainty of the outcomes of B should be evaluated, along with the benefits and costs, for comparison with C. For example, if, for any reason, [Service] is not able to obtain dredge materials from the channel-dredging project, there is no discussion of an alternative source for these critical materials."

Response: We agree that there is a level of uncertainty with any management decision. Because of this, we try to use an adaptive management framework. Adaptive management is a proactive process of learning what works on the ground by constantly adjusting strategies to respond to new information, spatial and temporal changes, and environmental and climatic events, whether foreseen or unforeseen, measured against a clearly defined goal or set of conditions. In addition, to minimize the potential for uncertainty, we developed CCP goals, objectives, and strategies for all the alternatives using a thorough assessment of available science derived from scientific literature, on-site refuge data, expert opinion within and outside the Service, and sound professional judgment. Please refer to the section on "Adaptive Resource Management" in chapter 4 of the CCP/EIS for more information.

Comment: PEER asks, "Does the Service intend to fill in breaches before or after the finalization of the CCP?"

Response: We identify filling the breaches along Unit II as a possible strategy under objective 3.1 of alternative B. We do not intend filling the breaches unless, and until, we determine that such a step would support either salt marsh restoration or comprehensive marsh restoration. We will base our decision on hydrodynamic modeling that is underway and by further consultation with the State and wetland experts.

Comment: Several commenters pointed out that Chapter 1 of the draft CCP/EIS states that "for the immediate future, the refuge has proposed to fill inlets and re-establish dunes along Unit II to maintain short-term stability," and noted that this immediately required action is specifically excluded from the preferred alternative.

Response: It was previously our intent to maintain short-term stability for Unit II by reestablishing the dunes, as explained in the November 2010 Dune EA and FONSI (USFWS 2010). However, site conditions have changed dramatically since then and there is no longer enough sand onsite to reestablish the dunes. This was included in an earlier draft of chapter 1 of the CCP, which predated the implementation and ultimate failure of the dune repair work, and was left in the chapter inadvertently. We apologize for any confusion and clarified this in the final CCP/EIS. We do not specifically exclude filling the breaches under alternative B. Rather, we would only conduct such work along the shoreline in the context of comprehensive marsh restoration, as the means to an end, not as the end goal itself.

Comment: One letter pointed out that a statement on page 4-97 of the draft CCP/EIS is misleading because "greater stability" is claimed, and that open access to the bay is envisioned by the Alternative, which will leave the area unstable.

> **Response**: The statement was referring to "greater stability" associated with salt marsh restoration, and we stand by our assertion that a restored salt marsh will provide greater stability to adjacent lands than the current condition— a heavily managed impoundment that has already experienced degradation from decades of hydrological alteration and would require frequent shoreline maintenance. We also establish, in the referenced paragraph, that the presence of a salt marsh will dissipate water energy from the bay. Under alternative B, we do not envision "open access" to the bay, but rather plan to restore healthy shoreline dynamics that would naturally include overwashes and inlets that form and which are likely to close on their own over time, as they have along the refuge shoreline many times over past decades (See figure 1-1). Such dynamics enable the salt marsh to build elevation vertically and keep pace with sea level, in order to reduce the odds that exactly the kind of marsh collapse that has occurred in Unit II could occur again in the future.

Comment: Several commenters, including the Prime Hook Beach Organization and the town of Slaughter Beach, pointed out that the CCP does not address the risk associated with leaving the breaches open if there is an oil spill in the Bay and are concerned that oil could then enter the impoundments.

> **Response**: We agree that the draft CCP/EIS was lacking in this regard, and have corrected this omission in the final CCP/EIS. The Delaware Bay has been, and will continue to be, vulnerable to oil spills and other pollutants. It is nearly impossible to provide a thorough evaluate of impacts of a potential spill because our analysis would greatly depend on what was spilled, how much was spilled, and the weather and tidal conditions at the time of the spill. We have added a discussion regarding impacts from potential oil spills near the refuge under each alternative to the "Impacts on Water Quality and Hydrology" section of chapter 5. We also added strategies to chapter 4 address the refuge's oil spill preparedness.

Comment: One commenter pointed out that the freshwater pond Silver Lake in Rehoboth and the town of New Orleans are evidence that freshwater ponds are sustainable along the coast.

> **Response**: We respectfully disagree that these examples are relevant for comparison to the highly managed impoundments on the refuge. Silver Lake is currently surrounded by an intact nourished and developed beach on its east side, a road on its west side and several housing developments. There are no sources of saltwater intrusion into the pond at this time. DNREC responds to occasional fish kills when dissolved oxygen concentrations become low during periods of summer heat. Otherwise, no active management is used to maintain its freshwater integrity other than rainfall that naturally is collected and retained. The same holds true for New Orleans. The freshwater integrity of areas in New Orleans are maintained if no physical changes occur that result in saltwater intrusion. However more often than not there are several areas in New Orleans where freshwater integrity of many natural and diked marshes are being compromised because of salt water incursions either from dike breaches, ground water depletion, salt water plumes migrating further landward and other causes. New Orleans remains constantly vulnerable to damage by storms and hurricanes.

Comment: One commenter noted that, while the CCP mentions a current easement restriction, it does not consider the impact of this easement, nor discusses the pros and cons of altering this restriction. The individual suggests that the Service evaluate the current easement restriction to a height of 2.8 feet (MSL) and likely change the easement.

> **Response**: We agree. Our water management will likely change as we develop a marsh restoration plan based on data collection and modeling. Based on this, we may need to remove or renegotiate the easement restriction. We added a strategy to revisit the easement restriction, once the marsh restoration plan becomes available.

Comment: One individual writes that on page 100 of the draft CCP/EIS, states-"use Christmas tree fences to reduce beach erosion." This contradicts the recommended practices of DNREC, which indicates that tannins leaching from dead Christmas trees are detrimental to beach grasses that are the primary plants of value for protecting the dunes from storms and erosion."

> **Response**: The statement in the draft CCP/EIS actually refers to fostering sediment deposition in the marsh. It says, "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." The Christmas trees would be placed in the water, not on the beach, so they would not affect beach grasses. The effectiveness of this approach will need to be further examined based on the hydrological and other planning efforts underway.

Comment: One individual writes, "I also question what we know about the currents or hydrology of the Delaware River and Bay, under both normal tide cycles and storm cycles. Observational studies have been devoted pretty much to anecdotal information and very little is seems to be based on hard data. For example, we have observed a slow erosion of Fowler Beach over the past 50 years. About 2000, the erosion rate increased dramatically. It has been mentioned that the repair and rebuilding of the jetty at Mispillion River was completed about the time the Fowler Beach erosion rate increased. Is this coincidental? Or have currents changed? Is Fowler Beach the focal point of where ocean storm tides and flow from up the river meet, causing beach scouring? Do we have sufficient data to produce a computer modeling program?

> **Response**: We are currently working closely with a contractor to gather all the data necessary for hydrological modeling, including data from the refuge and elsewhere in the region. The contractor has done similar modeling work along the Delaware Bayshore and has helped with the development of the 10-year management plan.

Comment: One individual writes, "Should Alternative B be chosen (converting Units II and III to salt water marsh), these Units will need access to Delaware Bay tides. I have not found any descriptions of how this will be accomplished. What flow is necessary to ensure the marsh levels will be maintained? Will additional Bay inlets be manmade? What about outlets? Will these inlets/outlets have some sort of water control? Will Prime Hook Creek be adapted to carry this flow? If so, what issues will this cause with the homes on Broadkill Beach that abut the creek and at the outlet at Roosevelt Inlet?"

> **Response**: We agree that these types of information are important in helping making management decisions. These are exactly the details that hydrological modeling currently underway will help us evaluate. In the draft and final CCP/EIS, we propose restoration, in the big picture, and acknowledge that the details of the restoration will not be possible until we have the modeling work completed.

Comment: The Sierra Club, Ducks Unlimited, and Defenders of Wildlife support the proposal to restore four impoundments to salt marsh to allow natural process to occur, such as sediment accretion, and to compensate for historic salt marsh losses in the Mid-Atlantic region. Defenders of Wildlife also feels that "maintain[ing] the altered hydrology of the refuge's impoundments goes against the Refuge Improvement Act [and is] a temporary and expensive management approach [particularly in light of climate change and sea level rise]." Ducks Unlimited stresses that converting the freshwater impoundments to salt marsh will "require the Service to place higher emphasis on the management of the remaining freshwater areas on and adjacent to the Refuge. The reversion will make these adjacent areas inherently more important for migrating waterfowl." The Delmarva Ornithological Society also supports the Service's plans to restore salt marsh habitat in Units I and II and "support the use of off-site sediments, if necessary, to aid in salt marsh restoration."

> **Response**: We appreciate the support for our proposed action.

Comment: The form letter makes the following recommendations about water level management in the impoundments: "Open the water control structures to drain to their lowest point from March 1st to September 30th. The control gates could close anytime if saltwater was entering the system. Then closing the water controls allowing the area to fill every fall and winter with freshwater from Prime Hook Creek and Slaughter Creek. This would encompass all of Unit II and Unit III. The freshwater impounded during the fall and winter should dilute the salt content in the marsh soil. Then repeat the following year. In Unit III, the cookie cutter should be used once a year to help maintain the shallow ditches. Salinity tests would tell how well it is working. This will not happen overnight, but then it was not destroyed overnight."

> **Response**: We are working to identify ways to manage the wetland in the short term to minimize damage as we await restoration opportunities. Our preferred alternative proposes to restore Unit II to salt marsh. The refuge acknowledges that the best management for Unit III is not yet clear. The overarching objective is for it to be more sustainable for the long-term. Clearly, it cannot continue to be managed in exactly the current manner, which has left it vulnerable to subsidence and wetland collapse in large portions. Without the results of hydrodynamic modeling currently in development, and other further analysis, it is difficult to know yet if salt marsh restoration would succeed, or if a return to impoundment management is even feasible given the many factors involved.

Comment: One individual writes, "Was the intent of [the failed attempt to fill in breaches] to protect the impoundments or to quiet the beach folks (as written your draft EA for the dune repairs?) Since then, water control structures have been left open and salt water continues to flush both Units II and III, destroying wetland plants that were valuable waterfowl habitat and food resources, and killing trees, shrubs and other vegetation. Simply put, destroying and degrading significant numbers of acres of wetland habitats and adjacent upland areas."

> **Response**: We described the purpose of the dune repairs in the final EA and FONSI. The Units are subject to daily tidal flow from the breaches. Refuge staff open or close the structures based on water levels within the impoundments. We feel that closing the water control structures may result in further flooding (e.g., additional areas flooded, flooded roads, and possibly flooded homes).

Comment: One individual writes, "What are your plans for the Unit IV impoundment? Never really talked about this in [alternative B] and HMP."

> **Response**: Under the preferred alternative the Unit IV impoundment will be managed as an impoundment as outlined under objective 3.2.

Comment: One individual writes, "In the past refuge management of wetland management of Unit III most importantly sediment conservation was a very significant consideration used to maintain the health of Unit III. It was the reason we always conducted very slow drawdown and reflood schedules as recommended by non-FWS wetland management experts in all the impoundments."

> **Response**: We are not aware of any refuge management plans that discuss sediment conservation. Sediment management is generally reserved for salt marsh management not freshwater impoundment management. We agree that slow drawdown and reflood schedules are beneficial for moist soil management. The refuge's annual water management plans cited the primary goal of water level management is to increase the foraging carrying capacity of the refuge's marshes. The refuge's water management was based on the idea that dynamic water depths and fluctuations will enhance moist soil productions. This adaptive management strategy included not only slow drawdowns, but also rapid drawdowns. Although rapid drawdowns are occurring more frequently, they have occurred in the past. We added a strategy to objective 3.1 under alternative A to clarify that such "storm water management" actions currently taking place now would continue.

Comment: One individual writes, "When the CCP process began, Prime Hook had 3 impoundments totaling 4,200 acres of high quality freshwater habitat and hosted tens of thousands of ducks each fall/ winter. Today, the numbers are well short of earlier numbers. This habitat has been completely degraded in the last 4 years."

Response: We acknowledge the loss and degradation of habitat in Chapter 3 and the impacts associated with alternative A.

Croplands and Cooperative Farming
(Letter ID#: 4, 28, 43, 51, 54, 55, 64, 67, 71, 80–Petition, 81, 95, 98, 104, 107, S11, 108–Form Letter)

Comment: We received many letters, including from the State of Delaware and Ducks Unlimited, requesting that the refuge reinstate cooperative farming on the refuge to provide food and resting areas for wildlife, particularly waterfowl and white-tailed deer. Several individuals were concerned that the habitat that was replacing these cropfields was inadequate for wildlife. For example, one individual writes, "This area has been replaced by dead trees…and dense areas of *Phragmites,* cat claw briars, and swamp gum trees." Another writes, "Returning the fields to native forest will take years. Meanwhile waterfowl and wildlife will be left with little or no food." Another suggests that the refuge could continue to farm but not use genetically modified crops. Another suggests that the refuge compromise and continue to allow cooperative farming for waterfowl in some areas, but allow other areas to transition to forest for other wildlife species. The State of Delaware feels that the Service's decision to not reinstate farming could "cause damage to private farmland [from] shading, noxious weeds, and wildlife damage" and they believe "forest land does not provide habitat for migratory waterfowl and other birds; and is in direct opposition to the original purpose of the refuge, which was to provide such habitat to waterfowl." Additionally, the State writes, "The Service should establish a balance between cooperative farming opportunities and upland forest restoration that considers the mutual benefits of agricultural production and habitat diversification."

Response: Farming was once a management tool on Prime Hook NWR to provide supplemental food for declining waterfowl species and was once believed to provide habitat for other animals. At its peak crop acreage in the 1970s, farming at Prime Hook maintained a modest amount of crops compared to the total cropland available to wildlife at the time on the Delmarva Peninsula. Currently, waste corn and soybeans resprout long before wildlife have a chance to feed on the seeds during the winter. Non-native cover crops that were planted in the past as part of the cooperative farming program on Prime Hook contributed a small amount of food to geese compared to the amount of food available from crops planted throughout Delaware and the Delmarva Peninsula. While the refuge provides vital wetland habitat to many species, the Delaware Wildlife Action Plan show that agricultural land is not critical habitat for birds, and habitat that has been altered for farming has actually led to a decline in some species.

Service policy (601 FW 3 Biological Integrity, Diversity and Environmental Health) states that "We do not allow refuge uses or management practices that result in the maintenance of non-native plant communities unless we determine that there is no feasible alternative for accomplishing refuge purpose(s). For example, where we do not require farming to accomplish refuge purpose(s), we cease farming and strive to restore natural habitats.

The refuge does not plant crops as a means of attracting wildlife away from private property. As an example, white-tailed deer are highly mobile, range over wide areas, and are abundant in Delmarva region. Although deer do feed within the refuge, food plots and cropland do little to attract deer away from surrounding property nor to increase local deer populations.

Regarding noxious weeds, Integrated Weed Management (IWM), is defined as the method of managing undesirable species through a combination of techniques that may include: education; prevention; mechanical, biological, and chemical control; and cultural methods, provides the most effective means of combating this problem. The refuge will apply these tools as need along the refuge/farmland interface.

As directed by Congress, the original purpose of refuge is migratory birds whereas this establishing purpose does not specify waterfowl. The primary purpose of the refuge is to provide habitat for migratory birds, which includes waterfowl, as well as many other waterbirds and migrant landbirds. Roughly 80 percent of the refuge is a mix of fresh and saltwater wetlands stretching from Slaughter Beach in the north to the Broadkill River in the south. Forested habitats, not agricultural lands, prove to be vital stopover sites on the refuge for migratory birds. While some habitat alteration can generally benefit some species, the Delaware Wildlife Action Plan encourage Federal and private conservation land managers to limit habitat management for one species unless those animals are considered threatened or endangered.

Agriculture for the purposes of production of a product for sale with the expressed intent of supplementing local farm income has never been the goal of cooperative farming. The intent of cooperative farming in the past was to provide forage for migratory waterfowl especially Canada geese, and to a lesser extent, dabbling ducks. According to the USDA, 1,383,920 acres (2,162 square miles) of corn, wheat, soybeans, barley and hay were planted or maintained on Delmarva in 2007. An additional 135 square miles of vegetables and potatoes were planted, which may also support green browse in winter. At its peak, the cooperative farm program at Prime Hook NWR managed 48 small fields (averaging 22.3 acres each), for a total of 1,070 acres, or 0.073% of the total cropland (2007 acres) on the Delmarva Peninsula. It is reasonable to conclude that the farmed acreage on Prime Hook NWR historically has actually contributed negligible forage to the highly mobile wintering goose population.

Historically, waterfowl were the most closely monitored and managed migratory bird populations. However, 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." These species include migratory birds (such as songbirds, colonial waterbirds, shorebirds, and raptors), as well as other wildlife, including mammals, fish, reptiles, amphibians, insects and plants.

In the late 2000s, the states completed plans that identified "Species of Greatest Conservation Need" (SGCN), their habitats; causes for decline; and a list of research, management and restoration needs for maintaining and improving wildlife populations. The Service examined the three State plans covering the Delmarva area, as well as plans put forth by national bird conservation groups: Bird Conservation Region (BCR 30) Implementation Plan, and the Partners in Flight (PIF 44) Plan. None of the plans considered land managed for agricultural grain production to be a critical habitat. In contrast, all plans placed forests and natural wetlands at the top of the list of declining and critical habitats for numerous priority species on Delmarva. The refuge currently manages over 5,000 acres of wetland habitats which are important for waterfowl and a variety of other waterbirds.

These plans list numerous other species of birds, other animals and plants that depend on forested, shrub and wetland habitat. Vast acreages of these habitats have been historically converted to agricultural fields, and more recently, have been converted to developed lands across the Delmarva. Habitat fragmentation, or the reduction of native habitat into smaller, discontinuous blocks, is repeatedly listed as a major factor in the decline or loss of many species of these plans, especially area sensitive species. The BCR 30 Plan states, "Habitat loss and fragmentation is the number one threat to all habitat types. Coastal marsh and mature forested habitats are the highest priority habitats within the BCR due to pressures, rate of loss, or lack of information on rate of loss and present spatial distribution."

Some individuals feel that increasing "edge habitat," which is a form of habitat fragmentation, can enhance "wildlife and habitat diversity." However, increasing habitat edge may increase the gross number of species found in an area, but this is often due to the introduction of generalist (or even invasive) species, those that can tolerate small, irregular patches of habitat, while numbers of wildlife species that have specific habitat requirements decrease. On the Delmarva Peninsula, native forests have been fragmented into small, often linear patches; shrublands and fallow fields are difficult to find; patches of natural habitats are isolated islands in a sea of intensively managed agricultural fields and urban/suburban development. The Delaware Wildlife Action Plan states, "Emphasize the management of ecological structure and function of key habitats over management of individual species. Management of wildlife species in Delaware has traditionally focused on game animals and sport fish, leaving the great majority of Delaware's wildlife entirely unmanaged…Many SGCN …are area-sensitive, requiring relatively large areas of mostly unbroken habitat to ensure their viability. State, Federal and [non-governmental organization's conservation lands… are particularly critical for meeting the needs of area-sensitive species."

Comment: The Center for Food Safety, Delaware Audubon Society, and a few individuals supported the proposal to not reinstate cooperative farming under alternative B. The Center for Food Safety writes, "Native wetland and aquatic habitats provide sufficient native food resources to satisfy the needs of migratory duck and geese species [and can help reduce overabundant snow geese populations." They also applauded the Service for its decision to not reinstate cooperative farming because it "would eliminate the cultivation of transgenic, herbicide resistant crops" that can "pose significant environmental and economic risks [such as] increased herbicide use, the development of herbicide resistant weeds, the risk of contamination [to non-transgenic crops], soil and water pollution, and harm to migratory birds and aquatic communities." One individual also supports this proposal because restoring previously farmed areas to forest "will be beneficial to native woodland bird species" and may help "remove CO2" from the atmosphere. Another feels that the refuge's 600 acres of previously farmed land is "insignificant" to the economy, as well as wildlife because "[w]ith modern farming, there is little waste grain."

> **Response**: We appreciate the support for our preferred alternative.

Comment: Several commenters felt that alternative C disingenuously proposes to conduct cooperative farming and use GMO crops. They felt that this was not a viable alternative management action and strategy because the refuge did not provide a written compatibility determination or NEPA documentation to support the need to use cooperative farming and/or GMO crops to achieve refuge purposes.

> **Response**: The draft CCP/EIS only included the compatibility determinations for those uses proposed under the Alternative B, the Service's preferred alternative. We did not complete compatibility determinations for uses only proposed under alternative C. We apologize for any confusion and have clarified this in the final CCP/EIS. Under alternative B, we found that cooperative farming was not appropriate at this time.
>
> Under alternative C, we proposed the use of a cooperative farming program to provide non-genetically-modified crops as cover crops for migratory birds. In the final CCP/EIS, we clarified our strategies on cooperative farming to state that should the decision be made to use genetically-modified crops on the refuge, it would require Service approval, a step-down Environmental Assessment, and cropland management plan would need to be completed to evaluate any potential use of genetically-modified crops, should the decision be made to use genetically-modified crops on the refuge.

Comment: Two individuals and the form letter made suggestions on how to manage previously farmed areas. One writes, "Why not consider [converting the] former croplands in Units I, II, and III to moist soils units to restore some freshwater habitat?" The other writes, "You do not need to return to cooperative farming. If you need green browse, use force account farming." The form letter suggests, "The fields north of Fowlers Beach and the fields adjacent to Prime Hook Beach Road on the south side could all be planted into forest. The remaining fields could be used again for agriculture."

> **Response**: We did consider converting former croplands to moist soil units. However, with the landward migration of the wetland, many of these fields will become future salt marsh. Managing these lands as moist soil units may result in some of the same problems we are currently having with our existing impoundments (e.g., subsidence and interruption of natural vertical accretion). Should the state and our other partners deem it desirable to increase the amount of freshwater wetland habitats, we recommend looking farther inland to areas which are not likely to convert to salt marsh in the foreseeable future. We might be willing to consider management of such areas, but have no plans to initiate any large-scale expansion of the refuge and such initiatives could be entirely conducted by the state or other partners.

Comment: The Delaware Division of Fish and Wildlife "urges the Service to consider maintaining a small scale farming program to provide habitat diversity and areas attractive to feeding waterfowl. This activity may be even more important given the unstable condition of the impoundments to attract waterfowl. Relative to songbird use, recent radar data analyses suggests that agricultural fields along the Delaware Bayshore are both highly used and persistently used during the fall migration of songbirds." Another individual similarly suggest that the Service maintain 200 to 300 acres of cropland (with 10 to 15 percent of crop remaining as spillage for wildlife) and "food plot demonstration" areas for foraging wildlife, including deer and turkeys.

Response: As stated in the draft CCP/EIS, in recent years, it has been apparent from anecdotal observations that duck species seldom or never used cropland field habitats on the refuge, likely due to wetland and aquatic habitats being readily available on the refuge. These habitats produce sufficient natural foods are also produced to satisfy the needs of Canada geese, especially if measures are taken to reduce snow goose numbers. In addition, eliminating farming on the refuge is consistent with recommendations in the Service's final EIS on the light geese management (USFWS 2007a), which encourages refuges to reduce areas planted to agricultural crops that serve as a supplemental food source for overabundant greater snow geese. We respectfully disagree with the State's interpretation of recent radar data analyses with regard to habitat use by songbirds. The final report submitted to the Service by Dawson and Buler in June 2012 specifically noted that locally important stopover sites were deciduous forests embedded within landscapes dominated by developed or agricultural lands, or near the shores of major waterbodies. Agricultural fields themselves were not highlighted as a habitat receiving high and persistent use during fall migration. On the contrary, the report identified preservation of natural habitat, particularly forests, in agricultural landscapes as a conservation priority. The refuge objectives regarding forest restoration are consistent with the findings of this research.

Invasive Plant Species
(Letter ID#: 65, 69, 72, 80–Petition, 108–Form Letter)

Comment: We received comments on invasive plant species from the Delaware Chapter of the Sierra Club, as well as in the form letter. The form letter stated that the refuge needs to control invasives, particularly *Phragmites*, Johnsongrass, and multiflora rose. The Sierra Club writes, "Promoting native habitat is especially important where wetland migration will occur, and is needed to ensure that natural habitat is established. Without intentional management of native wetlands, unmanaged areas will likely be dominated with invasive species."

Response: We agree that it important to controlling invasive species to protect native habitats and wildlife species. We include strategies to control invasive species under many of the objectives in alternative B, including using early detection/rapid response techniques and mapping invasive plant species occurrences on the refuge.

Comment: The EPA commented on the refuge's proposal to treat invasive plant species with pesticides, writing, "It should be clarified in the [final] CCP/EIS that all pesticides must be mixed, loaded, and applied in accordance with all label specifications and all applicators must be certified with the Delaware Department of Agriculture or working under the supervision of a certified applicator.

Response: Thank you for the comment. We updated our discussion of herbicide use in the section on "Managing Invasive Species" under in "Actions Common to All Alternatives" in the final CCP/EIS.

Comment: One commenter noted on text on page B-117 of the draft HMP. He writes, "Should the "eradication of exotic and invasive species" be given a high priority when on page 101 it indicates that the primary invasive plant, *Phragmites* spp., is a valuable component of improving accretion rates in salt marshes?

Response: According to Refuge System policies (517 DM 1 and 7 RM 14), refuges must use an integrated pest management (IPM) approach, where practicable, to eradicate, control, or contain pest and invasive species. Unfortunately, there are currently 10 invasive species on the refuge. Since refuge resources are limited, we must carefully choose which species and what areas of the refuge to focus our invasive plant control efforts. Under alternative B in the draft CCP/EIS, we propose the following priority order for invasive species management activities: 1) Prevent invasion of potential invaders; 2) eradicate new and/or small infestations; and 3) control and/or contain large established infestations. In the draft CCP/EIS, we use the term "eradicate" to apply small infestations or new invasions that are still isolated to a limited few locations. Since we will never eradicate *Phragmites* spp. across the whole of the refuge, we must choose where to conduct control for it. A *Phragmites* marsh will never be a goal, however where it appears to be maintaining the integrity of emergent marsh soils in Units 2 and 3, we may choose to leave it in place until a salt marsh restoration plan is underway.

Wildlife

General

(Letter ID#: 24, 65, 80–Petition, 82)

Comment: The Prime Hook Beach Organization and the authors of another letter felt that the CCP did not adequately analyze the impacts of the three alternatives on horseshoe crabs. The Prime Hook Beach Organization writes, "…and has allowed crabs to be stranded within the breaches where they will lay eggs in an unproductive environment. Crab hatchlings will not find their way out of the proposed inland bay nor will many adults. We expect the CCP to consider these impacts on the horseshoe crab in its analyses in any plan for going forward." The other commenters add that horseshoe crabs "are trapped by being washed into Unit II and dying. The fate of the horseshoe crab is directly linked to the fate of the migrating Red Knot."

Response: As stated in Chapter 4, Sandy Beach and Dune Grassland Habitats, we propose to allow natural processes to affect the evolution and functioning of coastal landforms and habitats (including sandy beach, overwash tidal flats, dune and grasslands, and mudflats) along approximately 1.5 miles of shoreline only in Unit I, as they naturally evolve in order to conserve spawning horseshoe crabs.

Sand will only be placed on the beach if it is needed for marsh restoration as proposed in the Service's preferred alternative B for beach nesting species or horseshoe crabs. The State of Delaware's Shoreline and Waterways Management Section has successfully conducted beach nourishment projects hauling sand from off-site sources to project sites that have been found to successfully create suitable habitat for horseshoe crabs and piping plovers (DNREC 2004). Refuge staff would work with DNREC and the U.S. Army Corps of Engineers to ensure proper sand size is obtained for any sand placed on the refuge. DNREC and the U.S. Corps of Engineers have analyzed the sediment of the main channel of the Delaware River. The results can be found at: *http://www.dnrec.delaware.gov/Info/Pages/US_Army_Corps_of_Engineers_2010_Dredging_Application.aspx* and at *http://www.nap.usace.army.mil/cenap-pl/drmcdp/pr.html*.

Within Chapter 5 of the CCP, we state, the arachnid, *Limulus polyphemus* (horseshoe crab) is another very important refuge invertebrate species listed as a sensitive and significant Delaware keystone species in the Delaware Wildlife Action Plan (DNREC 2005). It is also considered a species of conservation concern by the Atlantic States Marine Fisheries Commission. The horseshoe crab is listed as a managed species with its own ASMFC Interstate Fishery Management Plan for the mid-Atlantic to conserve and protect these unique invertebrates. Refuge beach habitats provide spawning habitats for horseshoe crabs and we participate in annual census activities to monitor population status which also benefits this species. The conservation of horseshoe crab spawning habitat is incorporated into all three alternatives.

Storm surge channels that cut through foredune ridges move invertebrates from nearshore environments to the beach face and back-barrier environments. Horseshoe crabs will use natural beaches and overwash deltas as spawning sites. Blue crabs will use restored salt marsh as a nursery area. Restoration of salt marsh in impounded wetlands will benefit invertebrate species that favor salt marsh (Gratton and Denno 2005), though the shift in invertebrate species composition may lag behind the shift in vegetation communities by a decade or more (Craft et al. 1999).

Comment: The authors of one letter were concerned about the selection of focal species for the refuge. They write, "The selection of species is only applicable for Alternatives B and C. It must be clear that Alternative A does not provide a stable environmental for these species because water levels cannot be controlled. Also, Alternative A is not fairly evaluated as being unacceptable because many species that were in the Impoundments are no longer present and only stand a chance of being reintroduced under Alternatives B and C." They then continue to say, "The selection of focal bird, fish, and insect species as indicators of ecosystem function is misleading. These were not these species in the Impoundments prior to the flooding. The baseline for analyses has to… reflect the species that were present prior to the breaches..."

Response: We developed the focal, indicator, and representative umbrella species based on wildlife surveys conducted in 2004 and 2005. All of these species were found on the refuge prior to flooding. These representative umbrella and indicator species were selected based on their ability to serve as monitoring targets to evaluate management actions directed at the habitats listed. The actual acreage and location of each habitat type will vary among the alternatives. In that manner, they do serve as the basis for evaluating all of the alternatives, including alternative A. We specifically discuss the impacts to many of these species and habitats in chapter 5 of the draft CCP/EA under the section on impacts that would not vary by alternative, as well as throughout the sections on impacts for each individual alternative.

Comment: The authors of one letter writes, "In late June of 2012 there was a major fish kill along the south side of the Prime Hook Road. This is an example of why Alternative A is bad for the environment as well as wildlife. Alternative A, as things are now, does not provide a stable saltwater environment, nor does Alternative B. This alternative traps fish and horseshoe crabs. It is obvious that there cannot be open access to the Bay. A hybrid Alternative to B needs to be developed that has a stable saltwater marsh that is not an extension of the Bay so that these negative impacts on wildlife do not occur… Once inside the Refuge they continue to be carried by wind driven currents with little to no chance of returning to the bay and surviving. Recent fish kills observed at the Prime Hook Road culverts bear this out."

Response: The June 2012 event was not an isolated incident and similar fish kills are a common phenomenon along the Atlantic seaboard as inland bays experience poor water circulation, warm temperatures, and nutrient overloads that can be a deadly combination for marine life during the summer months. Alternative B includes active restoration (e.g., improving wetland elevation and increasing historic flow and hydrology within refuge impounded wetlands) to ameliorate damage and facilitate the healthy succession to a brackish/salt marsh. A functioning salt marsh results from the interactions of salt marsh plants species diversity that flourish in response to specific patterns of tidal flooding. The ability of these systems to thrive is dependent upon the salt marsh's link to the bay. We also look to our neighbors and partners to reduce their levels of phosphorous and nitrogen use and run-off as the algeal bloom was exacerbated by excessive nutrient levels. Many states with vulnerable estuaries along the Atlantic seaboard are beginning to address nutrient run-off issues.

Comment: One individual stated that pages 5-90 through 5-l03 of the draft CCP/EIS do not consider terrestrial and freshwater invertebrates.

Response: Please refer to the "Impacts to Invertebrates" section on pages 5-104 to 5-133 in chapter 5 of the draft CCP/EIS.

Migratory Birds
(Letter ID#: 24, 37, 81, 93, 98, 100, 104)

Comment: One individual was concerned that refuge staff took down wood duck boxes. He writes, "[People] are not seeing the same number of wood ducks in the [refuge's] fields and ponds. [Why weren't local groups (e.g.4-H or young waterfowlers)] given the opportunity to maintain these boxes? Please restore Prime Hook to a prime wintering waterfowl location on the East Coast. Your decision will affect all migratory birds."

Response: During the last century, intensive management for wood ducks included establishing nest box programs in areas where there were a scarcity of natural cavities (e.g., deforestation of wetland areas). Starting in the 1970s, wood duck production was one of the management objectives at Prime Hook NWR. To help achieve this objective, the refuge started a wood duck nest box program in the 1980s and by the 1990s we managed over 500 nest boxes on the refuge. Nevertheless, by the late 1990s, we decided to change our emphasis from waterfowl production to maintaining and enhancing waterfowl migrating and wintering habitat. We made this change for two reasons:

- We feel that providing migrating and wintering habitat for waterfowl is the greatest contribution that the refuge could make for waterfowl resources in the Atlantic Flyway.

- Wood duck populations were no longer declining in the Atlantic Flyway (harvest numbers rank wood ducks as the third most harvested waterfowl species in Delaware and the second most abundant waterfowl species harvested in the Atlantic Flyway).

Because of this shift in management focus, we decided to discontinue the wood duck box program on the refuge and re-dedicate refuge funds and staffing to support higher priority management objectives.

Comment: The State of Delaware writes, "Although Service lands represent a small fraction of potential agricultural land in the state, these lands do represent strategically valuable wintering areas for migratory Canada Geese. It wasn't until agricultural producers on Delmarva established large scale farming of corn and soybeans did Canada geese change their wintering patterns and start short stopping the Carolinas in preference for Delmarva, thereby becoming the common winter occurrence in Delaware they are today. Now a similar phenomenon appears to be occurring north of Delaware but we not on the receiving end this time. Pennsylvania and New York are growing more corn and thus appear to be short stopping the geese from coming to Delmarva."

Response: Historically, migrant Canada geese wintered in all southern Atlantic Flyway states. In Georgia and Florida, major declines occurred between 1953 and 1960. Today, no Atlantic Population (AP) Canada geese are known to exist in these states. Midwinter survey estimates of Canada geese in South Carolina declined from 44,000 to 1,500 between 1964 and 2002. Today only a few remnant flocks winter in the state. Large numbers of Canada geese wintered in eastern North Carolina and Back Bay, Virginia. Migrant Canada geese wintering in these areas have declined greatly since the early 1960s (Management Plan for the Atlantic Population of Canada Geese, 2008).

Several factors contribute to the decline of AP geese in the southern Atlantic Flyway, including lower survival from increased exposure to harvest in more northern states and provinces; and distributional shifts caused by changes in agriculture, climate, and other factors often collectively referred to as "short-stopping." Goose managers have no ability to affect climate change or landscape-level agricultural practices. Since under these circumstances, "short-stopped" geese will not pass through Delmarva to reach wintering habitats, it is unlikely that maintenance of existing or increasing row-cropped acreage in the south will have any effect on the wintering distribution of birds to the north. Currently, the primary means to promote the long-term viability of the southern migrating group of geese is to modify the opening days of the goose hunting season (AMPFTAPOCG 2008). Presumably, this same strategy would be employed should the same phenomenon affect wintering AP Canada geese in the Chesapeake Bay.

The Service is faced with many competing interests. The Service's BIDEH policy encourages managing refuges as native, self-sustaining habitats to support a diversity of migratory birds. We can no longer afford to manage for only one guild (waterfowl). Service laws and policies now extend beyond waterfowl, alone. Delmarva refuges are dominated by emergent and impounded wetlands, habitats favorable to Canada Geese. Delmarva has ~1.4 million acres (2007) of row-crops (also favorable to Canada Geese), representing a relatively sterile, severely fragmented, landscape once dominated by forest. Much of the "forest" remaining on the shore is represented by relatively barren (biologically) loblolly pine farms. On Prime Hook NWR, we are proposing to eliminate cooperative farming on the refuge and restore these areas to native habitats, including forests. Habitats crucial to the other guilds, particularly those that are area sensitive, are likely to continue degrading to a greater degree than those habitats sought out by Canada geese.

Similarly, the final EIS on light goose management advocates changing refuge habitat management practices to reduce food availability and make habitats less attractive to light geese, such as snow geese. Again, we are proposing to restore croplands to native habitat. While such programs were not initiated specifically in response to the light goose issue, they will have the added effect of reducing food available to light geese, and perhaps, unfortunately from the State perspective, AP Canada geese as well. However, wetlands and agricultural crops are not currently limiting across Delmarva. Row-cropped acreage may wane over the long-term, but because of the primary economic importance of farming, and the secondary

economic/aesthetic value of Canada Geese, farming will continue in some measure. We also recognize the very real possibility for the long-term decline of AP Canada Geese wintering on Delmarva. Management will require proactive research and harvest management strategies to stem the potential loss. The refuge is prepared to participate with the Flyway in such programs if and when warranted.

Comment: One individual asks, "When was the last time anyone saw a pheasant [on the refuge]?"

Response: In the fall of 2011, mowing crews saw a pheasant on the Island Farm Tract. Pheasants are considered an exotic species and are not a management priority.

Comment: Several commenters felt the draft CCP/EIS was wrong in stating that there are ground-nesting opportunities for bird species, such as least terns and American oystercatchers, under alternatives B and C. For example, the authors of one letter write, "There cannot be any ground nesting birds in the overwash areas in an unstable environment that varies so much in water levels as the tides change, storms occur or winds blow heavily."

Response: We respectfully disagree, and find that there is scientific support for our assertion that there are increased opportunities for beach-nesting American oystercatchers, least and common terns, and piping plovers in overwash and other ephemeral barrier island habitats. These birds have evolved their life-cycle breeding strategies to use these highly dynamic areas. Federal recovery plans for the piping plover explicitly state that the net loss of breeding shorebird habitat may occur if inlet and shoreline migration is forestalled, because recently overwashed areas often constitute prime piping plover, American oystercatcher, least and common tern nesting sites (USFWS 1996). Numerous conservation plans for beach-nesting birds encourage the conservation and protection of natural processes of overwash and inlet formation that perpetuate the preferred habitat of these birds (USFWS 1996, DNREC 2005b, Steinkamp 2008, Conservation Action Plan for American Oystercatcher, Brown et al. 2001). These plans provided the foundation for our conservation goals and objectives for beach-nesting and migrating shorebirds.

Comment: The Delaware Audubon Society feels that clapper rails and black ducks will be adversely impacted if alternative B is adopted. They also feel that American black ducks are focal species for the refuge, and therefore should not be hunted on the refuge.

Response: We respectfully disagree.

As for clapper rails, alternative B includes the use of Conservation Order to hunt and control snow geese in salt marsh habitats. Clapper rails prefer nesting in habitat of salt marsh smooth cordgrass *(Spartina alterniflora)* and tend to concentrate along tidal creeks. Nests are usually in dense cover near water. Tall form cordgrass along ditches and ditched ponds provide the best breeding habitats. Early nesting from Virginia to New Jersey goes from April 1 to June 1 for first broods with later nests (second broods) from July 1 to 20. Only the Atlantic population from New England south to the mid-coast of North Carolina makes a traditional migration. Spring migrants move in March and April but their precise schedule and routes have not been determined. Nesting usually begins the first to second week of April to the end of June on the refuge. Fall migrants begin to depart in late summer and continue to move well into November. Clapper rails breeding further north migrate earlier. Snow goose Conservation Order hunting would occur from the end of January to mid-April in refuge salt marsh habitats proposed in alternative B. This hunting would be winding down just as clapper rail territories are starting to become established, and would not likely pose significant disturbance to clapper rail breeding cycles. Snow goose hunting in salt marsh habitats would also not interfere with clapper rail migrating cycles. The intent of the snow goose conservation order is to reduce snow goose populations, which can negatively affect clapper rail habitat. Secondly, alternative B proposes to restore up to 4,000 acres of former freshwater impoundments to salt marsh. These restoration efforts would have substantial benefits for local clapper rail populations.

As for black ducks, they were selected as a" focal" or indicator species by the refuge because they are included on several Federal and State lists of species of conservation concern, but more importantly for their close association with native salt marsh. Our assumption is that targeting habitat management actions to a few focal species will benefit hundreds of other fish, wildlife and native plant species. The Service's Migratory Bird Program has generated its own list of Birds of Management Concern and "Focal" Species. The Birds of Management Concern is a list of species, subspecies, populations or geographic segments of populations that warrant management or conservation attention. Birds of Management Concern are drawn from the list of species afforded protection under the Migratory Bird Treaty Act (50 CFR Part 10) and therefore fall under Federal jurisdiction. To be of management concern, a bird must be a high priority game bird, on the Birds of Conservation Concern 2008 list, a Federal threatened or endangered species listed in the United States or overly abundant leading to management conflicts. Within the Migratory Bird Program's list of "focal" species, not to be confused with the Prime Hook NWR-specific list generated by the refuge for this CCP, are some species of game birds, including the American black duck. The Migratory Bird Treaty Act, grants the Secretary of the Interior the authority to establish hunting seasons for any of the migratory game bird species. For waterfowl management specifically, the United States and Canada are divided into four flyways; the Atlantic, Mississippi, Central, and Pacific. In the United States, the Flyway Councils, consisting of representatives from state and provincial game-management agencies, recommend regulations to the Service for waterfowl and for most migratory, shore, and upland game birds. The Councils are advised by flyway technical committees consisting of state and provincial biologists. These technical committees evaluate species and population status, harvest, and hunter-participation data during the development of the Council recommendations.

The Service's Office of Migratory Bird Management, with advice from biologists in the Service's Regional Offices, evaluates the Council recommendations, considering species status and biology, cumulative effects of regulations, and existing regulatory policy, and makes recommendations to the Service's Regulations Committee to set hunting seasons for migratory birds that ensure healthy game populations in years to come and fair distribution of hunting opportunities throughout the migration routes.

The Service Regulations Committee considers both the Council and MBMO recommendations, then forwards its recommendations for annual regulations to the Service Director

Once regulatory proposals are approved, they are published in the *Federal Register* for public comment. After the comment period, final regulations are developed, which are then signed by the Assistant Secretary of the Interior for Fish, Wildlife, and Parks. From this federal framework, individual States may select hunting seasons and bag limits. Once the States have adopted their respective seasons and bag limits, individual refuges may choose to adopt State regulations in-whole, or the refuge may choose additional refuge specific regulations.

In an effort to reduce undesirable impacts on refuge resources and management programs, PHNWR has adopted more restrictive regulations than those adopted by either the Service's MBMO or the State of Delaware. These regulations include area closures (sanctuaries), hunting 4 of 7 days/week instead of 6 of 7, and ending the hunt day at 3:00 PM instead of sunset.

The commenter has taken issue with the Service's intention to hunt a "focal" species. As indicated above, black ducks and black duck hunting are managed on a state, flyway and continental scale. The process of setting hunting regulations is a deliberative one, based on substantial data. Regulations are set with the full knowledge and desire that a proportion of the population will be removed by hunters, whether on or off of NWRs. Within the northeastern US and eastern Canada particularly, the black duck is considered a valuable recreational and economic resource. The apparent 50% decline in black duck numbers over the last half of the last century, has raised concern for the long-term sustainability of a currently viable, albeit reduced, population. Thus, the American Black Duck has received the designation of "focal" species by the Service's Migratory Bird Program for some reasons other than those presented by PHNWR .

Under both the Administration Act, as amended, and 43 CFR 24, the Director as the Secretary of the Interior's designee will ensure that Refuge System regulations permitting hunting and fishing are, to the extent practicable, consistent with State laws, regulations, and management plans (605 FW 2). The Service and the State of Delaware consider the black duck population capable of sustaining harvest; so PHNWR will comply with State seasons and bag limits.

Finally, the potential restoration of 4,000 acres of former freshwater impoundments to saltmarsh (a preferred habitat for black ducks) would have beneficial impacts to local black duck populations.

Comment: Several commenters feel that there is a major fault in the basis for the draft CCP/EIS Alternatives because for bird population data in Impoundments II and III (e.g. Current Alternative A) an analysis of types and quantities present needs to be part of evaluation of Alternatives B and C.

Response: The only data we summarized in the draft CCP/EIS were from past surveys, meant to describe the historic and recent status of bird populations on the refuge. In chapter 3 of the final CCP/EIS, we updated this bird survey data to be as current as possible. The Statewide data comes from DNREC, and we rely on them for its timely availability. However, it is impossible to predict the specific response of bird populations, including the specific species and quantities present, for alternatives B and C, since those scenarios are hypothetical. We instead evaluate the expected impact of each alternative to bird populations based on scientific literature and an understanding of the life history of the species and species guilds. We have done this thoroughly within chapter 5 on the following sections: "Impacts to Waterfowl," "Impacts to Shorebirds," "Impacts to Landbirds," and "Impacts to Secretive Marsh and Waterbirds".

Comment: The Delmarva Ornithological Society encourages the Service to include specific conservation measures for the declining northern bobwhite. They suggest studying bobwhite habitat use, drafting a bobwhite management plan, and managing former croplands for the bobwhite. They also support reducing red fox population on the refuge "to more closely match historic population levels and to benefit ground-nesting birds and upland game birds, especially Northern bobwhite."

Response: We agree there is a growing concern for declining northern bobwhite populations. Under our preferred alternative, Goal 4 deals with early successional habitats such as grassland and shrub-scrub which would be benefit the local bobwhite population.

Comment: One individual pointed out that the refuge's purpose is "for use as an inviolate sanctuary, or any other management purpose, for migratory birds. However, he writes, "alternative B does not propose management practices with a stated goal towards creating habitat that is more attractive or suitable to migratory birds than the previously freshwater impoundments were."

Response: We acknowledge that the restoration of the impoundments to a saltmarsh may result in a loss of diversity at the local scale, but the restoration provides biological integrity and diversity at the landscape level. Managing habitat in the most sustainable and resilient manner is ultimately the best for migratory birds. A wetland that is vulnerable to repeated degradation doesn't serve wildlife well in the long run.

Threatened, Endangered, and Candidate Species
(Letter ID#: 28, 69, 81, 108–Form Letter)

Comment: One individual commented on federally threatened piping plovers. He writes, "Piping plover and other beach nesters will never nest as long as you permit continuous public access that especially reaches into April and May, a critical time when non-hunted migratory birds species need zero disturbance to set up critical nesting territories. The State law permitting public access from mean high water to the bay does not apply to Federal land. Besides, the Endangered Species Act takes precedence." The signatories of the form letter agree that the protection of endangered or rare beach nesting birds is important and suggest that they be protected as described under alternative C.

Response: Under objective 1.1 of alternative B, we propose to seasonally close the beaches to public access. However, we do not own the entire beachfront and some of the overwash areas. The Service does not have the authority to regulate private property but we agree that we have the authority to close intertidal areas extending out from our property if public access would harm wildlife. Although piping plovers occasionally visit the refuge, no nesting has occurred, thus limiting the role of the Endangered Species Act. Should they locate on private property adjacent to federal lands, we will work with our neighbors to help them understand and implement adequate beach management measures to help them avoid an inadvertent violation of the ESA.

Comment: The Delaware Chapter of the Sierra Club, one individual, and the form letter commented on the federally endangered Delmarva fox squirrel.

- The Sierra Club supported the proposed habitat management for Delmarva fox squirrels under alternative B, saying that "Promoting a diversity of native forest types within the refuge would provide valuable habitat for endangered and other species.

- The individual felt the Service did not adequately address the impacts of proposed hunting and fishing expansions on Delmarva fox squirrel, stating, "You need to more adequately discuss the impact of 8 plus months of continual hunting on their life cycle. You have increased the acreage of squirrel habitat opened to hunting and increased the number of days of hunting and scouting. The impact [of hunting and primitive fishing] cannot be insignificant."

- The signatories of form letter felt that there was too much emphasis on Delmarva fox squirrel in the draft CCP/EIS: "Why is there an emphasis to increase forest habitat for the endangered Delmarva fox squirrel. [It] is in the process of being declassified. That means it is not an endangered species anymore."

- One individual writes, "Current [Delmarva fox squirrel] program is surviving, not thriving. I question if the additional recommended program will have any significant short-term effect on the population."

Response:

- We thank Sierra Club for their support for the Service-preferred alternative.

- We conducted an Intra-Service Section 7 consultation with the Service's Ecological Service program, as required by the Endangered Species Act (Appendix G). According their recovery plan, Delmarva fox squirrels are not disturbed by human activities any more than gray squirrels, provided their habitat is satisfactory. The Service's preferred alternative proposes to improve Delmarva fox squirrel habitat. The refuge is closed to squirrel hunting. A portion of the refuge's squirrel habitat is currently open hunting with no known adverse impacts. The expanded forms of hunting will have negligible impacts to the Delmarva fox squirrels on the refuge.

- While it is true, the Service is considering the down-listing or delisting of the Delmarva fox squirrel, as of this writing of this CCP the Delmarva fox squirrel is still listed as endangered. Managing our forests for Delmarva fox squirrel also provides valuable mature forest habitat for migratory birds, a habitat type which has declined throughout Delaware. Furthermore, managing the forests for Delmarva fox and migratory birds supports the establishing purposes of the refuge.

- The small population on the refuge appears to be stable, although closely monitoring a small population is difficult. The commenter is correct in that many of the proposed strategies are long-term in nature (reforestation) and the benefits will not be known for years to come.

Nuisance Wildlife- General
(Letter ID#: 22, 64, 65, 67, 80–Petition)

Comment: One commenter felt our description of integrated pest management on page B-123 of the Draft Habitat Management Plan was deceptive. She requests that the Service change the phrase "wildlife management" to "wildlife killing" throughout the CCP and to stop "sneakily try[ing] to deceive…the Delaware public."

> **Response**: Comment noted.
>
> **Comment**: One individual was concerned with the impacts of predators on nesting shorebirds. He writes, "For the past few years, the overwash areas at the end of Fowler Beach Road hosted a large colony of Least Terns and a Pair of American Oystercatchers, all attempting to breed. To my knowledge, they were not successful because of predators. Although the bird's presence was well-known, no effort was made to install predator exclusion fencing. So if this is being changed to include active predator control, I strongly support that approach."
>
> **Response**: Under alternative B, the refuge proposes to implement a limited predator control program. Red fox, raccoon, gull, crow, rice rat, feral cat, and other species have been documented as effective predators upon nesting shorebirds, eggs, and chicks. Some shorebirds, such as the federally threatened piping plover and colonial beach nesting bird populations, are especially vulnerable to loss of suitable nesting habitat due to high sensitivity to human disturbance. Given the plight of migratory birds, especially those requiring the limited beach or island nesting habitats, the refuge may utilize a predator management program to benefit these species.

Comment: One commenter noted on Pg B-123 "An IPM approach to all Refuge Management Activities to eradicate, control, or contain pest and invasive species." If you have invasive insect species, pesticides may have to be used as a first resort, not a last. Pesticides are part of the IPM toolbox..."

> **Response**: We agree that pesticides are a "tool" in the integrated pest management "toolbox" and that pesticides are sometimes the most appropriate technique for treating a particular invasive species or infestation. We will evaluate each incident of invasive species colonization or expansion on a case-by-case basis to determine what the best treatment for that area is. Under Service policy (30 AM 12), the ultimate goal is to eliminate pesticide use on Service lands and facilities, where possible. Therefore, we will try to treat species without pesticides when appropriate and feasible. However, in some cases we will use pesticides.
>
> Unfortunately in the case of mosquito control, DCMS and the Service must face the irreconcilable fact that the State mandate to "eradicate mosquitoes" is in direct conflict with numerous legislative acts and Service policies the refuge must follow. Mosquitoes are a natural component of the coastal plain. As such, they are an integral part of the ecosystem the Service is obligated to manage. Current policy does not make distinctions between one native species and another (See also comments and responses below under, "Nuisance Wildlife- Mosquito Control."

Nuisance Wildlife- Snow Geese, Resident Canada Geese, and Mute Swans
(Letter ID#: 55, 65, 67, 80–Petition, 81, 93, 106, 108–Form letter)

Comment: The Delmarva Ornithological Society, one individual, and the form letter commented on overabundant and nonnative waterfowl. The Delmarva Ornithological Society supports reducing overabundant snow geese and resident Canada goose populations to help conserve salt marsh habitat, but urges the Service to monitor impacts from the Conservation Order on other waterfowl species, particularly American black duck. If there are any adverse impacts to waterfowl, they ask that we modify how we control these species.

Response: Thank you for your support. We agree an adaptive management strategy is required if monitoring indicates negative impacts are occurring in the salt marshes.

Comment: One letter states, "Alternative B would seem to favor more snow goose habitat, plus result in greater destruction of farmer's fields. It appears that more and more snow geese will be attracted to open water, allowing for more damage to developing marshes."

Response: We respectfully disagree that alternative B would favor more snow goose habitat. We believe that our proposal will eliminate the artificial food supply for snow geese by reverting agricultural areas to native vegetation. The final EIS for Light Goose Management in North America (June 2007) suggests that changes to refuge management can contribute to the return of snow goose population numbers to levels that are more compatible with the ability of natural habitats to support them. These changes include a reduction in the acreage of agricultural habitats in favor of more natural habitats such as native forest. This impact will also benefit a variety of other wildlife species that rely on these native habitats. The Conservation Order to reduce snow goose numbers suggests changes in hunting programs (e.g., electronic calls, unplugged shotguns, and more liberal bag limits) to allow hunters to harvest snow geese outside of the traditional migratory bird hunting season. The Conservation Order also offers increased harvest pressure opportunities to prevent and mitigate the destruction of any farmer fields that experience increased snow goose use. If more snow geese should be attracted to open water areas on the refuge, then increased hunting pressure on snow geese within the framework of new Conservation Order dates (February through mid-April) will mitigate damage caused by excessive snow goose herbivory to any developing marshes and wetland vegetation and protect salt marsh vegetation from excessive snow goose damage.

Unfortunately, it is impossible to provide quality habitat for waterfowl, waterbirds, secretive marsh birds and shorebirds while completely excluding snow geese. The snow goose Conservation Order is designed to reduce the size of the snow goose population and its impact on all available habitats, including salt marshes, agricultural crops and the fragile tundra breeding grounds.

Snow geese are quite mobile. Birds using Delaware's NWRs routinely move inland to feed. The historic refuge contribution of 400-600 acres of agricultural lands is dwarfed by approximately the 1.4 million acres available on the Delmarva Peninsula from which to feed. Planting crops in an attempt to hold snow geese on refuge will only eliminate these limited refuge acres for use by other trust resource species.

Comment: One individual writes, "The vision of the conservation order [allowing snow geese hunting on the refuge] was to protect crops. By opening the refuge [to snow geese hunting], particularly the marshes, will have the reverse effect – geese will no longer feed/rest on-refuge. They will fly off to impact on adjacent farmland, causing considerable damage to private farms around refuge."

Response: We respectfully disagree. The Conservation Order's intent is to reduce and stabilize the size of several overabundant populations of light geese that damage habitats on their breeding, migration, and/or wintering grounds. The Conservation Order allows for adaptive management in its habitat and hunting programs. Actions may include altering impoundment water levels, eliminate roosting sites, and moving birds to where hunting does occur. Any uses included with changes in management practices are only permitted after they have been determined to be compatible with the purposes of the refuge. We have found hunting the Conservation Order compatible for Prime Hook NWR (appendix E).

Comment: One individual feels that snow geese are contributing to the decline of marsh vegetation. He also feels that the dune breaches are exacerbating these issues.

Response: We agree as both issues can have negative consequences to the saltmarsh. The impacts are outlined in chapter 5.

Nuisance Wildlife- Mosquito Control
(Letter ID#: 7, 19, 24, 28, 46, 49, 64, 66, 67, 68, 69, 80–Petition, 81, 82, 96, 98, 104, 106, S15)

Comment: The Delaware Chapter of the Sierra Club and several individuals support the proposed changes to the refuge's mosquito control program under alterative B, specifically eliminating adulticides, in order to minimize impacts from pesticides to non-target species. One individual suggested "limiting the use of non-specific methoprene for larval control in favor of [the more specific *Bti*]." The Sierra Club encouraged discontinuing the use of all pesticides for mosquito control, and instead using natural management measures, such as "restoration of native habitats that [support] mosquitoes' natural predators." The remaining two individuals requested that we only spray during declared health emergencies. One commenter also wanted the refuge to discontinue the use of open marsh water management for mosquitoes because it can degrade habitats.

> **Response**: Thank you for your support.

Comment: We received 14 letters with comments against the proposed changes to mosquito control under alternative B. Four comments were generally opposed to changes in mosquito control, while others were concerned about public health and safety and potential impacts to surrounding communities. The town of Slaughter Beach suggested trying natural mosquito control methods, "such as selective ponding and ditching techniques," but that if these methods did not work, then they felt that Service must use pesticides. The authors of one letter felt that the mosquito control measures proposed under alternative B contradicted Executive Order 13352, which "specifically directs the Department of the Interior to take positive measures to protect the safety, health, and welfare of the communities it serves." They also stated that the State of Delaware pays for the mosquito control and "cares about the health and safety of surrounding communities" and the Service should continue its existing mosquito control program in coordination with State agencies.

> **Response**: The community's interpretation of the EO is incorrect. Cooperative conservation, as defined in Executive Order 13352, covers actions that "relate to use, enhancement, and enjoyment of natural resources, protection of the environment, or both, and that involve collaborative activity among federal, state, local, and tribal governments, private for-profit and nonprofit institutions, other nongovernmental entities and individuals." This EO may be interpreted as one of several "tools" or authorities that managers may employ as they use the full scope of the National Wildlife Refuge System authorities to protect refuge resources and values, while encouraging others to use theirs toward the same purpose. Nuisance oriented mosquito control, as directed by DMCS, is not a conservation activity designed to advance the laws and policies governing the management or purposes of the NWRS, hence EO (13352) does not apply.

Comment: DNREC-Mosquito Control Section and a group of local residents felt it was imprudent to require the declaration of a human health emergency prior to permitting the use of adulticides. Such an approach would be reactive not proactive.

> **Response**: The Service agrees. The Service's sole purpose in permitting the use of adulticides is to reduce a documented human disease threat. In other states where mosquito-borne diseases are more prevalent, disease is generally detected in mosquito pools, or birds up to several weeks in advance of human cases. However, the incidence of disease in mosquitoes or wildlife is far from a guarantee of mosquito-human disease transmission. This fact may be why many jurisdictions outside Delaware, including some national wildlife refuges, currently require the declaration of a public health emergency prior to conducting adulticide treatments.

We now believe that a public health emergency is too general a term for initiating adult mosquito control. Instead, initiating adult mosquito control will be triggered by documented mosquito-borne disease activity near the refuge. Appropriate documentation of a high risk to public health and safety would include adult mosquito monitoring data from the Refuge, or areas near the refuge that show an increase in the rate of disease-infected mosquitoes. Disease surveillance means pathogen presence in mosquito pool(s), wild birds, sentinel chicken flock(s), horses, or humans has been documented with its flight range of vector mosquito species present on the refuge. These conditions in combination with adult mosquito populations above established thresholds would trigger consideration of a more aggressive treatment strategy, including the use of adulticides. A threat is to be defined as detection of a mosquito-borne virus using any virus surveillance method of DMCS' choosing.

Comment: A group of local citizens wondered what agency was responsible for declaring a public health emergency and what criteria they use to determine if there is an emergency.

Response: Public health agencies make public health determinations. Within Delaware, contact Delaware Health and Social Services, Division of Public Health, for more information

Comment: DNREC – Mosquito Control Section is concerned that proposed restrictions on adulticide use on the refuge under alternative B of the draft CCP/EIS will make it more difficult and/or expensive for them to eradicate mosquitoes off the refuge.

Response: Unfortunately, DNREC-Mosquito Control Section and the Service must face the irreconcilable fact that the state mandate to "eradicate mosquitoes" and the numerous refuge-specific legislative acts and policies under which the Service must adhere are in direct conflict with each other. Mosquitoes are a natural component of the coastal plain. As such, they are an integral part of the ecosystem for which the Service is obligated to manage. Current policy does not make distinctions between one native species and another. Policy does dictate that our management advances the mission of the NWRS and the purpose for which the refuge was founded.

In Service policy (30 AM 12), the ultimate goal is to eliminate pesticide use on Service lands and facilities, where possible. While management costs are important, they are not the primary deciding factor in selecting a management approach. At times, it may be appropriate to select a more expensive management approach if that method is effective and reduces risks to humans and other non-target resources (517 DM). The basis for choice of pest reduction methods will be, in order of priority, 1) human safety and environmental integrity, 2) effectiveness, and 3) cost (30 AM 12). The CDC states, "effective larval control of the principal enzootic mosquito vector is probably a more cost-effective way to interrupt early-season virus amplification. We cannot manage federal wildlife refuges to eliminate nuisance native species, no matter how much we recognize that they are frustrating to people. We can take actions to reduce their numbers once there is a documented public health risk, as described in earlier responses and in the CCP.

Comment: DNREC-Mosquito Control Section indicates that they have fulfilled their duties adequately using the present protocols for adulticide treatments on the refuge with little change over the past 20 years. They wonder why change the refuge is now proposing to change these protocols.

Response: Prior to permitting mosquito surveillance and control, the Service must meet its obligations under the National Environmental Policy Act and complete a full environmental analysis. The Draft CCP/EIS and mosquito control compatibility determination represent our endeavor to analyze the impacts of mosquito control. Upon analysis, we find the use of the relatively target-specific larvicides permissible, but using adulticides for nuisance relief will materially interfere with and detract from the mission of the National Wildlife Refuge System and the purpose for which the refuge was established.

We recognize that nuisance mosquito species are an ongoing management concern of the State. We believe that the actions outlined in the CCP and the future development of a mosquito management plan will continue to be effective in preventing disease outbreaks and will also provide some ancillary benefits in controlling nuisance mosquitoes. However, we cannot allow the application of adulticides simply to control nuisance mosquitoes. As outlined in the CCP, we can only allow the application of adulticides when there is a high risk for mosquito-borne disease within the communities surrounding the refuge.

Comment: DMCS wishes to point out that simply because the other refuges on Delmarva (excluding Bombay Hook) do not permit mosquito control does not mean that it is not warranted.

Response: By DMCS standards whereby nuisance mosquitoes are to be eradicated, DMCS' assertion would likely be correct. But even the State of Maryland's policy on mosquito control would conflict with that of the State of Delaware where use of adulticides for nuisance control is concerned. Maryland policy states:

"Nuisance mosquito control will be provided only in residential areas (cities, towns, communities, individual residences) that specifically request mosquito control service and that cost-share to fund conduct of the program.

If any mosquito-borne disease becomes a real or imminent public health threat, adult mosquito control will be a priority issue. Under such conditions, spray exclusion zones will not be recognized and the action thresholds may be lowered. The Department will exercise all means possible to reduce the adult mosquito population to the lowest level possible within the area where disease transmission to humans is a concern."

The Service wishes to clarify that the other Delmarva refuges permit no form of mosquito control at all, including larvicides. Despite this fact, as far as the Service knows no real or imminent public health threat has been detected in the immediate vicinity of NWRs on Delmarva, with the exception of Chincoteague NWR in 1989. Please see next response for details.

Comment: DMCS indicates other mosquito control agencies wish to control mosquitoes on other refuges where it is not currently permitted.

Response: The Service wishes to point out that when, or if, a legitimate disease issue arises on those refuges, the mechanism exists within Service policy to permit mosquito control, if only on a case-by-case or temporary basis. DMCS indirectly indicated such regarding a 1989 outbreak of EEE in horses on Assateague Island National Seashore, where the National Park Service does not permit mosquito control. DMCS was apparently not aware that because of the unusual wet weather, the large number of mosquitoes, and the human health threat over the Labor Day weekend, the decision was made to spray on Chincoteague NWR as well. After consultation with the Center for Disease Control and regional office staff who obtained permission from the Chief of the Office of Environmental Protection Review, Department of the Interior, an aerial application of Dibrom, an adulticide, was applied to 5,700 acres of the refuge.

Comment: DMCS wishes to point out that other refuges do permit mosquito control even if most of the Delmarva refuges do not. A 2008 survey conducted by the American Mosquito Control Association found mosquito control was performed on 42 refuges around the country.

Response: Correct, approximately 40 of the 584 National Wildlife Refuges and Wetland Management Districts are currently permitted to use mosquitocides. However, approximately, 1 percent of the 584 are permitted to conduct mosquito control prior to the detection of mosquito-borne disease, otherwise they are relegated to using larvicides; most of the 40 are permitted for larvicides only. Big Branch Marsh NWR (BBMNWR) was specifically mentioned by DMCS as a refuge that applies adulticides over several thousand acres each year. This is true, however the application of adulticide on BBMNWR is contingent upon the detection of mosquito-borne disease prior to conducting treatment. Unfortunately, for areas around New Orleans, including Big Branch Marsh NWR, the climate and extended growing season will foster some disease amplification during some period nearly every year.

Comment: DCMS feels the Service relies too heavily on the Draft Mosquito Control Policy when placing restrictions on nuisance control of mosquitoes. Further DCMS feels it inappropriate to give any existing Service law or policy greater consideration than an as yet unfinalized mosquito policy. Another individual asked if the Service had finalized a national mosquito control policy and suggested that we should follow it once approved.

Response: The most important Federal statute guiding management of the NWRS and units is the National Wildlife Refuge System Administration Act of 1966, as amended (Refuge Administration Act – 16 U.S.C. 668dd-668ee). This law was significantly amended in 1997 with passage of the National Wildlife Refuge System Improvement Act of 1997 (Refuge Improvement Act).

The law makes clear that the NWRS is to be managed first and foremost for wildlife conservation. The Refuge Improvement Act also requires that six wildlife-dependent public uses be given priority consideration in refuge planning and management over all other general public uses. In essence, the law establishes a management hierarchy by declaring that refuges are to be managed first for wildlife, second for the six wildlife-dependent priority public uses identified in the Refuge Improvement Act (when compatible), and last for other general uses requested from the public (which would include mosquito control). Several substantive and procedural requirements associated with compatibility determinations form a major feature of the law. This is because all public uses must first be determined compatible with the purpose(s) of the refuge and the NWRS mission before that are allowed on a refuge. The law also requires monitoring of the status and trends of refuge fish, wildlife, and plants; as well as maintenance of the NWRS' biological integrity, diversity, and environmental health.

National guidance has been developed to implement some of the key provisions of the 1997 amendments to the Refuge Administration Act. This includes the Biological Integrity, Diversity, and Environmental Health policy (601 FW 3). Consistent with the Refuge purpose(s), this policy provides for maintenance of restoration of healthy, functioning biological communities composed of native species and habitat comparable with historic conditions. The policy favors refuge management, which restores or mimics natural ecosystem processes or functions. The policy generally discourages use of chemical pesticides and removal of native species, although the policy acknowledges that these actions may at times be necessary and appropriate. A key to proper implementation of this policy is evaluating how proposed actions would affect achievement of the Refuge purpose(s).

Another significant piece of national guidance developed in response to the Refuge Improvement Act is the compatibility policy (603 FW2). Mosquito control or other mosquito management activities proposed by a mosquito control agency or other non-NWRS party would qualify as a "refuge use" and the compatibility regulations and policy would require that a compatibility determination be made. This determination would be for the purpose of determining whether, based on the Refuge Manager's sound professional judgment, the proposed mosquito management activities would materially interfere with or detract from the refuge purpose(s) or the NWRS mission. This determination would need to be made in writing and would have to allow an opportunity for public comment.

The compatibility policy also states that a use must be determined not compatible if we have insufficient information to determine the use as compatible. In addition, if we have insufficient management resources (e.g., funds, staff, facilities, and equipment) to ensure that a use would occur in a compatible manner, then the use is not compatible. Finally, the Compatibility policy states that a use would not be compatible if the use conflicts with maintenance of refuge biological integrity, diversity, and environmental health (See Biological integrity, Diversity, and Environmental Health Policy).A refuge mosquito management program needs to be carefully planned an implemented to ensure that this last policy requirement is not violated.

The National Environmental Policy Act of 1969, as amended (NEPA – 42 U.S.C. 4321-4347) is another important Federal statute that would be triggered by a proposed refuge mosquito management program. NEPA's are primarily procedural in nature. Among other things, NEPA requires that Federal agencies "Utilize a systematic, interdisciplinary approach… in planning and decision=making…" and "…insure that presently unquantifies environmental amenities and values… [are]… given appropriate consideration in decision-making along with economic and technical considerations…" Prior to making a decision to undertake a proposed action, agencies are to consider a range of reasonable alternatives and the effects of their implementation. We have prepared this environmental impact statement in compliance with NEPA.

Despite the lack of final mosquito control policy, the Service has adequate Legislative Acts and policies guiding our decisions.

Comment: DMCS states, "There is a profound difference here between a risk-based probability assessment and a hazard-based possibility assessment. Risk is far more complex but realistic… Conversely, hazard can readily be found everywhere if one is looking for such … here all substances have the potential to be hazardous … if one were to now take a hazard-based assessment approach … where mere possibilities for harm become paramount …, you could then probably make a case for "just saying no" to almost any targeted pesticide product of your choosing."

Response: There is an apparent contradiction in DMCS' assessment of risk from pesticides and its assessment of risk from mosquitoes. Aside from the fact that State law mandates eradication of mosquitoes for nuisance purposes, DMCS justifies mosquito control, in part, on the historical presence of EEE and WNV in Delaware and the "possibility" of future human infections. Here in the absence of any current indication of disease in the local environment, DMCS allows the "possible" to trump the "probable."

As stated in the draft CD, "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.

Comment: DMCS states, "It should be noted that the USFWS's own policies require that pest management be part of a refuge's operations. The U.S. Department of the Interior's (DOI) Department Manual establishes a Department-wide policy to manage pests in manner that reduces risks from pests and gives full consideration at all times to the safety and protection of humans, including conducting appropriate pest detection and environmental surveillance and monitoring on refuge (571 DM, sec. 1.1 &1.5). Consistent with 517 DM 1, the USFWS's Service Manual (569 FW 1) establishes policy and responsibilities for pest management activities on refuge lands, including the need to eliminate or reduce impacts from invertebrate pests to achieve management goals and objectives (569 WF 1, sec. 1.4 &1.6)."

Response: Mosquitoes are a natural component of the coastal plain. As such, they are an integral part of the ecosystem for which the Service is obligated to manage. Mosquito management is not a refuge management program, but a refuge use requested by DMCS and permitted under annual SUP requirements. Sections of DOI policy as discussed by DMCS regarding the safety and protection to humans relate specifically to the mode, action, or toxicity of pest treatment, not the pest itself. Section 1.5 "… Bureaus will accomplish pest management through cost effective means that pose the least risk to humans, natural and cultural resources and the environment. The Policy goes on to state in Section 1.5 B., it is the department's policy to "Give full consideration at all times to the safety and protection of humans and other non-target organisms and resources." DMCS is required by the Service and the EPA to follow pesticide labels and Pesticide Discharge Permits under the Clean Water Act. Under the Service Manual, Section 569 FW 1, Integrated Pest Management Policy, Establishes policy, procedures, and responsibilities for pest management activities on and off Fish and Wildlife Service (Service) lands. The Service provides (below) the relevant statements within the policy regarding the limitation of adulticide use on refuge:

- Section 1.2 B. – IPM is "a science based, decision-making process that incorporates management goals, consensus building, pest biology, monitoring, environmental factors, and selection of the best available technology to achieve desired outcomes while minimizing effects to non-target species …" In an effort to minimize non-target effects on-refuge, the Service will permit the use of adulticides as a management tool once the DMCS surveillance program has detected mosquito-borne disease threat on the refuge or within the flight range of vector mosquitoes.

- Section 1.4 D. – Our policy is to, "Use IPM methods to eliminate or reduce impacts from vertebrate and invertebrate pests to achieve site-management goals and objectives.

- 1.6 B. – The Service will manage pests when, "the pest is detrimental to site management goals and objectives; AND."

- 1.6 C. – The Service will manage pests when "the planned pest management actions will not interfere with achieving site management goals and objectives."

Sections mentioned above are not mutually exclusive. Mosquitoes are a natural component of the ecosystem and do not interfere with Service goals and objectives for the refuge. Mosquito population management for nuisance purposes does not advance the mission of the Service or purposes for which the refuge was founded. However, the Service will permit the use of adulticides as a management tool once the DMCS surveillance program has detected a mosquito-borne human health threat.

Comment: DMCS implies that there may be an increase in the incidence of vector-borne disease off of the refuge as a result of changes proposed for adulticide treatments on the refuge.

Response: To date the Service has never received any real-time data indicating a mosquito-borne public health threat has existed or presently exists in or around the refuge. EEE and WNV data acquired by the Service covering Sussex County Delaware has come from the Centers for Disease Control (CDC) website. Over the period 2003-2011 there were a total of 2 positive sentinels for EEE, both recorded in 2005. The CDC reports 10 positive sentinels for WNV over the same period, but only one human case of WNV. Specific locations for all positive or negative tests within the county are unknown.

Comment: DMCS states that non-pathogenic health conditions or potential medical complications such as dermal irritations, allergic reactions, and secondary bite/scratch infections should be more relevant when considering the need for adulticide treatments on the refuge.

> **Response**: In rare instances, as little as a single mosquito bite may incite an immune response resulting in anaphylactic shock, as does a bee sting in some individuals. This reaction is truly life threatening; however, no level of mosquito control can guarantee zero bites. The DMCS nuisance threshold is 5 bites per minute for either ground or aerial adulticide treatments. The standard in Maryland is 3 bites per 2 minutes for ground-based treatments, but 12 bites per minute for aerial treatment. 2 landings (slaps) per 2 minutes has been established by the Minneapolis Metropolitan Mosquito Control District. It appears there is no exact threshold that is foolproof.
>
> Native populations of deer flies, green heads, black flies, gnats, and no-see-ums can easily rival mosquito densities and contribute to considerable human discomfort, and potentially medical attention. Nevertheless, DCMS does not mention consideration of ailments derived from these sources of an acute enough nature to justify their control.

Comment: DMCS has indicated that mosquito control may have to be eliminated within the communities outside the eastern border of the refuge because of concern over spray drift.

> **Response**: The DMCS's concern is unfounded. The Draft CCP (chapter 5) and Mosquito CD (Appendix E) currently states; "The refuge has no jurisdiction over mosquito control on lands outside the refuge boundary. The Service recognizes that spray drift will likely enter the refuge from the three neighboring barrier island communities during mosquito control on those lands. Since the State employs best management practices and follows the EPA-approved label directions, the Service expects impacts to refuge resources to be negligible."

Comment: DMCS is concerned about the local economic impact and reduced "quality of life" associated with reducing use of adulticides on refuge.

> **Response**: Mosquito control is a relatively rare practice on the nation's National Wildlife Refuges and Wetland Management Districts (WMDs). Several dozen are permitted to use larvicides, but only approximately 1% of the 584 NWRs and WMDs are currently permitted to allow adulticide treatments prior to documenting a public health threat. A health threat entails some form of local disease documentation in the form of disease incidence (or above average incidence/infection rates) in mosquito pools, sentinels, wild birds, equines or humans.
>
> Prime Hook NWR is not unique in being located close to centers of economic significance, including resorts. Back Bay NWR is located within the city limits of Virginia Beach, VA. Resort patrons enjoy the city and its beaches in part, perhaps, due to an effective mosquito control program that is restricted to areas outside the refuge borders. Chincoteague NWR in Virginia does not permit mosquito control; the town regularly sprays within its own jurisdiction using aerially applied adulticides. Many other refuges permitting larvicides only are located in or near coastal resorts (e.g. Newburyport, MA; Charleston, SC; Sanibel, FL) as well as urban-suburban areas (e.g. Minneapolis, MN; Philadelphia, PA). Based on these facts, it is apparent that mosquito control authorities throughout the country serving high densities of residents and visitors have designed their mosquito control programs to adequately address nuisance complaints, with little apparent negative impact on the local economy. Fire Island National Seashore has established a different mosquito control threshold and strategy than that which is applied to the rest of Long Island.

Comment: Some commenters state; "FWS – in all three of its alternatives – wants to ban eradication of adult mosquitoes."

Response: Under alternative A, current management, adulticides are permitted. Alternatives B and C consider mosquitoes a natural component of the coastal plain. As such, they are an integral part of the ecosystem for which the Service is obligated to manage. DCMS and the Service must face the irreconcilable fact that the state mandate to "eradicate mosquitoes" and the numerous refuge-specific legislative acts and policies under which the Service must adhere are in direct conflict with each other. Thus, the refuge does wish to "ban eradication of adult mosquitoes" ON-refuge for nuisance purposes only.

Comment: The authors of one letter states "FWS is proposing to actively prohibit other agencies, which do care about the health and safety of surrounding communities, from taking action."

Response: The Service does care about the health and safety of its visitors and the surrounding communities. The Service's preferred alternative proposes to restrict the use of adulticides unless surveillance data documents a high risk disease threat on the refuge or within the communities surrounding the refuge. The Service does not prohibit DMCS from mosquito control.

Specifically in response to the community's concerns, the Draft CCP does not advocate the prohibition of mosquito control on the refuge. The Service will continue to permit DMCS to conduct mosquito control through the appropriate use of larvicides and maintenance of existing OMWM sites on the refuge. To facilitate further the reduction of risk to mosquito-borne disease in humans, the Service will modify the draft CCP to indicate a requirement for documentation of a high risk mosquito borne disease on the refuge or within the flight range of the vector species.

Finally, the Service does not have the authority to prohibit other agencies from conducting their respective duties outside the refuge boundary, including the surrounding communities. The Draft CCP (p. 5-111) and Mosquito CD (p. E94) currently states; "The refuge has no jurisdiction over mosquito control on lands outside the refuge boundary. The Service presumes mosquito control will continue in the neighboring communities as prescribed by DMCS.

Comment: "Do not propose the elimination of adulticide use on the refuge (even with an exception for a "declared public health emergency")…"

Response: The Service will remove the requirement for a "declared public health emergency" as a prerequisite before permitting an adulticide treatment. However, mosquito-borne disease activity must be documented on the refuge or with the flight range of vector mosquito species present on the refuge. Disease surveillance determines that there is a high risk for mosquito-borne disease within the vicinity of the refuge. Because the efficacy and effects of adulticides are variable, adulticides should not be applied broadly without site-specific data indicating a need for control. This data can be used to evaluate a number of factors including environmental conditions, dead bird presence, and human cases to determine adulticides should be used considered. We would only consider application in areas where a pathogen is present and/or mosquito populations thresholds have been exceeded on the refuge that can be effectively treated while minimizing non-target effects.

Comment: "Do not consider increasing the DMCS's current spray threshold criteria before mosquitocide use can occur on-refuge…"

Response: Under current conditions spray threshold criteria for larvicides will likely remain the same. However, the Service can foresee the potential for adjusting the criteria for larvicides and/or adulticides under the following circumstances:

- Local human disease outbreak whereby thresholds would likely be lowered.
- Introduction of a new mosquito-borne disease to the Delmarva Peninsula area whereby thresholds may be lowered.

- Introduction and proven effectiveness of a human vaccine for one or more of the mosquito-borne diseases present on Delmarva at that time, whereby thresholds may be raised.

- Climate change alters weather patterns and lengthens the growing season producing conditions for annual detection and amplification of enzootic disease, whereby thresholds may be lowered.

- Delaware is hit by a hurricane that precipitates a potential mosquito-borne health emergency, whereby thresholds may be lowered.

Comment: "Do not try to somehow incorporate measures of arbovirus presence or abundance into the DMCS's spray threshold criteria and decision-making beyond what already exists…"

> **Response**: We recognize that nuisance mosquito species are an ongoing management concern of the State. We believe that the actions outlined in the CCP and the future development of a mosquito management plan will continue to be effective in preventing disease outbreaks and will also provide some ancillary benefits in controlling nuisance mosquitoes. However, we cannot allow the application of adulticides simply to control nuisance mosquitoes. As outlined in the CCP, we can only allow the application of adulticides when there is a documented high risk for mosquito-borne disease within the communities surrounding the refuge.

Comment: DMCS continues, "… attempting such additional incorporation (of arbovirus presence or abundance) will be very impracticable to do (technically or otherwise); will have very little if any meaningful value or utility in the real world; will create undue and unnecessary complications (and logistical nightmares) for how mosquito control is performed on-refuge; and will cause more costs and labors for the State."

> **Response**: Disease surveillance is a standard tool advocated by the CDC, mosquito control and health agencies across the country. It is considered prudent to do so as an advance warning of a potential or increasing risk of human infection. Surveillance is critical to guiding mosquito management action. Given the historic incidence of mosquito-borne disease in Delaware, mosquito monitoring is critical. Monitoring and surveillance data on mosquito abundance and disease prevalence from the refuge and surrounding areas will help inform mosquito management actions needed on the refuge.

Comment: DMCS continues with their comments, "Per the Service's Draft "National Mosquito Management Policy" released in October, 2007, the Service is now seemingly attributing an ability for rank-and-file mosquito control programs across the country to detect the presence of let's say (for Delaware's situation) EEE and WNV arbovirus on some type of gradient or sliding scale in real-time manner, relative to any need to then possibly undertake some mosquito control actions on-refuge that might quickly be warranted. This simply wouldn't be the capability or situation in the real world, short of mosquito control programs then having to spend mega-bucks to try to ramp-up and do such." DMCS continues with discussion of their existing program. "… we operate 24 sentinel chicken stations around the state from July into October to monitor for occurrences of EEE and WNV, with one of these stations near Prime Hook NWR. Each week 2 sentinel chickens per station are tested for presence of EEE or WNV antibodies, with test results reported to us by the Delaware Public Health Lab about one week after chicken blood samples are drawn and submitted to the Lab. We're thus dealing with arbovirus results per any given station per week that indicate the presence or absence of arbovirus in but only 2 samples or specimens, which is not very conducive at all for making such results into any type of gradient or sliding scale regarding arbovirus presence or abundance, while also being about a week past when the samples were taken.

How we really use the arbovirus results from any given sentinel chicken station is to then determine if we need to increase our local larval or adult mosquito population surveillance efforts for vector mosquito species of concern, to then possibly be enhanced within the area represented by a virus-positive sentinel chicken station, since the State doesn't have the resources or ability to intensively and continuously saturate the entire state with mosquito population monitoring efforts for vectors of concern and for the latter, please be aware that for baseline and operational response purposes, the DMCS also operates a network of NJ adult mosquito light traps at 36 permanent locations around the state, with 3 of these NJ adult light trap stations near Prime Hook NWR). Whenever we have a sentinel chicken sero-convert (i.e. be antibody-positive for EEE or WNV), then to the best of our program's capabilities and resources, we'll quickly but temporarily enhance our larval or adult mosquito population monitoring efforts in the local area, via undertaking additional larval surveys, operating portable CDC adult light traps, undertaking additional adult mosquito landing rate counts, and paying even more attention to the numbers and patterns of local public complaints received seeking mosquito relief. Based upon this additional or enhanced local surveillance of mosquito population levels for vector species of concern, we might then locally undertake mosquito control actions as warranted."

Response: Other vector control programs take a different view: For example, the tiered response thresholds in the phased response plan incorporated into the Grays Harbor County, Washington, Mosquito-Borne Disease Response Plan, specifies the following definition for "Alert Level 3", "Moderate Risk of Human Outbreak:

- Spring, summer, or fall.
- Areas with initial confirmation of mosquito-borne virus activity in birds before August.
- Confirmed equine or human infections.
- Sustained mosquito-borne virus activity in birds or mosquitoes in the absence of human infections

Alert Level 3 – Response:

- Continue activities in level 2.
- Consider implementing adult control if the minimum infection rate (MIR) in vector species meets or exceeds 5 per 1000.
- Focus control efforts where surveillance indicates potential for human risk to increase.

The Grays Harbor Plan continues, "In general, the finding of a positive bird or mosquito pool does not by itself constitute evidence of an imminent threat to human health and warrant adulticiding. Adulticiding will be considered only after consideration of the risk to human health by taking into account multiple factors, including: documentation of the present of mosquito-borne viruses in the area; the abundance and species of the mosquito populations; the mosquito minimum infection rate (MIR); the density and proximity of human populations; the time or year and weather conditions; accessibility to the area where the mosquito vector is located; rapidity of the response as determined by the seriousness of the public health threat, and the potential impact on people and the environment.

Analysis of mosquito pools, as specified by the Grays Harbor Plan, California Mosquito-Borne Virus Surveillance and Response Plan, Florida Mosquito Control Arbovirus Response Plan – West Nile Guidelines for Mosquito Control Responses, Massachusetts Department of Public Health 2012 Arbovirus Surveillance and Response Plan, or the City of Boulder (Colorado) West Nile Virus Mosquito Management Plan to name a few, would give more complete information yielding specifics on the mosquito infection rates and whether secondary or bridge vectors are involved. However, the Service understands the budgetary constraints within which Delaware's program must function, as well as their acquisition of data which is "not very conducive at all for making such results into any type of gradient or sliding scale …"

Consequently, quantification of data in the form of mosquito infection rates, multiple positive or clustered mosquito pools, or multiple or widespread positive sentinels, representing a threshold for treatment calculated on a "gradient or sliding scale", will not be required. The Service requires nothing of DMCS other than verification of mosquito-borne disease via one of the standard methods used by DMCS and/or health monitoring programs in the state prior to conducting an adulticide treatment on-refuge.

Comment: Many public health officials and mosquito control professionals share a well-founded perspective that in areas where mosquito-borne diseases are enzootic/endemic, then simply having mosquito population levels for vector species of concern exceed a tolerable threshold level becomes unto itself a type of "public health emergency" or situation, whether officially declared or not, warranting quick and appropriate mosquito control actions. And at a minimum, they take this view in that effective mosquito control actions, based upon concerns for and reactions to vector mosquito population levels alone, will then prevent or reduce the possibility that such a public health situation could morph into a "declared public health emergency."

Response: The Service recognizes that there are policies and mosquito-borne disease surveillance and control plans from other states and municipalities, advocating less extreme measures that apparently meet their satisfaction, without undue harm to human health.

The State of North Carolina is a prime example. North Carolina with its myriad wetlands, including cedar swamps that are considered hot spots for EEE, does not conduct aerial adulticide treatments unless there is a State of Emergency, usually associated with a hurricane, which permits FEMA to cover the cost. Dare County and the Outer Banks region, home to Cape Hatteras National Seashore, Pee Island and Alligator River NWRs, The Nature Conservancy, State owned lands, and isolated resort communities sandwiched within these public and private lands, does not conduct aerial adulticide treatments. Relatively isolated municipalities receive truck mounted adulticide treatments, however individuals within those municipalities may exercise their own interests and have their properties excluded. Approximately 50,000 acres (20 percent) of the land area within Dare County is within the jurisdiction of the local mosquito control agency.

The North Carolina Mosquito Vector Control Association (NCMVCA) goes into some detail on their website describing the procedures for targeting adult mosquitoes using ground based Ultra Low Volume (ULV) applications. This requires a plan of action to maximize the ground control effort. Basic targeting considerations include the species of mosquito to be controlled, and identifying and prioritizing all the potential treatment (protected) areas, locating productive mosquito habitat within the protected area and evaluating the mosquito production adjacent to the protected areas. NCMVCA indicates the local control agency should plan for up to 21 days of treatments for each mosquito hatch. For planning purposes they also calculate the potential acreage that a single truck can treat, multiplied by the number of trucks available, to determine the maximum operational capacity of the program. "The goal is to minimize human interaction with mosquito populations for the three-week adult mosquito period."

Comment: DMCS makes extensive comments on the use of limited data regarding the effects of OMWM on obligate salt marsh passerines. DMCS points out weaknesses in the paper the Service cited on the subject.

Response: The Service was made fully aware of the weaknesses in study design and conclusions made some time ago, thus the Service had already inserted the following statement in the draft CCP, "Limitations in the study design prevent any definitive cause-and-effect conclusion, which underscores the need for more research on the effects of open marsh water management on salt marsh obligate productivity."

DMCS goes on to indicate that during the 1980's the State, involving DMCS biologists, performed surveys of both Seaside and salt marsh sparrow populations at Bombay Hook NWR; they have provided some of the results in their written comments. The Service apologizes for having overlooked the State study but our historical files contain no final report or publication. However, the Service will insert a synopsis of those results into chapter 5 of the CCP, as provided, cited as (DMCS, written communication).

Comment: DMCS takes issue with the following statement in the draft CCP indicating there apparently has never been any quantitative study done on the effects of OMWM on the black rail. "There is concern about the impacts of open marsh water management on black rail, a species of concern associated with tidal high marsh, which prompted the state of Maryland to cease such management in the early 1990s (DNREC 2005). Circumstantial evidence from at least one site in Delaware supports this concern, and the issue warrants further study."

> **Response**: The Service extracted this information from a document published by the Delaware Department of Natural Resources and Environmental Control, of which the Mosquito Control Section is a part.

Comment: "Do not try to somehow incorporate considerations of natural mosquito predator population abundance into the DMCS's spray threshold criteria and decision-making…"

> **Response**: The Service agrees. Under certain environmental conditions mosquito reproductive biology is well equipped to overwhelm the limited number of native predators. Determining the threshold at which predators can make a significant impact on mosquito numbers is not feasible. References to mosquito control via native predators will be modified or eliminated. Any requirements of DMCS to monitor mosquito predator populations will be eliminated as well.

Comment: "Do not call for the involvement of federal and/or state public health officials in making the DMCS's operational spray/no spray decisions…"

> **Response**: Since DMCS is the agency within Delaware that conducts disease and mosquito surveillance, sets thresholds, make the disease notifications, and conducts the mosquito control, the Service will modify the draft text to indicate same.

Comment: To maintain quality of life for neighboring communities while reducing public exposure to hazardous vector-borne diseases, the Service should continue to permit, in the manner currently performed, the judicious application of insecticides for control of larval and adult mosquitoes.

> **Response**: Comment noted, however the Service will modify the current treatment regime to bring it into compliance with refuge-specific laws and policies. Adulticide use for the purpose of nuisance control has been found to materially interfere with and detract from the fulfillment of the Refuge System mission and the purposes of the refuge.

Comment: DMCS indicates, "The Service's proposed prohibition on aerial adulticiding over some adjacent refuge lands might lead to the need to more frequently have to run our "fog trucks" through town, …, and thereby then unnecessarily increase the frequency of exposure of community residents and visitors to our adulticide sprays."

> **Response**: First, note that under alternative B from the draft CCP/EIS adulticides would be permitted, subject to the declaration of a public health emergency. Secondly, this requirement will be changed to detection of a public health threat. Lastly, the Service has examined the DMCS website listing public notifications of truck-mounted or aerial mosquito control treatments by town across Delaware, giving close attention to the towns to the south of PHNWR. It appears that larval mosquito control on PHNWR is remarkably effective as reflected in the number of total adulticide treatments (truck-mounted or aerial) required in the neighboring towns compared to other sites in the county. The Service notes that DMCS appears to use truck-mounted adulticides in the coastal towns routinely, representing considerably more treatments in those locations than the neighboring three communities currently receive. It would appear that DMCS is now distressed at potentially having to adopt the same management regime in the three communities bordering PHNWR as the coastal towns. The Service realizes that a new management paradigm for the region will likely be required, unless mosquito-borne disease is detected consistently in the area of the refuge. This change may result in an increased number of adulticide treatments required in the three communities, but evidence indicates the number of treatments may have to increase several times the current rate to match the number of treatments in the towns on the coast where chemical exposure appears to have yet reached a threshold for concern from the DMCS.

Comment: The DMCS's state enabling statute makes reference to the important need to treat mosquitoes as a nuisance too. This nuisance aspect of state law might also govern the federal government's tort liability relating to possible mismanagement of federal lands on a federal agency's part resulting in a nuisance that harms or injures third parties (in this case in the form of intolerable infestations of mosquitoes originating from refuge lands that then plague or harm people in off-refuge areas). Federal law might actually obligate the Service to consider nuisance principles relative to mosquito control in order to avoid tort liability under the Federal Tort Claims Act (FTCA), whereby a waiver of sovereign immunity for a federal agency might be invoked per the FTCA for a tort claim brought by a state against a federal agency.

> **Response**: Comment noted. Our attorneys advise us that directives concerning the management of federal land in this matter will not subject the Service to tort liability.

Public Use and Access (See also "Hunting")

General

(Letter ID#: 22, 24, 30, 53, 61, 67, 81, 93, 98, 108–Form Letter)

Comment: A few individuals suggested collecting a fee from all refuge visitors. One writes that the refuge "should not allow some to access the refuge free of charge while only hunters have to pay."

> **Response**: We do not currently charge an entrance fee for all visitors since there are many entrances to the refuge, such as off Broadkill Beach Road, Prime Hook Beach Road, Fowler Beach Road, and Slaughter Beach Road. Without having a one-way in, one-way out road, the collection of entrance fees becomes difficult (see also response under "Hunting Fees and Program Costs").

Comment: One individual writes, "Turtle killing is not appropriate or compatible for this refuge. There is no need to allow this turtle killing."

> **Response**: We agree that turtle harvesting is not a compatible use at Prime Hook Refuge. Although we found turtle harvesting appropriate in the draft CCP/EIS, we ultimately found it not compatible and are not proposing to continue to allow it on the refuge. Please see the findings of appropriateness and compatibility determinations in Appendix E.

Comment: The form letter states, "Foord's Landing launch area should be offered [for recreational boating]. It could be restricted to March 1st to October 1st for things like fishing and canoeing. Then it could become available to the duck hunters to use through the fall and winter."

> **Response**: We agree that providing access to Prime Hook at Foord's Landing to hunters, anglers, canoers, and kayakers will enhance their fishing, hunting, and wildlife observation/photography experiences. Please see objectives 5.1, 5.2, and 5.3 under alternative B in the draft CCP/EA for our specific proposals.

Comment: Two individuals ask, "When did [Prime Hook NWR] become a private beach? It was never private, and I don't want to spend my tax dollars on something that is used by few." Another asks, "Is the boat ramp at Oyster Rocks Road public."

> **Response**: Prime Hook Refuge is open to all members of the public and offers a wide variety of public use activities. The commenter may be confusing the Prime Hook community with the refuge. The Prime Hook Beach community is a private beach. The boat ramp at Oyster Rocks road is public.

Comment: The Delmarva Ornithological Society is concerned that closures for hunting will negatively impact other visitors engaged in non-consumptive uses. They write, "We also feel that the new eastern Prime Hook Creek closures starting in September will interfere with recreational paddlers during peak fall bird migration. Ideally, [it] should be open to paddlers through the end of October…"

Response: We recognize that there can be conflicts between different refuge user groups. Visitor safety is important to us and during recent years, the easternmost four miles of Prime Hook Creek has been closed in early September for safety concerns due to hunting of teal in the adjacent Prime Hook (State) Wildlife Area. We propose to continue with this September closure under the Service-preferred alternative. Access will continue to be closed through mid-March for hunting on federal and state areas during the three seasonal splits of the waterfowl season and for other management purposes. The westernmost portion of the creek will be open year-round. Access for boats and canoes is from the boat ramp located behind Brumbley's Family Park off of Route 1 near Waples Pond.

> Also, in response to comments we received, we made several modifications to our hunting program proposal under alternative B in the final CCP/EIS, including not opening Prime Hook Creek to hunting. We highlight these at the beginning of the appendix under "Introduction."

Comment: One individual would like the refuge to expand public access. He writes, "I strongly support opening more of the refuge to the public for hiking, birding, nature observation, and fishing. When I used to be allowed to take birding groups into closed areas of the refuge, this was a big draw for participants.

Response: Thank you. Expansion of wildlife observation opportunities are discussed in chapter 4 of the CCP/EIS.

Comment: One individual asks, "Please define "incidental recreation"? It would appear that this CCP provides for more than incidental recreation (e.g., hunting)."

> **Response**: The National Wildlife Refuge System Administration Act of 1966, 16 U.S.C. §§ 668dd, 668ee, and the Refuge Recreation Act of 1962, 16 U.S.C. § 460k authorize the Secretary of the Interior to permit "appropriate incidental or secondary use(s)" of wildlife refuges, even though "recreational" in character, including hunting, which are "compatible with, and will not prevent accomplishment of, the primary purpose for which the[se] areas were established." 16 U.S.C. §§ 460k, 668dd(d). One example could be canoe trips, which help to facilitate a priority public use in wildlife observation.

Comment: The State of Delaware writes, "Things like signs, maintenance of boat launch areas, trails, road maintenance and even blinds (which could serve as bird observation sites) are needed for activities other than hunting. Is the maintenance of these facilities evaluated in a cost analysis for other recreation programs?"

> **Response**: Under the Service's preferred alternative B, we propose to construct one or more blinds designed for wildlife photography; however these blinds will also offer opportunities for wildlife and nature viewing. The CCP identifies additional funding and staffing required to implement the objectives and strategies for visitor services. Compatibility determinations for all refuge uses evaluate "Availability of Resources" which provides a description of costs and staff necessary for the use.

Comment: Several individuals were concerned with the impacts of road removal on refuge visitors, specifically surf fishers and birders.

> **Response**: Adaptive management is necessary if Fowler Beach Road, from Slaughter Canal to its terminus at the Delaware Bay, is abandoned by DELDOT and donated to the Service. If, upon DelDOT's removal of the existing layer of asphalt overlying unconsolidated fill, the walking trail will serve its purpose of public use until marsh vegetation and hydrologic function reclaim the trail and the formally bisected habitat (Units I & II) function as one unit. When conditions are deemed unsafe, access will not be permitted to Fowler Beach for public use opportunities such as wildlife observation, wildlife photography, and fishing.

Comment: One individual writes, "The section on "south of Broadkill Beach Road", [on page 4-130 of the draft CCP/EIS] is unclear what you plan to do. Are you stating that you will remove the existing (illegal) walkway and replace it with a new one? How…will people get across the tidal gut?...Are you planning to destroy fragile tidal wetlands? Do you intend to do an EA? Do you plan to get permits? In addition, it appears that you will open the trail/tower during the early deer seasons."

Response: We have revised objective 5.2 under alternative B to state more clearly the Service's proposal for this trail. We propose to either use the existing trail or reroute the trail to the east and construct a smaller, less intrusive boardwalk, trail, and parking area. We do not propose to allow hunting in the area where the trail would be located. We also will obtain all necessary permits and comply will all laws and Service policies.

Wildlife Observation and Photography
(Letter ID#: 24, 28, 56, 65, 80–Petition, 81, 93, 107, 108–Form Letter)

Comment: The authors of one letter and the form letter requested the refuge provide additional wildlife observation and photography opportunities for visitors with limited mobility or disabilities. The form letter states, "There should be viewing areas for people who are not able to walk or walk any distance. There should be areas cleared, so people could view the animals and birds from their vehicles on Turkle Pond Road and the main road leading to the office." The individual writes, "all…viewing areas…need to provide accommodations for handicapped persons."

Response: In regards to opportunities for people with limited mobility, in addition to the two existing wheelchair accessible trails, observation platform, and fishing pier, the refuge is proposing under Alternative B to provide an additional wheelchair accessible photography blind. Mobility impaired individuals can also use the existing roadside pull-offs along Broadkill Beach Road and Prime Hook Beach Road wildlife observation and photography opportunities.

As far as clearing new areas for wildlife viewing, we feel as though removing habitat for the sole purpose of increasing wildlife viewing opportunities conflicts with the Service Mission and Refuge's purposes because the reduction of habitat may decrease the biological diversity and the integrity of the area. Removing habitat fragments the landscape and may reduce the potential viewing of many species that are area-dependent or have specific habitat requirements. We also feel that the refuge has sufficient parking areas, hardtop roads, foot trails, and observation towers available for physical and visual access to wildlife.

Comment: The authors of one letter feel that none of the alternatives provide enough wildlife viewing and photography opportunities. They write, "The CCP needs to consider the addition of more sites for wildlife viewing and photography such as at the end of the roads used for hunting access off of the Prime Hook Road." The form letter also states, "Hiking trails and photography could be enhanced as needed."

Response: Objective 5.2 in alternative B, which is the Service-preferred alternative, expands and enhances opportunities for wildlife observation and photography by adding seven new trails totaling 3.7 miles throughout all four refuge management units on existing maintained trails or interior refuge roads, bringing the total number of trails to 14 and 9.9 miles. These new opportunities almost entirely coincide with existing hunter access points, including those off of Prime Hook Road. While seasonal closures will occur to reduce conflict between recreational uses, ensure visitor safety, and/or minimize wildlife disturbance, these are nonetheless increased opportunities above what is currently offered.

Comment: The authors of one letter feel the analysis of impacts of each alternative on wildlife observation and photography opportunities is incorrect. They write, "…Alternatives B and C claim that there will be better opportunities for bird watching and wildlife photography than [under] the current situation – Alternative A. [However,] there was much more opportunity for wildlife and bird watching and photography prior to the breaches occurring. At a minimum, the CCP needs to support recreating the environment that was present before the breaches occurred regarding wildlife and bird watching and photography."

Response: Our analysis of wildlife observation and photography opportunities compared the number of opportunities and public use infrastructure under each of the alternatives. Our intent was not to compare the exact species of wildlife that visitors might see under each alternative. We feel that alternative B proposes to provide more opportunities for wildlife observation and photography through the addition of trails and a wheelchair accessible photography blind. The breaches obviously have made changes in conditions at the refuge, and this fact may require adjustments and altering expectations on the part of frequent visitors and residents.

Comment: The Delmarva Ornithological Society writes, "With the anticipated abandonment of the eastern section of Fowler Beach Road by DELDOT, Delmarva Ornithological Society urges the USFWS to pursue all reasonable alternatives to provide access to birders and other user groups to…Units I and II. An observation tower would be ideal, and [we could help] advise on placement and construction. We are aware of the challenges presented by the unprotected nature of the area, but feel that the quality of birding and wildlife watching provided by the overwash areas is of such unique values that every effort should be made…to provide safe and adequate access…In addition, it is important that the Delaware Shorebird Project and other researchers have safe access to [monitor shorebirds and beaching nesting birds]. Retaining the prime viewing opportunities at Fowler Beach should be a focal point of the Bayshore Initiative, and we urge the Service to work with stakeholders and the State…to continue to provide access…"

Response: We agree the Fowler Beach provides some quality wildlife observation. However, it would be environmentally and fiscally irresponsible of the Service to construct another viewing platform in the area that is dynamic without careful consideration. The previous tower was constructed in 2006 and was all but destroyed by 2010. We will continue work with our partners to try and come up with the best possible solution.

Comment: One individual is concerned that popular birding locations on Fowler Beach Road will be lost when the road is removed. He also writes, "The Old Shop Road should also be opened as soon as possible." Another similarly states, "The observational uses and trail uses envisioned in this section will be greatly diminished if Fowler Beach Road and Primehook [Road] are compromised. In fact, not only would access be limited, but parking areas indicated as needs for these uses will be difficult to create if the terrestrial acreage continues to be compromised as would seem to be indicated by Alternatives A or B."

Response: We agree that Old Shop Road should be opened as soon as possible. We also acknowledge the Service may have to scale back its proposals for public use facilities along Fowler Beach and Prime Hook Roads. We may need to alter our existing plans depending on a number of unpredictable factors such as:

- Additional storm damage to the roads and associated parking areas.
- Continued subsidence of land-base.
- Success or failure of habitat restoration.
- Potential accelerated sea level rise.
- DelDOT maintenance schedule.

Specifically, regarding Fowler Beach Road, National guidance has been developed to implement some of the key provisions of the 1997 amendments to the Refuge Administration Act. This includes the Biological Integrity, Diversity, and Environmental Health policy (601 FW 3). Consistent with the Refuge purpose(s), this policy provides for maintenance of restoration of healthy, functioning biological communities composed of native species and habitat comparable with historic conditions. The policy favors refuge management, which restores or mimics natural ecosystem processes or functions. The Service believes the removal of the road would assist in the restoration of Unit II.

Wildlife observation is a refuge use subject to compatibility (603 FW 2). The Compatibility policy states that a use would not be compatible if the use conflicts with maintenance of refuge biological integrity, diversity, and environmental health. If a decision is made to remove the road, that decision would be based on our efforts to restore natural hydrology of the marsh.

Comment: One individual writes, "There are additional "hunter" trails on Deep Branch Road, why not open to birders/hikers?" He also asks. "Will these new trails be maintained? Or will they be left overgrown and unmaintained as are the existing trails?"

Response: The preferred alternative does propose opening a trail on Deep Branch Road for wildlife observation, please refer to objective 5.2 under alternative B in the CCP/EIS. Once open, we would maintain these trails, as well as continue to manage the refuge's other existing trails.

Comment: One individual writes, "The maximum acreage impacted by your trails is about 30 acres. How is this more disturbing and disruptive and negative to wildlife than proposed expanded hunting?"

Response: Trail use can and does impact wildlife. However, we anticipate the impacts to be minor. We would continue to monitor the refuge for potential impacts and would take steps to limit access or close areas to protect refuge resources, if necessary.

Comment: One individual states, "Concerns about safety-large exposed roots-were ignored (Blue Goose Trail)… There will only be a matter of time before someone is hurt."

Response: We are aware of the exposed roots on the Blue Goose Trail. The refuge's brochure, signage, and website alert the public to the potential tripping hazard. The Blue Goose Trail offers exceptional birding opportunities.

Comment: One individual is concerned that proposed new trails would "fragment valuable habitat, including wetlands."

Response: Although the Service's preferred alternative proposes to open seven new trails totaling 3.7 miles, we propose to construct these new trails using existing and already maintained trail and road networks. The total number of refuge trails would 14 (total of 9.9 miles). Two of these trails may need improvements aside from already occurring maintenance. We will evaluate the existing trail infrastructure on Vergie's Pond and decide whether to use it or reroute the trail to the east and construct a smaller, less intrusive boardwalk, trail, and parking area. The proposed trail off Slaughter Beach Road uses an existing interior road that will require the removal of some vegetation for the trail and parking area.

Comment: One individual writes, "The proposed Broadkill Dike Trail is an excellent idea; however it could and should be expanded to Petersfield Ditch. A portion could be closed during deer hunting season. How does necessary maintenance affect proposing opening of the trail? Will it take over 15 years? This a 15 year plan?"

Response: The proposed Broadkill Dike Trail, which is 0.2 miles long, will be open as a new hiking trail and will allow visitors to access the Black Farm Trail from an existing parking area. Since there are already 6 miles of hiking trails in this area covering various habitats, the Service did not feel that extending this trail to Petersfield Ditch would offer anything different than what is currently available to refuge visitors.

Comment: One individual requests that the refuge "Complete and open the observation platform on Vergie's Pond and the walkway to the platform from the east end of Broadkill Road."

Response: The Service proposes to evaluate the existing trail infrastructure on Vergie's Pond and decide whether to use it or reroute the trail to the east and construct a smaller, less intrusive boardwalk, trail, and parking area as discussed in Objective 5.2 of alternative B.

Comment: One individual asks if the easternmost and westernmost trails near Prime Hook Creek are open or closed on Sundays. He also states that the public will need to be advised of any trail closures during hunting seasons.

> **Response**: Opportunities for wildlife observation and photography on refuge trails will be expanded under the Service-preferred alternative. Potential conflict between refuge users is expected to be managed through seasonal closures, which are discussed in detail by area in Objective 5.2 in alternative B. Specifically, Prime Hook Creek will be open with a seasonal closure of Eastern Prime Hook Creek (from Foord's Landing to headquarters ramp) every day from September 1 through March 15. The western portion to Prime Hook Creek will remain open daily throughout the year. The refuge will continue to post trail closures on its website and visitor center as needed.

Comment: One individual requests that the refuge enlarge the three pull-offs on Broadkill Beach Road due to safety concerns (e.g., they are too narrow and the drop-off is too steep). Another individual suggests that the refuge "build a handicap accessible wildlife observation platform for the marsh on the Prime Hook Road because people stopping to look at wildlife block the road/make it unsafe."

> **Response**: Roadside viewing opportunities provide visitors unique opportunities to watch or photograph wildlife using their vehicle as a "blind." The Service does not see any advantage of constructing a roadside wildlife observation platform since all individuals with or without disabilities can safely use these pulloffs. Because wetlands border roadside vehicle pull-outs, enlarging these areas would require obtaining necessary permits and possible mitigation. Proper use of these pullouts provides visitors with enjoyable and safe outings.

Environmental Education and Interpretation
(Letter ID#: 28, 107)

Comment: The State of Delaware suggests the refuge install educational signs at the end of Fowler Beach Road to inform visitors of impacts of human disturbance on breeding and foraging shorebirds."

> **Response**: The Service agrees that providing interpretive opportunities on the impacts of human disturbance on breeding and nesting shorebirds creates a great opportunity to inform and instill a greater appreciation for these resources to refuge visitors.

Comment: One individual suggests the following, "Explore the opportunities to provide a cooperative education experience for college students, in conjunction with local universities and colleges."

> **Response**: We agree. The refuge has established strong relationships with some local schools, colleges, and universities, and we hope to partner with others to expand our environmental education program. The environmental education component of the visitor services step-down plan will help us address this.

> **Comment**: One individual does not support developing an interpretive auto tour route at this time. He writes, "Due to the disconnected road system around the Refuge, I feel this may not be a good use of financial resources, except in the area around [Refuge Headquarters]."

> **Response**: We propose in Objective 5.4 of the Service-preferred alternative to develop interpretive auto tour and hiking routes using advanced technology (radio, compact disc, cell phone, or downloadable programming).. We do not plan to physically connect these roads into one drivable loop, but rather enhance opportunities for visitors to increase their understanding of the natural and cultural resources of the refuge along each of these roads using new technology that is now readily available and inexpensive.

> **Comment**: One individual feels that the current Visitor Contact area does not have enough room for new panels and displays" and states that he supports developing new displays as proposed under alternative C in the draft CCP/EIS.

Response: We will be updating or replacing the existing kiosks and signs on the refuge. Objective 5.4 of the Service's preferred alternative further states that we will increase and enhance interpretive materials and programs about natural and cultural resources. We agree that space is limited in the Visitor Contact area, and this area must be used efficiently. We appreciate the recommendations for additional programs and outreach materials. We will consider them as we develop our visitor services step-down plan.

Fishing and Crabbing
(Letter ID#: 22, 28, 36, 62, 107)

Comment: One individual supports the proposed changes to fishing and crabbing under alternative B.

Response: We thank you for your support of our preferred alternative.

Comment: One individual writes, "Commercial fishing is not compatible with [taking] the fish the birds need to eat to live. [S]top [all] commercial fishing at this site."

Response: We found commercial fishing and crabbing not appropriate on Prime Hook NWR and do not propose to allow it on the refuge. Please refer to Appendix E, "Compatibility Determinations and Findings of Appropriateness" in the draft and final CCP/EIS.

Comment: One individual writes, "Just to remind you…you are required to follow the State of Delaware…fishing laws in the booklets."

Response: According to U.S. Fish & Wildlife Service policy (605 FW 2.3), regulations permitting hunting and fishing within the Refuge System must be, to the extent practicable, consistent with State fish and wildlife laws, regulations, and management plans.

Comment: The State of Delaware recommends, "If Fowler Beach is opened to night fishing; provision should be made for increased enforcement presence during that time."

Response: We agree and plan to increase law enforcement presence during that time.

Comment: One individual writes, "The salt water intrusion from the Delaware Bay has brought blue crabs and crabbers position themselves in culverts along [Prime Hook] Road, parking dangerously."

Response: The Refuge Improvement Act of 1997 identifies fishing as one of six priority, wildlife-dependent public uses that are to receive enhanced consideration in refuge planning. The interest in crabbing has grown in recent years on the refuge. We propose to open fishing and crabbing along Prime Hook Beach Road as discussed in Objective 5.3 in Alternative B. Parking is only allowed on existing pulloffs and access is restricted to the pulloff area to provide safety for visitors and to avoid traffic issues. The refuge will consider fishing and crabbing along Broadkill Road and Fowler Beach Road in the future if there is a demand and if visitor safety and adequate parking can be guaranteed.

Dog Walking
(Letter ID#: 22, 24, 28, 29, 81, 90)

Comment: Many individuals commented on dog walking. One felt it was contradictory to allow field dog trails, but not dog walking. The remaining individuals were against the proposal to close Prime Hook NWR to dog walking. One felt that such a closure would "exclude a great number of casual walkers and nature lovers" and felt that the refuge should mitigate against wildlife impacts from dogs by requiring dogs to be leashed, prohibiting dogs from sensitive areas (e.g., seasonal closures of shorebird nesting areas, increased monitoring, law enforcement, and signage. Another felt that the impacts of dog walking were similar and no more adverse than those from humans walking on trails, hunters walking off trail, and using hunting dogs. The third states that he has been visiting the refuge for years and has never seen any negative incidents with dogs and asks "What negative impacts have you noted at Prime Hook? What problems have you documented?" He asks that the Service rewrite the compatibility determination to allow dog walking, as long as dogs are leashed and owners pick up their dogs wastes. He also asks, "How does walking [dogs] on refuge trails impact shorebirds?"

> **Response**: Dog walking was found to be not appropriate in appendix E of the refuge's final CCP/EIS. Dog walking does not support the biological and public use goals and objectives for Prime Hook NWR, as defined in the comprehensive conservation plan for the refuge. These goals and objectives emphasize conserving habitats and species of conservation concern and offering priority, wildlife-dependent recreational uses to help visitors build an appreciation and understanding for the refuge's natural and cultural resources. Dog walking also does not support the refuge's purpose as an "inviolate sanctuary… for migratory birds." Allowing dog walking on the refuge may prevent us from achieving our goals, objectives, and the refuge purpose because the presence of dogs can negatively impact migratory birds and other wildlife species, either directly through predation or indirectly by displacing wildlife species. Many wildlife species perceive dogs as natural predators, which causes them to react to the presence (by visual and scent) of dogs. Common reactions include vacating and avoiding areas disturbed by dogs. Domestic dogs can also depredate native wildlife and displace native migratory bird species from their native habitats. Allowing dog walking may also conflict with public use goals and objectives because the displacement of wildlife by dogs could materially interfere with wildlife observation, a priority public use of the refuge. There are also many sites throughout the surrounding area that provide opportunities for accompaniment by a pet.
>
> The use of (dog) retrievers by waterfowl hunters and upland game hunters engaged in legal hunting activities on the refuge is allowed because 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.
>
> Many individuals walk their dogs along the beach, which does affect shorebirds. If the Refuge is to have a successful beach nesting area, we must eliminate dog walking on the beach. The elimination of dog walking would benefit migrating and nesting shorebirds along the beach.
>
> Also, although we did find field dog trials appropriate in the draft CCP/EIS, we ultimately found field dog trials not compatible and are not proposing to allow this use on the refuge.

Comment: One individual asked, "Page 4-22 refer to "commercial" dog walking as inappropriate. Are you stating here that recreational dog walking will be permitted?

> **Response**: The refuge proposes to eliminate dog walking whether it is recreational or commercial. The statement has been clarified in the final CCP/EIS.

Other Recreational Activities
(Letter ID#: 24, 29, 34, 81, 93)

Comment: One letter suggests, "Beekeeping should be allowed in controlled areas [on the refuge]."

> **Response**: Bee keeping manages colonies of the European honey bee, which is an exotic species. Colonies have been declined the past 30 years, due to mites, disease, habitat loss, and a decline in beekeepers. However, there are about 4,000 species of native bees north of Mexico, of which 200 have been found in Delaware. Native bees are a vital component for the pollination of native flora, which are four times more attractive to bees than non-native plants. Currently, much effort is being given to promote these native habitats, particularly in Delaware *(http://dda.delaware.gov/plantind/pollinator.shtml;* accessed November 2012).
>
> Bee keeping has been allowed on the refuge in the past; however, it is not a priority public use. Subject to compatibility, it does not, as a standalone activity, contribute to the fulfillment of refuge purposes, and promotes an exotic species. This use 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. See the finding of appropriateness and compatibility determination in Appendix E.

Comment: Several respondents commented on the impacts of expanded hunting on canoeing and kayaking opportunities on the refuge. One letter states, "You have effectively wiped out much of the canoe/kayak areas with your expanded hunting program. You did not address the impact on these visitors or the economic loss to the community. At least several hundred people will be impacted [including local businesses]."

> **Response**: Based on responses from the CCP public comment period, we have revised the final CCP/EIS to not open hunting on Prime Hook Creek and to continue allowing year-round access to visitors for uses such as wildlife observation, wildlife photography, and fishing to the western 4 miles of Prime Hook Creek.

Hunting

Hunting - General
(Letter ID#: 9, 13, 16, 22, 28, 29, 32, 36, 43, 45, 46, 49, 53, 60, 64, 66, 67, 71, 80–Petition, 81, 92, 97, 98, 100, 104, 105, 106, 107, 108–Form Letter, S14, S18)

Comment: PEER stated that the broad-spectrum hunting expansion across all habitats of the refuge landscape contradicts the very specifically worded "Prime Hook purpose" that wildlife-oriented recreational development be "incidental" and strongly reverses the primary NWR system refuge use of conservation of wildlife. The operative word is "incidental" as it relates to the alternative B hunting expansion development, where hunting is not taken and defined as occurring concurrently with other primary uses as a minor accompaniment, or as being a minor, casual or subordinate in nature to the primary refuge use of conservation."

> **Response**: As stated earlier, Sections 5(c) and (d) of the National Wildlife Refuge Improvement Act states "compatible wildlife–dependent recreational uses are the priority general public uses of the NWRS and shall receive priority consideration in planning and management; and when the Secretary [of the Interior] determines that a proposed wildlife-dependent recreational use is a compatible use within a refuge, that activity should be facilitated, subject to such restrictions or regulations as may be necessary, reasonable, and appropriate."

In addition, the expansion of the refuge's hunt program is responsive to Executive Order 13443, "Facilitation of Hunting Heritage and Wildlife Conservation." The purpose of this order is to direct 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 Department of Agriculture, to facilitate the expansion and enhancement of hunting opportunities and the management of game species and their habitat."

Comment: One individual writes, "Blaze orange or hunter orange is a state requirement. Additional rules were added a number of years ago that required the orange not be faded and not be camo. Again, this is a safety concern."

Response: We agree that requiring individuals to wear hunter orange in firearm hunting areas during hunting season is important for safety and require hunters on the refuge to comply with this State requirement. We specify in the refuge-specific hunting regulations in Appendix C that "any time the State hunting regulations require that hunters display hunter orange, the material must be solid-colored. We prohibit hunter-orange camouflage materials."

Comment: One individual suggests writing separate compatibility determinations for each hunt. He writes, "Evaluating each hunt separately will show the weakness of some hunts.

Response: According to refuge compatibility policy, a use may be an individual use, a specific use program, or a group of related uses. The policy further states that whenever practicable, the refuge manager should concurrently consider related uses or uses that are likely to have similar effects and associated facilities, structures, and improvements, in order to facilitate analysis of cumulative effects and to provide effective public review and comment. For example, birding field trips, canoe trips, and nature walks are three different uses related to the wildlife observation program, and therefore evaluated in one compatibility determination. Similarly, each hunt is evaluated for its own specific effects, but also grouped together as part of the hunting program, and evaluated in the hunt plan, the hunting compatibility determination, and the CCP/EIS. Viewing all of the uses at once assists in consideration of potentially competing uses, allows us to group uses in a way that makes sense, provides a holistic view of the entire program, and provides a more concise opportunity for public review and comment. The 1997 National Wildlife Refuge System Administration Act stipulates that hunting (along with fishing, wildlife observation and photography, and environmental education and interpretation), if found to be compatible, is a legitimate and priority general public use of a refuge and should be facilitated. The Administration Act authorizes the Secretary to allow use of any refuge area for any purpose as long as those uses are compatible.

Comment: One individual feels that the refuge should stop allowing upland game, small game, and other migratory bird hunting. He writes, "The number of hunters and success cannot support this entire program."

Response: The 1997 National Wildlife Refuge Improvement Act identifies hunting as one of six priority public uses to be facilitated on Refuges. Hunting is a compatible use and consistent with the purposes of Prime Hook NWR.

Comment: One individual suggests that the refuge not allow hunting scouting by boat because he feels it is "counterproductive to quality hunting because of too much disturbance."

Response: Taking time to scout the refuge and learn its areas not only minimizes risk, but also makes for more successful outings. For waterfowl hunting, enhanced opportunities for scouting will only be allowed on Sundays immediately prior to each of the duck season splits to minimize disturbance to wildlife.

Comment: One individual writes, "How many other refuges have interpreted the Executive order on hunting as you have and opened up such large portions of the refuge to hunting? This EO (2007) was geared to opening up more hunting areas on BLM lands. In addition, an EO does not trump compliance with RIA."

Response: The Executive Order directs the Department of the Interior and its component agencies, bureaus, and offices, which includes the U.S. Fish and Wildlife Service "to facilitate the expansion and enhancement of hunting opportunities and the management of game species and their habitat." The Service must remain compliant with its legislative mandates such the Refuge Improvement Act of 1997. In the preferred alternative, we propose to expand, enhance or maintain opportunities for all of the priority public uses, and not solely hunting.

Comment: The State of Delaware writes, "The Service should ensure that Delawareans of all ages and physical abilities have adequate access to hunting opportunities on the Refuge that are compatible with management on adjacent state lands and with non-consumptive public uses on the Refuge. The form letter also asks the refuge to consider hunting opportunities for all ages, writing "More emphasis on youth hunts for both waterfowl and deer hunting. Youth are the future."

Response: We agree and are committed to promoting youth hunting opportunities. We have provided hunting opportunities and access for hunters of all ages and abilities on the refuge. As described in Chapter 3 of the draft CCP/EIS, the refuge has a disabled hunt program, participated in young waterfowlers program, and provides youth hunts for deer and waterfowl. The Service's preferred alternative builds on those current opportunities. To the extent possible the Service and the State have a consistent hunt program. (Also see the section on "Hunting for Individuals with Disabilities" below).

To encourage youth participation in hunting activities, the Service will collaborate with State partners and NGO hunting organizations to develop hunter training programs that instruct beginning hunters in the knowledge and skills necessary to become responsible, respected individuals who strive to learn all they can about the species being hunted and to become knowledgeable in firearms safety, hunter ethics and wildlife conservation. The Service will also develop mentored hunting programs and offer programs developed by NASP (National Archery in the Schools Program) to encourage family participation in archery.

Comment: One individual writes, "Does the refuge receive some reward for opening the highest percent of the refuge in the region to hunting? Who benefits from the increased hunting acreage?" He adds, "The refuge's title should be changed to the Prime Hook National Hunting Preserve."

Response: Hunting is one of the priority public uses mandated by the National Wildlife Refuge System Improvement Act of 1997 and hunters will benefit from the expanded hunting acreage and additional hunting opportunities. Wildlife observation and photography are also priority public uses and non-consumptive visitors will benefit from new opportunities from the 14 trails covering 9.9 miles on the refuge, of which seven are new totaling 3.7 miles.

Comment: One individual writes, "Just to remind you…you are required to follow the State of Delaware Hunting…laws in the booklets."

Response: According to U.S. Fish & Wildlife Service policy (605 FW 2.3), regulations permitting hunting and fishing within the Refuge System must be, to the extent practicable, consistent with State fish and wildlife laws, regulations, and management plans.

Comment: The State of Delaware and one individual are concerned with the Service's definition of quality hunting. The State writes, "The connotation for quality as written in the CCP seems to indicate greater success of harvesting waterfowl. However, for many hunters, quality may be just the fun of being in the marsh for the day with family or friends. Harvest success may have very little to do with the quality of the experience whereas accessibility and opportunity may be of greater importance. So we recommend striking the term quality due to its subjective nature."

Response: The Service agrees that the term "quality" is a subjective term since there is a substantial diversity in what people are seeking in outdoor recreation, such as hunting. A quality hunting experience to one hunter may be completely different to another hunter. However, the term "quality" is emphasized in the Service Manual, Chapter 605 FW 1, General Guidelines for Wildlife-dependent Recreation by stating that, "The overarching goal of our wildlife-dependent recreation policy is to enhance wildlife-dependent recreation opportunities and access to quality visitor experiences on refuges while managing refuges to conserve fish, wildlife, plants, and their habitats." Throughout the CCP, the Service uses the term "quality" not to indicate that proposed changes will guarantee an increase in harvest success, but rather to emphasize enhanced opportunities or access such as increased hunting acreage, new opportunities for free-roam hunting, increased hunt days, decreased fees, and turkey hunting opportunities, and many others explained in Objective 5.1 of Alternative B.

Comment: One individual asks, "Are you going to cut fire paths (for hunters) as you do for the bird watchers?"

Response: We are unaware of any "fire paths" cut for other priority uses of the refuge and do not plan to create any.

Comment: One individual requests that the refuge clarify the regulations on outboard motors. He writes that there is a "misconception among hunters that the 30 horsepower regulation for outboard motors does not apply to mud motors."

Response: We appreciate the comment.

Comment: Many individuals support the refuge's existing hunt program under alternative A, and do not support the proposed changes under alterative B. On the other hand, another writes, "I support reduced spending of refuge manpower and dollars by phasing out fixed hunting structures and simplifying the hunt program."

Response: We appreciate these comments. Based on comments we received, we have made several changes to our proposed hunting program under alternative B in the final CCP/EIS. We highlight these at the beginning of the appendix under "Introduction."

Comment: The authors of one letter write that they do not support "the use of ammunition that pollutes our environment."

Response: Comment noted.

Comment: One individual writes, "Have you evaluated the impact of opening the Millman Tract to [deer and turkey hunting on] the homes at Grant's Way?"

Response: The Millman Tract—which is an area north of Route 16 and is adjacent to homes in Grant's Way—was previously hunted under private ownership up until the Service purchased it in 2001. Because of this, we do not expect the proposed hunting activity to have adverse impacts on these homes.

Comment: The State of Delaware writes, "One of the objectives listed by the Service in the CCP was a reduction of disturbance to waterfowl. We contend that the Service may actually increase disturbance by mandating free roam hunting, especially the altered habitat state of the wetland units (relative to waterfowl hunting) and the unfamiliarity with areas by some hunters."

Response: Free roam hunting, or not restricting to hunters to a fixed location, will not be unique to Prime Hook NWR. This type of hunting opportunity for deer has been permitted under current management for years with negligible impacts in the salt-marsh areas in Unit I. Free roam hunting is also allowed on some State-managed areas including the salt-marsh habitats on the Little Creek Wildlife Area near Port Mahon, C & D Canal Wildlife Area, portions of the Milford Neck Wildlife Area, Nanticoke Wildlife Area, and others. Free roam hunting areas on the refuge may increase the potential for waterfowl disturbance; however these disturbances are mitigated by providing 3,185 acres of sanctuary (no-disturbance areas) in Units II, III, and IV, hunting no more than 40% of the refuge as mandated, and limiting hunting days

(four days per week) and hours (3PM closure). Free roam hunting of waterfowl is also permitted in some ponds in an area south of Prime Hook Beach Road. The Service also anticipates that the number of hunters in Unit I will be limited by access due to the small boat ramp and parking area on Fowler Beach Road. Disturbance is also decreased to waterfowl by closing the Oak Island Area in Unit II, the area south of Fowler Beach Road in Unit II, and disabled deer hunting area in Unit IV in late November to hunting and by closing the Deep Branch Trail to non-consumptive users from September 1 through March 15.

Comment: PEER writes, "In the past three years, the Service has physically destroyed more than 50% (approximately 4,000 acres) of its freshwater emergent marsh. Now, the Service's alternative B proposes to use open saline lagoon areas the Service has recently degraded as waterfowl sanctuaries and to march battalions of hunters onto the last healthy marsh remnants remaining on the refuge."

Response: We respectfully disagree. Repeated Nor'easter storm events in 2009 and 2010 overwashed the duneline along Unit II, impacting the artificially managed freshwater impoundments south of Fowler Beach Road. The Service proposed to fill the breaches to restore the duneline, as a short-term measure to slow erosion and to allow careful analysis of management options. The size of these breaches elevated 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. Legal challenges delayed the dune repair until 2011. By the time the repair was conducted, Hurricane Irene in 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 just weeks later.

Furthermore, we are providing 3,185 acres of sanctuary area (no-disturbance areas) for waterfowl and other wildlife that will serve as feeding and resting areas. Specific descriptions of these sanctuary areas can be found in chapters 4 and 5 of the CCP/EIS, but are roughly Unit II, the lower half of Unit III, and Unit IV. Habitat conditions are in a state of transition and the Service anticipates areas affected by storm erosion and flooding to be restored to salt marshes through restoration efforts proposed in Objective 3.1 of alternative B. Hunting of snow geese throughout the main hunting season and during the conservation order will be an important and necessary management tool to reduce snow goose population numbers and to minimize consumption of new vegetative growth resulting from restoration efforts.

Providing access for hunters is critical to their success. Lastly, the Service does not anticipate "battalions of hunters" across the refuge landscape. In the lottery waterfowl area, the Service limits the number of hunting parties through the use of designated blind sites. In free roam areas, hunters are limited by the available access for parking and boat launching and by hunters thinning themselves out as a way to minimize conflict with other hunting parties.

Comment: The State of Delaware asked why the Service needs to prepare a hunting compatibility determination along with the CCP.

Response: Statutory authority for Service management and associated habitat/wildlife management planning on units of the Refuge System is derived from the National Wildlife Refuge System Administration Act of 1966, as amended by the National Wildlife Refuge System Improvement Act of 1997 (16 U.S.C. 668dd-668ee). The Refuge Improvement Act provided a mission for the Refuge System and clear standards for its management, use, planning, and growth. The Act recognizes that wildlife-dependent recreational uses – hunting, fishing, wildlife observation and photography, environmental education, and interpretation – are legitimate and appropriate public uses of National Wildlife Refuges. However, these refuge uses must still be evaluated by each refuge with regard to compatibility, which includes considerations of several factors. Sections 5(c) and (d) of the National Wildlife Refuge Improvement Act states "compatible wildlife–dependent recreational uses are the priority general public uses of the NWRS and shall receive priority consideration in planning and management; and when the Secretary [of the Interior] determines that a proposed wildlife-dependent recreational use is a compatible use within a refuge, that activity should be facilitated, subject to such restrictions or regulations as may be necessary, reasonable, and appropriate." Through this required compatibility determination process, hunting has been found to be compatible on Prime Hook NWR.

Comment: The State of Delaware recommends "that the Service reconsider their selection of areas for expanding hunting and incorporate more hunter input into the selection of proposed hunting areas."

> **Response**: The CCP public comment period offered seven information gathering opportunities which provided in detail the expanded hunting opportunities in the Service's preferred alternative (alternative B). The well-publicized public meeting and open houses held in Milton, Milford, and Lewes, Delaware, were an adequate and acceptable form of public involvement. Individuals had several options for providing comments directly to staff for consideration. In the final CCP/EIS, changes to hunt areas were incorporated that were based on feedback received from hunter comments. We highlight these changes in Objective 5.1 of the final CCP/EIS, Appendix C, and at the beginning of this appendix under "Introduction."

Comment: One individual writes, "Hunters will trespass and take their chances with the adjacent landowners. Opening of this area will result in trespass to the other islands, which are supposed to be closed. You do not address potential impact to a federally-identified archeological site located on Oak Island."

> **Response**: We respectfully disagree. The Service believes the vast majorities of hunters are law-abiding citizens and will respect neighboring landowner's property rights.
>
> Although the refuge provides hunting maps and refuge-specific regulations, it is ultimately the responsibility of the hunter to know and obey them. Unfortunately, not all do. The Service will ensure that refuge boundaries are, and continue to be, properly posted to notify both refuge visitors and private landowners. Private landowners will be encouraged to contact either refuge and/or State law enforcement officers if trespassing incidents occur and every effort will be made to respond in an efficient and timely manner. The Service also encourages private landowners to post their own property, although we have designed hunting zones to be administered in a safe manner, and have buffers around communities and roads. Coordination with DNREC advises that there are already sufficient laws and regulations in place to discourage boundary shooting. Furthermore, neighboring landowners would benefit by having easy access to designated areas open to hunting on the refuge.
>
> Hunting is not new to this area. Much of the private property adjacent to the refuge is already being hunted. These areas include: Unit I along the western boundary, Unit II along Cods Road and Fowlers Beach Road, Unit III along the southeastern portion near Broadkill Beach, along Prime Hook Creek, and in the state managed Prime Hook Wildlife Area, and Unit IV along the Broadkill River, Petersfield Ditch, and in salt marshes on the western boundary. Hunting has been open in all four units of the refuge and Unit I has been hunted for years by free-roaming hunters seeking deer and upland game in refuge salt marshes.
>
> Furthermore, a designated safety zone has been in effect for year in Unit I bordering the community of Slaughter Beach. No hunting is allowed in the marshes of Unit II bordering the Prime Hook Beach community. In Unit III along the Prime Hook Beach and Broadkill Beach communities, waterfowl hunters must hunt from designated blind sites. In Unit IV along the Broadkill Beach community, disabled hunters must hunt from fixed ground blinds.

Comment: The Humane Society of the United States writes, "Alternative B would result in destructive visual and auditory disturbance to wildlife, and degrade the refuge habitats. Because of the geography of PHNWR there is virtually no area of the refuge that is not susceptible to the auditory and visual disturbance that would be caused by the expanded hunting proposed in Alternative B. These effects, in turn, make PHNWR no sanctuary at all for these animals."

> **Response**: We agree, in part, with the contention that "there is virtually no area of the refuge that is not susceptible to auditory and visual disturbance …" The refuge is relatively narrow and is crossed by several county roads. Some days auto traffic on Route 1 can be clearly heard a couple miles to the west, aircraft fly overhead, patrons of the refuge drive the county roads, birders walk the trails, refuge staff run tractors and airboats as part of their management program, residents drive to and from the

neighboring communities to the east, beach enthusiasts travel to the public beaches, kayakers paddle the creek, crabbers park along the roads, and a limited number of people hunt on or adjacent to the refuge. Unfortunately, this is the nature of NWRs in the heavily populated eastern United States. Most refuges on the east coast do not harbor qualities that we generally think of as constituting "wilderness" (e.g., quiet, or solitude). The term "sanctuary", as used in the context of the CCP, indicates an area free from hunting. A key feature of a sanctuary is to make it large enough that intrusions on its borders do not unduly disturb the normal lifecycle functions (e.g., feeding, resting, preening, and courtship), or cause the birds to take flight. We believe the areas designated for sanctuary are sufficiently large to reduce the detrimental effects of all forms of disturbance, including those resulting from hunting activity.

Comment: Several felt that the refuge's proposed changes to its hunt program will negatively impact marsh habitats. The Humane Society of the United States, the Pegasus Foundation, and Delaware Votes for Animals write, "Because Alternative B permits an 8 ½ month-long hunting season in critical marsh habitats, the continuous and overlapping seasons, particularly in the September to April period, punctuated with shooting and concentrated disturbance by hunters, would cause significant degradation of the marsh habitats."

Response: Based on responses from the CCP public comment period, the Service has revised the final CCP/EIS to not open hunting on Prime Hook Creek and the saltmarsh areas along the Broadkill River of Unit IV. The possibility for new trails to be developed from repeated hunter entry may occur in all hunt areas, including salt marsh habitats. 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 as discussed in "Impacts to Vegetation" in chapter 5 of the final CCP/EIS.

Furthermore, salt marsh habitats were found to be the most resistant to human trampling when compared to other habitats such as a natural dune, a man-made dune, and man-made coastal grasslands (Anderson 1995). This study analyzed the vegetation of five paths (one in each of the habitats) created and sustained by human trampling and reported that trampling of vegetation (estimated to be 1,815-3,630 passages per year) can be considered as very light. Even though it created paths and reduced vegetation cover and species diversity, the paths still retained a persistent vegetation (Anderson 1995). We predict that far fewer than 1,800 will free roam hunt in refuge salt marsh habitats, and therefore predict that the impact from the trampling of vegetation would be considered very light and consistent with the findings reported in Anderson (1995).

Comment: The Delaware Audubon Society, PEER, the Humane Society of the United States, and several individuals feel that expanding the refuge hunting program does not comply with the refuge's purposes. For example, PEER writes, "Opening up the entire refuge for 8 ½ months to new and continuous forms of hunting activities is an excessive expansion of the hunting program that materially interferes with and detracts from the refuge's primary use of conservation and the refuge's specific "purpose" uses which include:

- For use as an inviolate sanctuary, or for any other management purpose to conserve migratory birds;
- Protection of natural resources;
- Conservation of endangered and threatened species; and
- Incidental fish and wildlife-oriented recreational development."

PEER continues, "The CCP/DEIS downplays or ignores that the majority of refuge recreational users are non-hunting, wildlife recreationalists. Based on the Service's own data, non-consumptive users account for 90% of all wildlife-dependent recreational users, while hunters account for 2% of annual recreational visits. This clearly demonstrates that there is no real need for supporting what appears to be an unwarranted and unnecessary hunting expansion across the entire refuge as outlined in Alternative B for 2% of refuge's recreational users. Current hunting levels are more than adequate and sufficient to address the recreational needs of these "two percenters."

Response: We respectfully disagree with these conclusions. The Refuge Improvement Act of 1997 identifies hunting as one of six priority, wildlife-dependent public uses that are to receive enhanced consideration in refuge planning. The others are fishing, wildlife observation and photography, and environmental education and interpretation. Our mandate is to provide high-quality opportunities for those priority uses when they are compatible with refuge purposes, goals, and other management priorities. The Act does not establish a hierarchy among the six priority uses, but requires the Service to facilitate them when they are compatible and appropriate. In fact, we maintain or enhance opportunities for all six priority public uses in our preferred alternative. Expansion of hunting opportunities at the refuge does not come at the expense of other priority public uses. Many of the proposed changes in the hunt program have been developed to be responsive to public input and in coordination with DNREC to solve issues of inefficiency and complexity. The Service presents a full range of alternatives for hunting and analyzes their direct, indirect, and cumulative impacts. The Service also presents in Appendix C of the CCP, a Hunting Management Plan, which includes an analysis of cumulative impacts of the preferred alternative. Appendix E of the CCP, "Findings of Appropriateness and Compatibility Determinations," includes a compatibility determination for public hunting. Appendix G of the CCP, "Intra-Service Section 7 Biological Evaluation Form," includes an analysis for listed species.

Executive Order No. 13443 (August 16, 2007), "Facilitation of Hunting Heritage and Wildlife Conservation," reinforces the importance of hunting for recreational and management purposes on national wildlife refuges. That order recognizes the declining trends in hunting, and directs the Department of the Interior and other federal land management agencies to "facilitate the expansion and enhancement of hunting opportunities and the management of game species and their habitat." It also states that federal agencies are to "manage wildlife and wildlife habitats on public lands in a manner that expands and enhances hunting opportunities, including through the use of hunting in wildlife management planning." Our Regional Visitor Services Program Team also identified hunting as an "area of emphasis" for this refuge, followed by wildlife observation and photography as a tool to assist refuge managers and staff in a declining budget environment and to direct attention to what refuges do best. In 2006, each refuge in the region was assigned a first and second priority area of emphasis based on many criteria such as refuge purposes, local interest in the recreational activity, opportunities for unique experiences, and opportunities to attract National/international exposure. One of the uses of these areas of emphasis is to support CCP teams as long-range goals, objectives, and alternatives are developed.

Public opportunities to hunt on the Delmarva Peninsula are decreasing with increasing private land development. Refuge lands are thus become increasingly important in the region as a place to engage in this activity. A recent study found that 78 percent of hunters in Delaware hunt on private land (U.S. Department of the Interior 2006). When asked the importance of hunting activities in the U.S. Geological Survey visitor and community survey (Sexton et. al 2007), a little over half of the responses rated them as moderately to very important. Furthermore, hunting participation in Delaware has increased, which is in contrast to recent national trends (U.S. Fish and Wildlife Service and U.S. Census Bureau, 2006). However, new preliminary data now indicates that hunting participation in the nation has increased nine percent from 2006 to 2011 (U.S. Fish and Wildlife Service 2012). This latest trend is encouraging and the Service will continue to provide and enhance opportunities for this traditional, long-standing recreational activity on the Delmarva.

The Migratory Bird Conservation Act of 1929 authorizes acquisition of refuges as "inviolate sanctuaries" where the birds could rest and reproduce in total security. In 1949, this "inviolate sanctuary" concept was modified by an amendment to the Migratory Bird Hunting and Conservation Stamp Act which permitted hunting on up to 25 percent of each inviolate refuge. Another amendment to the Migratory Bird Hunting and Conservation Stamp Act in 1958 increased the total area of an inviolate refuge that could be opened for hunting up to 40 percent.

Whether an area is an inviolate sanctuary is a function of the mechanism of its creation. If a refuge was acquired as an inviolate sanctuary, only 40 percent of the refuge area may be opened at one time for hunting of migratory game birds. However, if the refuge was not acquired as an inviolate sanctuary, 100 percent of the refuge area may be opened for hunting.

The Fish and Wildlife Improvements Act of 1978 amended Section 6 of the National Wildlife Refuge System Administration Act of 1966 (16 U.S.C. 668dd) to provide for the opening of all or any portion of an inviolate sanctuary to the taking of migratory birds if taking is determined to be beneficial to the species. Such opening of more than 40 percent to hunting is determined by species. This amendment refers to inviolate sanctuaries created in the past or to be created in the future. It has no application to areas acquired for other management purposes.

The comment that the refuge is open to hunting for 8 ½ months out of the year is misleading. Yes, there is the potential for the refuge to be open for this length of time; however, the vast majority of the hunting will occur during the main hunting season, which typically runs for 5 months from September through January with additional hunting opportunities for rabbit through the end of February. Hunting during the snow goose conservation order, which will occur for 2 ½ months from late January through mid-April, will take place mostly in the wetland areas, leaving the upland areas open to other uses. This late season is not anticipated to bring large numbers of hunters, but is beneficial to the species and other wildlife due to overpopulation of snow goose on the refuge. We would only issue five or fewer turkey hunting permits and the vast majority of the refuge would remain open to wildlife observation and other non-consumptive uses during the turkey hunting season. The Headquarters area remains available 363 days a year for non-consumptive uses but portions may be closed for turkey hunting. Most other areas are open on every Sunday during the hunting seasons.

Comment: The Delaware Audubon Society, Humane Society of the United States, The Pegasus Foundation, Delaware Votes for Animals, and several individuals are concerned about the impacts of free roam hunting on refuge wildlife and habitats, as well as causing conflicts among hunters. For example, the Delaware Audubon Society writes, "Alternative B proposes to allow various types of roam hunting for deer and turkey by an unlimited number of hunters. This will undoubtedly lead to habitat alteration and degradation, as well as conflicts among hunters over hunting locations." Specific species and habitats mentioned include: marsh, salt marsh, water upland, and habitats; snow geese, American black duck, clapper rail, northern bobwhite, pheasants, red fox, woodcock, snipe, and wild turkeys.

Response: We respectfully disagree. We included an analysis of the impacts of hunting in chapter 5 of the draft and final CCP/EIS. Please also see similar comments and responses under "Hunting Safety, Including Conflicts with Other Users and Adjacent Landowners." We do expect some conflict among hunters over desired hunting locations and we will continue to encourage proper hunting ethics. However, the numbers of hunters that would be on the refuge at any time is not unlimited; we would only issue five or fewer turkey hunting permits, and the number of deer hunters that can free roam at any time would be limited by the capacity of the 13 parking areas found on or near the refuge that total approximately 72 vehicle spaces.

Comment: One individual writes, "Your maps incorrectly imply that Petersfield Ditch and Headquarters Ditch are open (not closed) during hunting. (Example Page 4-67)."

Response: We agree and are sorry for any confusion this many have caused. We have updated the maps and text in the final CCP to indicate that access to Prime Hook Creek from the refuge boat ramp is closed from September 1 through March 15.

Comment: One individual writes, "What is the purpose for opening the refuge to fox hunting?" and asks, "Is the refuge open to kill season only or also the chase season?"

Response: The State of Delaware permits hunting for red fox to reduce the incidence of mange outbreaks to maintain a healthy population and to reduce fox predation on migrating and breeding birds, particularly State and federally endangered and threatened species. Fox hunting would only be permitted when concurrently hunting deer and only in areas open to deer hunting. Chase hunting is prohibited.

Comment: Several commenters are concerned that the refuge is going to discontinue hunting reporting requirements. One letter states, "The data gathered from these reports is valuable information for evaluating the hunt and its impact on species hunted as well as the number of hunters afield…How will that aid hunt evaluation and monitoring of impacts on wildlife and wildlife habitat? How will you monitor cumulative impacts to both hunted and non-hunted wildlife?"

> **Response**: Harvest data will not be collected through refuge staff. However, deer harvest data will be available through the State Division of Fish and Wildlife's harvest reporting system and migratory bird harvest data will be available through the Harvest Information Program, or HIP. Migratory bird hunting frameworks are revised annually by the Service and this process is discussed thoroughly in the section, "Impacts to Waterfowl," in chapter 5 of the final CCP/EIS. 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.

Comment: One individual was concerned about the following statement on page E-140 of the draft CCP/EIS: "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." The individual writes, "How do you rectify [this statement] with the realities of damage to habitat and the public outcry for safety?"

> **Response**: We respectfully disagree. The proposed hunting program reflects a diversity of safe, quality hunting experiences that minimize impacts to both habitat and wildlife resources. Changes in habitat conditions, visitor use, and unexpected circumstances may require adaptive measures where the refuge manager may have to either restrict or liberalize hunting regulations if they conflict with other higher priority refuge programs or endangers refuge resources or public safety.

Comment: The Humane Society of the United States is concerned with the refuge expanding areas open to hunting. They write, "Refuge areas would be greatly expanded to accommodate extended and expanded hunting seasons, to wit:

- **1,513 acres** would be added to the deer hunting area;
- **1,732 acres** of fragile salt marsh would be opened to waterfowl hunting; and
- **3,472 acres** would be **newly** added for turkey hunting."

> **Response**: We believe that the proposed hunting expansions will provide a more quality hunt for hunters, and will not occur in areas or times currently allowed to other non-consumptive users. Many of these proposed "new" hunting areas are currently open to some type of hunting or have been previously open either under refuge management or private ownership. For example, Unit I is currently open for deer and upland game hunting (including dove hunting) and we now propose to open it for waterfowl hunting. The only refuge lands we propose to open to hunting that is not currently being hunted for any species includes: an area located north of Prime Hook Road commonly referred to as Oak Island (deer only), an area north of Route 16 referred to as the Millman Tract (deer and turkey), an expanded area of the existing Jefferson Lofland Area and Headquarters Area (deer and turkey), an expanded area of the Unit III waterfowl hunt area (waterfowl only), and an area west of Petersfield Ditch in Unit IV. Of these areas, Oak Island was previously hunted under refuge management up until 1995 and the Millman Tract was hunted under private ownership up until the Service purchased it in 2001. The expanded areas of the Jefferson-Lofland Area, Headquarters Area, and nearly all of the proposed Unit III waterfowl hunt area were previously hunted under refuge management. No prior hunting of the area west of Petersfield Ditch is known.

Hunting Safety, Including Conflicts with Other Users and Adjacent Landowners
(Letter ID#: 4, 5, 9, 13, 16, 17, 24, 28, 29, 31, 32, 34, 35, 36, 37, 40, 41, 43, 45, 53, 60, 64, 70, 71, 73, 80–Petition, 81, 82, 88, 92, 97, 98, 100, 103, 104, 105, 106, 107, S6, S7, S11, S12, S16, S17)

Comment: Several commenters, including the Delaware Audubon Society, feel that closing portions of the refuge for hunting activities would negatively impact other refuge users. One letter states, "The majority of refuge visits based on PHNWR annual visitation numbers come from non-consumptive recreational users, who come expressively to see and observe wildlife at Prime Hook. Yet, as the major recreational user group of the refuge their opportunities are instead being significantly reduced and/or totally eliminated for 8 ½ months during proposed expanded hunting activities." Another writes, "Opening up more trails is a wonderful idea, but the major part of the year those trails will be closed to those who want to take a walk or simply observe nature." Similarly, The Canoe Crusiers Association of Washington, D.C. was concerned about nonmotorized boating closures due to hunting. They write, "We would like to…urge a change in the current restrictions on paddling on the refuge. Specifically…the closure of Prime Hook Creek between early October through March…to minimize wildlife disturbance and avoid hunting conflicts…there is no reason the resource cannot be more equitably shared…by setting aside some days for paddling or distributing a limited number of passes. [We consider the cooler months prime paddling time]…As for hunter conflicts, if the hunters are not currently shooting each other or disturbing each others' success, why would an occasional few paddlers have a greater impact."

On the other hand, one individual does not feel that the existing hunt program conflicts with other users. He writes, "From what I've noticed…I find the [proposed changes to] hunting [under alternative B] over kill. During the hunting season I've see only a few bird watchers in the area."

> **Response**: We respectfully disagree. Areas and opportunities that birders, hikers, photographers, and other non-consumptive recreational visitors enjoy and use on the refuge currently will be not be reduced or curtailed under the Service's preferred alternative. The majority of the refuge would remain open to wildlife observation and other non-consumptive uses, and provide more opportunities and open areas than under current management, as described under objective 5.2 in alternative B of the CCP/EIS. More specifically, opportunities for wildlife observation and photography have been expanded to include seven new trails totaling 3.7 miles throughout the refuge in all four management units on existing maintained trails or interior refuge roads, bringing the total number of trails to 14 and 9.9 miles. The Headquarters area, which contains six trails covering six of the nine total miles of refuge trails, remains available 363 days a year for non-consumptive uses, but portions may be closed for turkey hunting. All other areas except for the Deep Branch Trail, Fowler Beach Road trail (southside), and Prime Hook Creek are open on every Sunday during the hunting seasons. The Deep Branch Trail, the Fowler Beach Road trail (southside), and Prime Hook Creek are open with seasonal closures of every day from September 1 through March 15 and if necessary during the snow goose conservation order or turkey hunting seasons. If and when the photography blind is available on the southside of Fowler Beach Road, this portion of the trail will be open year round and open every Sunday during the hunting season. The majority of the hunting will occur during the main hunting season, which typically runs for five months from September through January, with additional hunting opportunities for rabbit through the end of February. Hunting during the snow goose conservation order, which will occur for 2 ½ months from late January through mid-April, will take place mostly in the wetland areas, leaving the upland areas open to other uses. This hunt is not anticipated to bring large numbers of hunters, but is beneficial to the species and other wildlife due to overpopulation. With five or less turkey hunting permits issued in April and May, a vast majority of the refuge would still remain open to wildlife observation and other non-consumptive uses.

Comment: Many commenters felt that adding free-roam hunting and removing deer stands and duck blinds would reduce safety. Several felt that blinds and stands were important for older and youth hunters. For example, the State of Delaware recommends, "that the Service consider maintaining some stands to provide safe and accessible hunting opportunities for older hunters and youth." The town of Slaughter Beach writes, "There is an increased risk to public safety if free-roam hunting is allowed around or within our borders."

Response: Visitor safety at refuges is a high priority when developing compatible wildlife-dependent recreation programs, such as hunting; however, it is ultimately the responsibility of every hunter to be safe. An accident involving hunter safety results from either a lack of hunting ethics or a violation of hunting regulations. Under alternative B, we would recommend and encourage the use of portable deer climbing stands, but will not require it. For hunters who may be unable to climb trees using portable deer stands or who may wish to hunt from permanent deer stands or duck blinds, the State-owned Prime Hook Wildlife Area, which adjacent to the refuge, will continue to provide these opportunities.

Providing elevated deer stands, and to a lesser degree waterfowl blinds, is relatively unique to Delaware. There are many areas on the Delmarva Peninsula, other than Prime Hook NWR, that offer public hunting opportunities in free-roam areas where the hunter can use their own blind or stand, if desired.

Based on the comments we received, we conducted a web-search for public lands within the three states making up the Delmarva Peninsula in order to evaluate the prevalence of permanent waterfowl blinds or deer stands on public hunting lands. We looked at a wide range of public lands (215 different tracts) including state parks, national parks, state forests, Chesapeake forest lands, and natural resources management areas.

Of the 215 tracts we evaluated, 131 offered waterfowl hunting. Of the 131, only 36 provided either a pit or standup blind somewhere on the tract. For example, Tuckahoe State Park provides 4 pit blinds but also allows free roaming along the Tuckahoe River. Of the 36, 28 were located in Delaware, 8 in Maryland, and none in Virginia. Twenty tracts required hunters to hunt at a stake or within some designated distance from a blind site where the hunter would provide the blind (if desired), including 9 in Delaware, 11 in Maryland, and none in Virginia. A total of 84 tracts permitted free-roam hunting where the hunter would provide the blind (if desired), 17 in Delaware, 60 in Maryland, and 7 in Virginia.

Of the 215 tracts we evaluated, 181 offered some form of deer hunting; we did not make a distinction between the various methods (e.g., some tracts may be limited to bow hunting only). Of the 181 tracts, 95 were located in Delaware, 77 in Maryland, and 9 in Virginia. A total of 51 of the 181 tracts required hunters to use stands that were provided, all of which were located in Delaware. Free-roam hunting was permitted on 165 tracts, including 80 in Delaware, 76 in Maryland, and 9 in Virginia. We acknowledge that some free roam areas were for bow hunting only, however such a distinction would only apply in Delaware; all deer hunting tracts in Maryland and Virginia permitted free-roam hunting regardless of hunting method.

For the 85 tracts located in Maryland and Virginia where no stands are provided, only 2 require an elevated stand, which the hunter must provide. For areas immediately adjacent to the building complex on Blackwater NWR, the hunter must use an assigned blind site where the hunter erects a stand with a platform minimum of 8 feet above the ground. All other tracts on Blackwater NWR are free-roam where ground-hunting is permitted. The second site where elevated deer hunting is required is on Chincoteague NWR, around the tour loop. Here the hunter must erect his/her own stand with a platform minimum of 14 feet above the ground. All other areas on Chincoteague NWR permit free-roam hunting.

We should also add that rifle hunting, as well as deer drives, are permitted on most public hunting lands on the lower eastern shore of Maryland and the eastern shore of Virginia. Please also see our responses below under “Waterfowl Hunting – Blinds” and “Deer Hunting – Tree Stands.”

Comment: One individual writes, “There is no safety zone along Fowler and Slaughter Beach Roads or along the beach. What happened to public safety considerations?”

Response: State law requires hunters to be a minimum of 15 yards away from public roads providing a safety buffer, and hunters are not allowed to shoot across a public road or right-of-way. Currently, much of the areas bordered by Fowler Beach Road and Slaughter Beach Road are hunted, and the safety record to date has been excellent. There is also a safety zone in place (please see map 4-9 in the CCP/EIS) in Unit I near the more populated Slaughter Beach community.

Comment: The Humane Society of the United States writes, "Populations of turkeys, foxes, pheasants, and bobwhite quail on PHNWR are very low; allowing them to be hunted will impinge upon the public's aesthetic interest in observing wildlife. Some may not even exist on the refuge. But, opening a formal hunting season for these animals will guarantee that if they are seen, they will be shot or shot at, depriving the visiting public and non-consumptive users any ability to see, enjoy or interact with these animals."

> **Response**: The game species listed in the comment are considered residents, subject to hunting regulations set by the State of Delaware. Pheasants are also an exotic species in Delaware. The State of Delaware monitors these species populations and sets seasons and bag limits, as warranted. Also, where and when game density is low, hence hunter success is low, hunters typically move on to other sites, potentially improving their opportunity for success.
>
> The commenter should be aware that a proportion of all animal species living in areas outside tracts delimited for hunting are subject to numerous sources of natural mortality, as well, though it is unlikely that either hunting or natural sources of mortality "will impinge upon the public's aesthetic interest in observing wildlife." There is no "guarantee that if they are seen (by hunters) they will be shot or shot at …" Hunters must abide by State and Refuge specific regulations, including seasons, bag limits, methods of take, and open/closed area restrictions, to name a few. These regulations are designed to limit excessive harvest of animals.
>
> The Refuge Improvement Act does not prioritize the six primary wildlife dependent public uses. Consumptive and non-consumptive users on PHNWR will be separated, by design, in time and space, permitting all individuals to pursue their preferred form of wildlife dependent recreation without undue interference from the other.
>
> Finally, hunters, as much as anyone, enjoy the aesthetics associated with viewing wildlife during all periods of the year, not just during the hunting season. Under the preferred alternative, opportunities for all visitors to enjoy wildlife will be enhanced by maintaining existing, or opening new parking lots, access trails, boat ramps, fishing areas, and photo blinds.

Comment: The authors of one letter recommend having a self service check-in and check-out for hunters. They feel that hunter safety requires knowing that safe exit has occurred. Similarly, another felt that removing stands and blinds could make it difficult to find "lost hunters." He writes, "Currently there is no staff available at the end of the hunt…If a hunter is overdue, first responders have [a better] chance of locating the individual if they at least have a starting point [such as] a stand or blind."

> **Response**: Visitor safety is a key issue in providing quality compatible wildlife-dependent recreation programs, such as a refuge hunting program. Check stations are generally used to control hunting area access, collect biological information, and, when appropriate, to enforce hunting regulations. Although the refuge's hunting program is developed in such a way to provide a safe and wholesome hunting opportunity, it is the responsibility of every hunter to develop a plan for every hunt to include preparation, communications with companions, knowledge of location, emergency preparedness, safety, etc. This responsibility also applies to all refuge visitors, including trail users, anglers, canoers, birders, and photographers.

Comment: Several individuals were concerned that deer and waterfowl hunters in free-roam hunting areas might trespass and interfere with private landowners adjacent to the refuge. Several others felt that adjacent landowners would be at a higher risk of being hit by stray bullets if waterfowl blinds and deer tree stands were eliminated. One writes, "In past years with no safety zone in place we had problems with all types of hunters trespassing from the refuge side. A recent safety zone has helped but is no longer in your preferred option. We should be able to walk on our property anytime without fear of public hunter contact or being shot. Private landowner's should have protections from public hunters… We should not be responsible for policing our land against trespassers...We have encountered armed trespassers on our land (with no enforcement available) and have had shot rain down on us as we walked our farm. When asked, management felt that a 100 yard safety zone was asking too much. Considering that the Refuge has 10,000 acres at its disposal, our safety should rank higher on the list of priorities. The refuge should be a good neighbor, a part of our community. We need a buffer zone..."

> **Response**: Map 4-16 of the CCP/EIS shows buffer zones for hunting for the Service's preferred alternative, which maintains the Slaughter Beach safety zone. Although the refuge provides hunting maps and refuge-specific regulations, it is ultimately the responsibility of the hunter to know and obey them. Unfortunately, not all do. We will ensure that refuge boundaries are, and continue to be, properly posted to notify both refuge visitors and private landowners. We encourage private landowners to contact either refuge and/or state law enforcement when these trespassing incidents occur and every effort will be made to respond in an efficient and timely manner. We also encourage private landowners to post their own property, and there are laws and regulations in place to discourage boundary shooting.

Comment: One individual writes, "Hunters in the proposed hunt areas along the Broadkill River and Petersfield Ditch in Unit IV will be violating Delaware law by hunting within 1,500 feet of established blinds located on private property near or adjacent to the refuge."

> **Response**: Based on public comment, we have revised the refuge's final CCP/EIS to reflect a reconfiguration of hunting areas, which is described in objective 5.1 of alternative B. We no longer propose waterfowl hunting in refuge areas adjacent to the Broadkill River and Petersfield Ditch. For clarification, the proposed activity to hunt this area in the draft CCP/EIS was not in violation of Delaware law since hunters would be hunting on shore and not by boat. According to the Delaware Administrative Code in Title 7 (Natural Resources & Environmental Control), Section 2.3.1 of the Wildlife Section states "During the season for the hunting of migratory waterfowl, it shall be unlawful for any person to hunt from a boat of any kind that is within 1500 feet of an established blind…"

Comment: The authors of one letter feel that the "primary objectives" of the refuge's hunting program should be safety, followed by the quality of hunting experience.

> **Response**: We agree that public safety is the most important objective of the refuge's hunting program. "Quality" is a subjective term as there is a substantial diversity in what people are seeking in outdoor recreation, such as hunting. A quality hunting experience to one hunter may be completely different to another hunter. In the preferred alternative, we propose to expand hunting on refuge lands to offer quality opportunities for hunting deer, waterfowl, upland game and webless migratory birds (dove), and turkey. Hunters would also have the opportunity to harvest a renewable resource in a traditional manner, which is culturally important to the local community. Under all alternatives, the public will be able 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. The Service also makes special accommodations for mobility-impaired hunters and youth hunters, which will provide the opportunity to experience a wildlife-dependent recreation, instill an appreciation for and understanding of wildlife, the natural world, and the environment, and promote a land ethic and environmental awareness.

Comment: One individual suggests creating hunting zones and limiting the number of hunters allowed in each zone for safety reasons and to limit conflicts among hunters.

Response: We agree that zoning of hunt areas and limiting hunter numbers are methods that can be used to limit conflicts among hunters and other user groups. In fact, alternative B proposes to limit hunter numbers in the Deer and Waterfowl Lottery Hunt Areas because these have historically been highly used areas. Futhermore, zoned areas or blind sites are proposed for the Waterfowl Lottery Hunt Area to create designated areas for each hunting party. We have also proposed areas that do not restrict the hunter to a defined area, which is discussed in further detail earlier in this section.

Hunting Fees and Program Costs
(Letter ID#: 4, 5, 14, 15, 16, 17, 24, 28, 60, 81, 92, 98, 100, 103, 107)

Comment: A few individuals suggested expanding the use of volunteers to administer the hunting program to cover staff shortfall.

Response: Volunteers contribute great ideas and enthusiasm, and we are very supportive of expanding opportunities for volunteers at Prime Hook NWR. Volunteers contribute, and will continue to contribute, by helping with the success of the hunting program through maintenance and public outreach. The level of training required for many programs such as the hunting program, and the level of responsibility that go with them make it unrealistic, and even unfair, to expect volunteers to run them.

Comment: Several individuals felt that the refuge should not make any changes to the existing hunt program, but rather focus on properly funding the program. One writes, "This is a major refuge mission and should be properly funded."

Response: Refuges receive annual funding from an annual budget approved by Congress. In the Service's Northeast Region, refuges are currently funded at 75-percent staffing and 25-percent operating levels. Prime Hook NWR also receives funding from permit fees that are collected for the development, operation, and maintenance of the permitted forms of recreation such as hunting. At least 80 percent of all fees collected remain available for expenditures at that location, with the remaining balance used region-wide.

Reduced funding over the past several years has placed the Service in a position where it had to reduce staffing nationwide and the refuge system has sustained flat lined budgets since 2009. Regardless of funding levels, the refuge's current hunting program is inefficient and requires a significant amount of staff resources. Administrative burdens of the existing hunting program are out of balance with other priority refuge needs and services and the amount of station resources going into the program seem to far exceed what is necessary to provide for a quality hunting program. Alternative B, the Service-preferred alternative, reduces this administrative burden and minimizes the amount of staffing resources needed to conduct the hunt by 54 staff days and $17,890.

To improve the refuge's program, we evaluated the refuge's existing hunting program, incorporated the opinions of hunters, and developed alternatives 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 (August 16, 2007).

Comment: A few individuals suggest that the refuge charge a fee to all refuge visitors, not just hunters. One writes, "To eliminate hunting time and increase the fees for hunters is [discriminatory]. If money is the issues then mandate a permit…for ALL that enter the [refuge]." Another writes, Can other public use programs on the refuge be fee based to allow more of the money collected from hunting fees to be returned to the hunting program?"

Response: The refuge does not charge an entrance fee for all visitors since there are many entrances to the refuge (see response above under "Public Use and Access").

Comment: Several individuals are opposed to increases in hunting fees, while a few others feel that the increased hunting fees are necessary "because of the cutback[s] in Washington" and "to offset costs." One opposed writes, "I dislike the new fee…it would triple the cost to hunt a single day on the refuge." Another writes, "The new electronic way costs us hunters, the fees are put on us. Doesn't sound right that we have to pay for something we don't want!!!"

Response: To encourage hunter participation, hunting fees are being eliminated to provide opportunities to hunt waterfowl, deer, and upland game in some refuge areas at no charge. Fees will still be required for lottery hunt areas 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.

Under the Service-preferred alternative, 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. The application fee, processing fees, and change from a $5 per hunter fee to a flat $15 per blind fee are the most significant changes from the current fee structure. 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 Service costs by over $3,000 and all application and processing fees will be paid to the contractors for administering this permitting process.

Comment: One individual writes, "Hunters and anglers pay for the refuge through Duck Stamps, hunting/fishing licenses, and taxes on gear, ammunition, and equipment. Any money collected from hunting permits should be used towards the refuge's hunting program." Another individual concurs, writing, "Please listen to us, Prime Hook was made for hunting, is paid by ONLY HUNTERS and we deserve some say!!! We have no problems with birdwatchers or hikers but we all know they have no fee for what they do."

Response: We recognize hunters and anglers have been and continue to be major financial supporters for conservation in this country. In fact, the funds collected from the sale of Migratory Bird Hunting and Conservation Stamps (Ducks Stamps) have purchased over 80 percent of the land that now make up the Prime Hook NWR. However, operation and maintenance funds for national wildlife refuges do not come from the sale of hunting/fishing licenses, the sale of Duck Stamps, or from taxes on equipment, but from general tax revenues.

The Federal Aid in Wildlife Restoration Act of 1937 or "Pittman-Robertson Act" and the Federal Aid in Sport Fish Restoration Act of 1950 or the "Dingell-Johnson Act or Wallop-Breaux Act" provide Federal aid to the States for management and restoration of fish and wildlife through excise taxes on fishing equipment, ammunition, guns, boat motor fuel, and others. Revenue generated from hunting and fishing license fees also supports State fish and wildlife programs.

Refuges receive annual funding from an annual budget approved by Congress. The Refuge Improvement Act requires that each refuge facilitate compatible hunting, fishing, wildlife observation, photography, interpretation, and environmental education. Permit fees are charged and collected for the development, operation, and maintenance of the permitted forms of recreation such as hunting. At least 80 percent of all fees collected will remain available for expenditures at that location, with the remaining balance used region-wide. Fees collected from lottery hunts will be used for costs such as printing annual hunting regulations, sign replacement, disabled hunting blind maintenance, and other infrastructure and maintenance needs.

Comment: The State of Delaware writes, "The CCP also mentions that many of your proposed hunting changes are scheduled to reduce cost. Although we certainly understand the need to be cost efficient in operating the hunting programs, we also contend that supporting hunting is a focus of our joint mission and therefore we should not expect the cost of running the program to be balance with income generated. We are in the business of providing hunting opportunities to the public and there will be costs that must and should be absorbed. We do not analyze habitat development and maintenance in terms of user cost; why do we then evaluate priority recreational activities for their programmatic cost?"

> **Response**: Refuge management's primary focus must be on the refuge purposes and the Service Mission; other uses remain secondary and are permitted only when found compatible. The Refuge Improvement Act does not prioritize the primary wildlife dependent recreational uses. Under the current hunt management regime, hunting is consuming an inordinate amount of refuge staff time and resources, competing directly with other equal or higher refuge management priorities. Revision of the hunt plan is necessary to bring refuge management more in line with statutory responsibilities. The proposed hunting changes are scheduled to reduce the cost for both administering the hunting program and for the hunter. The Service realizes that some costs associated with administering any recreational program must be absorbed; however, the Compatibility Policy (603 FW 2) requires that an analysis of costs for administering and managing the use must be completed to ensure that there are sufficient resources. Furthermore, the Recreation Act requires that staffing and funds are adequate to administer the program.

Hunting Lottery
(Letter ID#: 4, 14, 15, 16, 17, 28, 31, 37, 43, 53, 57, 60, 77, 81, 92, 95, 97, 100, 103, 108–Form letter)

Comment: Many respondents felt that the refuge should stay with the current daily permit system for waterfowl hunting because requiring hunters to sign up for a blind in advance will eliminate the ability to choose a blind according to weather conditions, hunting pressure, and competition as hunters can do with the current daily standby drawing. Many stated they felt the current system works well and do not see any reason to change it.

> **Response**: Preseason lottery drawings are proposed for high demand areas, including the lottery deer hunting area (Headquarters Area), disabled deer and waterfowl hunting areas, lottery waterfowl hunting area, and lottery turkey area to reduce hunter conflicts, lessen administration, and provide equal opportunity for all hunters. Particularly on opening days, it is common to see 60 to 80 duck hunting parties show up for 25 to 27 blinds and to see over 100 deer hunters show up for 32 deer hunting stands. Preseason lottery drawings 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/or scout, which ultimately helps to improve their hunting experience. Daily standby lottery drawings would be eliminated for reasons outlined in objective 5.1 in alternative B.
>
> In particular, for waterfowl hunting, the preseason lottery drawing will randomly select a blind site location for a given date. The permittee must choose to accept by completing payment or deny the selection. It is possible for someone entered in the drawing to be randomly selected for multiple dates. However, for the vacant hunting opportunities not selected during the preseason lottery drawings, hunters will have the flexibility to go to the third party contractor's website on a first-come, first-serve basis at any time (24 hours a day) during the hunting season, view available hunt dates and blind site locations, and select and pay for these permits, even on the day of the hunt. Refuge staff will work with the contractor to provide the highest level of customer support.

Comment: Several individuals felt that the proposed lottery system for issuing waterfowl hunting blinds might result in blinds sittingempty if people decide not hunt them on any given hunt day. They were disappointed that there is no chance for stand-by hunters to hunt if others do not show up.

Response: Yes, on any given hunt day "no-shows" may occur and those blinds would not be available to other hunting parties on that day. We predict that the number of no-shows will be few since the blinds will be paid for in advance and only the permittee is required to be present. Since the permittee may bring any two unnamed hunters, the permittee has flexibility in adjusting the members of his hunting party at any time due to unexpected circumstances. Furthermore, our proposed hunting program allows permitted parties to secure a blind site location even though they may not hunt until later on that day to catch ducks returning to the refuge marshes. Hunters may forfeit their permits to the contractor without compensation to make available for other hunters.

Comment: Several individuals pointed out that not everyone has internet access or the necessary computer skills to participate in the preseason lottery drawing.

Response: For those individuals who do not have computer access, customer representatives would be available by telephone during business hours on weekdays to assist. A kiosk may also be available at the refuge for hunters to check the availability of hunting opportunities online.

Comment: Several hunters were concerned that people might attempt to limit hunting by reserving all of the blinds during the preseason lottery drawings.

Response: All applicants in the deer and waterfowl preseason lottery drawings have equal chances of being selected multiple times. For the vacant hunting opportunities not selected during the preseason lottery drawing, hunters will be allowed to claim only one permit per day to avoid someone from claiming all available vacancies at one time. All fees must be paid prior to the issuance of the hunting permit. For those attempting to submit duplicate entries or reserve blinds with no intention of hunting them, we have been assured by third-party contractors that there are adequate checks in lottery software programs to detect these circumstances. Tens of thousands of hunting permits have been issued to hunters at other national wildlife refuges through a similar lottery system with no occurrence of any of these issues.

Comment: One individual suggested the following: "To solve the issue of collecting the money and permits several days a week, move the lottery to the outside of the visitor center and make a slot on the building where hunters can safely deposit their permits/money and can be counted only once a week."

Response: We appreciate your suggestion; however, permits and fees must be collected more frequently to ensure proper accountability. We have proposed to use a web-based system to issue permits and collect fees, which is discussed in Objective 5.1 of the Service's preferred alternative.

Comment: One individual writes, "The lottery is not good for nonambulatory hunters since most hunt in the afternoon because the lottery makes you reserve a blind for the morning and most of us live 1 to 1.5 hours away, which is impractical to be there that early."

Response: We disagree. Under the Service's proposed hunting program, successful lottery applicants will be issued a permit for a date and he/she may choose when they would like to hunt during that day (e.g. he/she could choose to hunt all day, only in the morning, only in the afternoon, etc.). No check in is required.

Hunting Times and Dates
(Letter ID#: 4, 14, 15, 16, 28, 31, 37, 43, 53, 64, 67, 77, 80–Petition, 92, 97, 98, 99, 103, 107)

Comment: Many commenters did not support the proposal to change waterfowl hunting hours under alternative B. In particular, they did not want the refuge to close to waterfowl at 12 p.m. because they feel the early afternoon is a productive hunting time. Most requested the refuge continue to allow hunting until 3 p.m. Similarly, The State of Delaware recommends the Service consider closing the daily hunts at 3:00 PM or later. This would be consistent with management on state areas providing familiarity and reduce complexity to waterfowl hunting regulations within the State.

Response: We have revised the final CCP/EIS to allow waterfowl hunting four days per week until 3:00 p.m in all waterfowl hunting areas to be consistent with State hunting regulations and hunting programs on State wildlife management areas.

Comment: Many commenters asked why the refuge was proposing to change hunting days and requested that the refuge keep hunting days to Monday, Wednesday, Friday, and Saturday.

Response: We have revised the final CCP/EIS to allow waterfowl hunting four days per week in all waterfowl hunting areas.

Comment: The State of Delaware recommends that the Service restore Friday as a waterfowl hunting day.

Response: As noted above, we have revised the final CCP/EIS to allow waterfowl hunting four days per week in all waterfowl hunting areas to be more consistent with State regulations. This may very well include a Friday hunt day but is subject to change for management purposes if necessary.

Deer Hunting – General
(Letter ID#: 28, 81, 95, 108–Form Letter)

Comment: The form letter states, "Archery, including the crossbow, should be allowed."

Response: We agree. The Service fully supports archery hunting, including the crossbow, as explained in objective 5.1a under alternative B in the draft CCP/EIS.

Comment: One individual suggested adding a handgun deer hunt on the refuge, stating, "This is an extension of the State deer hunting season that many folks enjoy. Follow State regulations."

Response: We generally seek additional opportunities to harmonize the refuge and State regulations. Except for the January hunt, the refuge permits the hunting of deer with a handgun provided that State regulations are abided by.

Comment: One individual felt that discontinuing cropland management on the refuge was negatively affecting the quality of deer hunting opportunities. He writes, "I would probably still deer hunt there is the conditions were better [and] there were crops planted again. I feel Prime hook in the past could possibly be in the future one of the best public hunting properties in the US. In my opinion it can only be improved by going back to the management policies of the past, i.e. planting crops and some form of freshwater impoundment."

Response: Farming was once a management tool on Prime Hook NWR to provide supplemental food for declining waterfowl species and was once believed to provide habitat for other animals. At its peak crop acreage in the 1970s, farming at Prime Hook maintained a modest amount of crops compared to the total cropland available to wildlife at the time on the Delmarva Peninsula. While the refuge provides vital wetland habitat to many species, the Delaware Wildlife Action Plan shows that agricultural land is not critical habitat for birds.

Deer Hunting – Tree Stands
(Letter ID#: 4, 5, 13, 15, 28, 31, 32, 36, 37, 49, 60, 73, 77, 88, 92, 95, 97, 100, 103, 106, 108–Form Letter, S6, S7, S16)

Comment: Many individuals were concerned with the proposal to phase out permanent deer stands and allow "free-roam" hunting because they felt it was unsafe and would lead to shooting accidents, would result in a poorer quality hunt, or lead to trespassing issues. Some were also concerned with the impacts on older hunters.

Response: We appreciate the concern with the planned phase out of permanent deer hunting stands on the Prime Hook NWR. This is a difficult issue due to the number of hunters involved and the strong traditions that have developed. We feel that the proposal will improve the quality of the refuge's hunt programs. First, hunters who prefer the use of a tree stand may use their own portable stand. We believe that free-roam hunting will address the following issues proposed by hunters: hunters have expressed an interest in scouting, having the flexibility to have greater access to where the deer are located, and/or the ability to adjust their hunting locations for weather conditions to enhance the quality of their hunt. We also feel that free-roam hunting makes the most sense given proposed changes in refuge management. Because we propose managing more acreage as forest and grassland, hunters will need the freedom to choose how and where they hunt (See also comments and responses under "Hunting Safety, Including Conflicts with Other Uses").

Comment: One individual suggests creating "stand sites," similar to the waterfowl blind sites, in place of the tree stands to improve safety and reduce conflicts among hunters.

Response: Year to year changes in habitat conditions due to succession will make it very difficult to provide fixed hunting positions. Please also see similar comments and responses under "Hunting Safety, Including Conflicts with Other Users and Adjacent Landowners."

Waterfowl Hunting – General
(Letter ID#: 14, 15, 16, 81, 93, 97, 100, 105, 108–Form letter)

Comment: One individual stated that she did not support hunting on the refuge. She cited the following reasons: it is not compatible with other public uses, uses taxpayers money, wildlife watchers outspend hunters, hunting is not in the public interest, and hunters may negatively impact refuge habitats and disturb, injury, or kill wildlife. In particular, she was concerned about hunting during the fall when species are migrating. She also did not see any benefits from hunting, writing "It dissolves the effectiveness of the entire plan to save birds, which is why the refuge was first founded."

Response: We understand some citizens' concern with hunting on national wildlife refuges. Prime Hook NWR, as well as the entire Refuge System, is guided by laws enacted by Congress and the President as well as policy derived from those laws. The Refuge Improvement Act identifies hunting as one of six priority public uses to be facilitated when compatible with the purposes of a refuge and the mission of the Refuge System. Hunting is consistent with the purposes of the refuge. While National Wildlife Refuges are managed first and foremost for wildlife, the focus is on perpetuating populations, not individuals. Hunting does adversely affect individual animals, but is allowed when it will not threaten the perpetuation of the population as a whole.

Comment: One individual writes, "The area on Broadkill south of the refuge has private blinds all around it [and] doesn't produce much!!! Also to hunt [the newly proposed areas] near Wapples Pond, there is a boat ramp close to the [waterfowl] blinds but it is on private property, the boat ramp that we would have to use that is owned by the refuge is a very long ride!!!"

Response: Based on public comment, we have revised the refuge's final CCP/EIS to reflect a reconfiguration of hunting areas, which is described in objective 5.1 of alternative B. We no longer propose waterfowl hunting in refuge areas adjacent to the Broadkill River and Petersfield Ditch or west of Foord's Landing on Prime Hook Creek.

Comment: Several individuals were concerned that the refuge's waterfowl hunting program is being negatively impacted by habitat management decisions. One writes, "Bottom line is, Prime Hook's hunting has been what it is by being a freshwater impoundment system as its been for years.. New areas, and added opportunities will not be providing anything additional at all if the ducks aren't there to begin with, and from what I gather with the preferred habitat management plan, I don't see how they can be." Another writes, "The waterfowl hunting program is not the problem- it's your lack of waterfowl habitat [management]."

Response: Please see similar comments and responses above under "Dune Breach, Marsh Restoration, and Shoreline Stabilization" and "Migratory Birds."

Comment: Several individuals and organizations were concerned about the impacts of waterfowl hunting on refuge habitats, vegetation, and wildlife. For example, the Humane Society of the United States writes, "Other waterfowl will be adversely impacted if Alternative B is adopted. We request and recommend a candid and comprehensive analysis of the aggregate impacts of 8 ½ months of largely continuous waterfowl hunting on the refuge wildlife and waterfowl habitats, the wildlife itself, and the non-consumptive visitor experience." The Delmarva Ornithological Society writes, "[We are] not aware of any biological reason for doubling the areas available to waterfowl hunting to the maximum 40% of the refuge. While we generally support increasing opportunities for waterfowl conservation and education through hunting, we [are concerned about the impacts of hunting on non-consumptive user groups]."

Response: We regret if we gave the impression that we are proposing continuous waterfowl hunting throughout the refuge. For example, on page C-55 of the draft Hunting Management Plan (appendix C of the draft CCP/EIS), we indicate that the waterfowl season will extend from September to February in the lottery hunt areas and regular hunt areas. Our intent here was to show the potential range of the hunting season. The actual season length, including starting and ending dates, will vary annually. The actual number of huntable days will vary annually, as well.

For example, during the 2012 to 2013 regular duck hunt season, the Federal framework only permits a maximum of 60 days hunted during the 128 days between September 22 and January 27. Based on this framework, the State of Delaware selected a 60-day season spread over 3 time periods. Because of additional restrictions imposed by the refuge (e.g., only allowing waterfowl hunting 4 days a week rather than 6 days a week), the regular duck season on the refuge will actually be 40 days. Similarly, for the 2012 to 2013 migratory Canada goose season, the Federal framework permits a maximum of 50 days hunted between the 83 days between November 15 and February 5. The State of Delaware selected a season of 49 days spread over 2 time periods, both of which run concurrently with portions the regular duck season. Again, because of additional restrictions imposed by the refuge, the actual length of the migratory Canada goose season will be 32 days.

Prior to the Conservation Order taking affect in late January, snow goose hunting on the refuge will occur in the same areas/blinds and on the same specific hunting dates as other waterfowl hunting. Many of the commenters were likely concerned about the Conservation Order hunt season for snow geese. Under this order, snow geese may be hunted in all emergent wetlands continuously (except Sundays) from January 28 to April 13, 2013, once all other waterfowl hunt seasons have closed. Snow geese present a fairly unique issue due to their overabundance. The Service, Canadian Wildlife Service, and all of the Provinces' and States' fish and wildlife agencies hope to drastically reduce the size of the current continental populations of snow geese, because they have caused dramatic damage to very fragile arctic breeding grounds that are important to many species of breeding migratory birds. In order to reduce snow geese populations, these agencies have lengthened hunting seasons for snow geese, increased bag limits, and liberalized methods of take. We propose to open all available habitats on the refuge from January 28 to April 13 to specifically reduce damage sustained from overbrowsing of refuge salt marshes.

We project, based upon previous similar hunts on the refuge, that very few hunters will take advantage of the snow goose hunting opportunity for the following reasons: The hunting season starts October 1, several weeks before large numbers of birds arrive on the Delmarva Peninsula, many hunters prefer deer hunting at this time, and snow geese are difficult to hunt. We expect that hunters will take an incidental few snow geese during the regular duck and migratory Canada goose season. Over the period 2001 to 2006, when the refuge was open to late season snow goose hunting, 100 hunters harvested 96 snow geese over a shortened season extending from late January to mid-March. The hunter success rate averaged 0.96 birds/hunt. Because of the difficulty of hunting snow geese, hunting parties were composed of a minimum of two hunters. Thus a maximum of 50 total parties hunted over a combined total of approximately 216 days available over the 6 year period, each party potentially having several thousand acres upon which to hunt. Based on this information, we project negligible impacts to other refuge resources from snow goose hunting.

In addition, non-refuge areas in Delaware will also be open to snow goose hunting during the same period. It appears anecdotally that the limited number of hunters that attempt snow goose hunting during the late season are likely to do so from agricultural fields, alleviating most waterfowl hunting pressure on Delaware's tidal marshes and impoundments.

Wildlife observation is the primary reason most visitor and community residents visit the refuge, and is considered a very important activity to their visit. Expanding the huntable area for waterfowl hunting will not impact non-consumptive user groups. Over 90 percent of non-consumptive users use trails in the headquarters area, or public roads that border or transect the refuge. Currently, the headquarters area is closed a maximum of two days per year; non-consumptive users are allowed to recreate in the headquarters area 363 days per year. This remains the same under the Service's preferred alternative. Similarly, people would still be free to observe wildlife from the public roads as they do today.

For a more comprehensive analysis of waterfowl hunting impacts on refuge resources please see relevant sections in chapter 5 of the CCP/EIS; the Hunting Management Plan (Appendix C in the CCP/EIS); and the compatibility determination for hunting (pages E-191 through E-150 in appendix E of the CCP/EIS)

Comment: Several individuals and organizations were concerned with the refuge's interpretation of "sanctuary." One writes, "The concept of a 'sanctuary' is nothing more than a bait and switch, smoking [sic] mirror scam. Currently, all of Unit II is a sanctuary; salt marsh in Unit IV is a sanctuary; in essence, the salt marsh in Unit I is a waterfowl sanctuary, open only to a few deer hunters; and the west end of Prime Hook Creek is a sanctuary for waterfowl hunters. You plan to waterfowl hunt in the 'sanctuary' area of Units I and IV and the west end of the creek and close a foodless section of Unit III and call it a sanctuary?"

Response: The term "sanctuary," as used in the context of the CCP/EIS, indicates an area free from hunting and other uses. A key feature of a sanctuary is to make it large enough that intrusions on its borders do not unduly disturb the normal lifecycle functions (e.g. feeding, resting, preening, and courtship) or cause the birds to take flight. We believe the areas designated for sanctuary (3,185 acres) are sufficiently large to reduce the detrimental effects of all forms of disturbance, including those resulting from hunting activity.

Also, based on responses from the CCP public comment period, we have revised the final CCP/EIS to not open hunting on Prime Hook Creek and most of Unit IV. Based on these revisions, the refuge would now include the following adjusted sanctuary areas: Unit II (~1,800 acres), the southern half of Unit III (~390 acres), and in Unit IV (~995 acres).

Comment: One individual writes, "Since you have allowed Unit III to deteriorate to a landscape with no aquatic foods other than invertebrates, why not keep the waterfowl hunting area as it currently exists until you have rehabilitated the marsh? Keep the salt marshes and the west end of the creek closed to waterfowl hunting. This will result in less damage to valuable salt marsh."

Response: Based on responses from the CCP public comment period, the Service has revised the final CCP/EIS to not open hunting on Prime Hook Creek and most of Unit IV. The possibility for new trails to be developed from repeated hunter entry may occur in all hunt areas, including salt marsh habitats. 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 as discussed in "Impacts to Vegetation" in chapter 5 of the final CCP/EIS.

Furthermore, Anderson (1995) found that salt marsh habitats are more resistant to human trampling when compared to other habitats such as a natural dunes, manmade dunes, and manmade coastal grasslands. This study analyzed the vegetation of five paths (one in each of the habitats) created and sustained by human trampling and reported that trampling of vegetation (estimated to be 1,815 to 3,630 passages per year) can be considered as very light. Even though it created paths and reduced vegetation cover and species diversity, the paths still retained a persistent vegetation (Anderson 1995). Even using inflated and unlikely estimates of free roam use in refuge salt marsh habitats for deer and waterfowl hunting, the impact from the trampling of vegetation would be considered very light and consistent with the findings reported in Anderson (1995).

Comment: One individual writes, "A question on why Fields along Prime Hook Road were opened to waterfowl hunting was answered – at public meetings there are some small ponds there. Those ponds contain state rare plants, which you claim you will protect. Is opening these fields another 'open the max' mentality or is it a prelude to a return to farming and opening field hunting to support state needs?"

Response: The area south of Prime Hook Road has provided deer and upland game hunting opportunities in the past and will now provide opportunities to hunt waterfowl. This area has been previously open to hunting of webless migratory birds, including dove, woodcock, and snipe. Scattered throughout this area are ponds in the wooded areas, a larger pond referred to as Miry Pond, and the marsh adjacent to the State-owned Prime Hook Wildlife Area that will now provide quality waterfowl hunting experiences. Fields in this area are proposed to become either forested or shrubland and will not be suitable for waterfowl hunting. The majority of hunters will choose to hunt in the larger ponds and marsh areas and not the smaller ponds, which are located near the road. Two of these small ponds were reported to have state rare flora when surveyed in 2004-2005, which was prior to salt water intrusion into refuge wetlands. We recognize that there will be a loss in habitat and wildlife diversity due to the effects of saltwater intrusion and those impacts have been addressed in the chapter 5 of the final CCP/EIS.

Comment: One individual writes, "Hunting in the salt marshes, particularly in Unit I, will result in excessive loss of birds due to the numerous mosquito control OMWM ditches."

Response: We respectfully disagree. Ditches created from Open Marsh Water Management (OMWM) and grid ditching are common on the refuge and throughout Delaware's salt marshes, where waterfowl hunting has occurred for years. By law, hunters must make a reasonable effort to recover downed birds in their respective hunt area and the Service believes that the vast majority of hunters go above and beyond a reasonable effort.

Comment: One individual writes, "Keep it in the same area with the addition of a proposed "run and gun" area in unit 1, however no jumpshooting. Don't open PMH Creek to hunting as it's a roost area. Don't open blind sites on Broadkill River across from a neighbor's permanent duck blind."

Response: Based on responses from the CCP public comment period, the Service has revised the final CCP/EIS to not open the areas along the Broadkill River and west of Foord's Landing on Prime Hook Creek to hunting. Please see similar comments and responses regarding free roam hunting under "Hunting Safety, Including Conflicts with Other Users and Adjacent Landowners."

Waterfowl Hunting – Blinds

(Letter ID#: 4, 9, 14, 15, 16, 17, 28, 31, 32, 36, 37, 43, 53, 60, 64, 73, 77, 80–Petition, 81, 88, 92, 95, 97, 98, 100, 103, 104, 105, 106, 108–Form Letter, S16)

Comment: Many commenters noted waterfowl hunting should stay the same with the blinds provided. For example, the form letter states, "Blinds are a must with waterfowl hunting." Many were particularly concerned about the impacts of removing waterfowl blinds on youth and older hunters and public safety. One individual writes, "In order to provide a quality hunting experience for ALL hunters, these blinds MUST be maintained. Hunting from a boat is far too dangerous for adolescent hunters just learning to properly handle a firearm, and too physically demanding for aging hunters…[free-roam areas provide little to no hunting opportunities for these group]...It is my belief that the USFWS has the responsibility to provide equal opportunities to these age groups."

However, several individuals were ambivalent about, or supported, phasing out waterfowl blinds. One felt that going to blind stakes since it provides hunters with an opportunity to adapt to changing environments. Another says, "I could live with this change, but we will need better markings for blind sites and ditches."

Another individual suggested compromise. He writes, "I am probably the exemption to most hunters that have contacted you & I would like to see the blinds removed & have just blind sites. I also understand the desire some people have for keeping blinds, especially for children or older hunters. Maybe a compromise & remove 1/2 to 3/4 of the blinds & replace them with blind sites. This will reduce your management costs some & still provide a protected area to hunt from."

> **Response**: We appreciate the concern with the planned phase out of permanent waterfowl hunting blinds on the refuge. This is a difficult issue due to the number of hunters involved and the strong traditions that have developed. Hunters have expressed an interest in scouting and/or the ability to adjust their hunting locations for weather conditions to enhance the quality of their hunt. Upland habitats on the Refuge are expected to change with more acreage proposed to be managed in forests and grasslands, further emphasizing the need allow hunters the freedom to choose how and where they hunt (See also comments and responses under "Hunting Safety, Including Conflicts with Other Users and Adjacent Landowners").

Comment: The form letter states, "Offer some field blinds in Units II, III, and IV. Hunting the field blinds the same days as the waterfowl blinds." Another individual suggests the following: "Place A-frame blinds in some fields similar to Bombay Hook [National Wildlife Refuge] for more opportunities."

> **Response**: We appreciate the suggestions. However, under alternative B, we propose to eliminate cooperative farming and plan to either reforest these fields or allow them revert to shrubland. Because of this, there will not be quality opportunities to hunt from field blinds in these Units.

Comment: Many commenters were concerned that the refuge is planning to remove some of the most productive waterfowl hunting blinds on the refuge, specifically blinds 17, 19, 20, 21, and 32. For example, one writes, "No to shutting down the 6 south side blinds. It is the best hunting at Prime Hook." Several also felt that the proposed new hunting areas would not offer quality waterfowl hunting opportunities.

> **Response**: Based on responses from the CCP public comment period, the Service has revised the final CCP/EIS to keep the area where these blinds are located open to waterfowl hunting. Proposed waterfowl hunting areas now include Unit I (free-roam hunting), Unit III (south of PH Road-free roam hunting; the lottery hunt area which now includes the area south of the HQ Ditch), Unit IV (disabled blind only). The area near Prime Hook Beach for disabled hunters is now closed and all disabled waterfowl hunting will be in the current wheelchair accessible blind in Unit IV. Areas of free-roam hunting along the Broadkill River and hunting west of Foord's Landing on Prime Hook Creek are now closed.

Comment: Several individual suggested using volunteers to maintain permanent waterfowl blinds. One writes, "…if it is because of money, have us volunteers help out to manage them, or raise the regular drawing fees up and put some money to maintain them." Another writes, "Is the proposed removal of hunting structures because of budget shortfalls?

> **Response**: Volunteers contribute great ideas and enthusiasm, and we are very supportive of expanding opportunities for volunteers at Prime Hook NWR. Volunteers contribute, and will continue to contribute, by helping with the success of the hunting program through maintenance and public outreach. The reasoning for proposed changes to the hunting program, including the removal of hunting structures, are discussed in detail in objective 5.1 of the Service's preferred alternative in chapter 4 of the final CCP/EIS. Similar comments and responses can also be found under "Hunting Fees and Program Costs" in this appendix.

Comment: One individual is concerned that eliminating permanent waterfowl blinds may lead to conflicts among hunters. He writes, "I see blind sites causing problems amongst us hunters. I see hunters hunting outside of the designated areas causing a conflict amongst other hunters."

Response: Although the permanent waterfowl blinds on the refuge are proposed to be phased out over a five-year period, hunters in the lottery area 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. Although some conflicts are expected, most hunters promote proper hunting ethics, are law-abiding, and are respectful to fellow hunters.

Comment: The Humane Society of the United States and one individual were concerned that adding additional blinds would negatively affect migratory birds. The individual writes, "Your proposed hunt would close blinds in the "sanctuary" area but add others, an increase of 5 blinds. Added to the marsh opening and the early teal season, the birds get the short end of the stick. So much for wildlife first. Is not the refuge purpose to manage for migratory birds?"

Response: We have included a complete analysis of the impacts to all wildlife, including waterfowl, in chapter 5 of the refuge's final CCP/EIS (see also responses under "Hunting – General"). To minimize waterfowl disturbance, we have designated approximately 3,185 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 Unit II (~1,800 acres), the southern half of Unit III (~390 acres), and in Unit IV (~995 acres). The northern portion of Unit IV, which contains a trail and observation platform, will be closed from the Monday before Thanksgiving to March 15 to also minimize disturbance to wildlife in this area. The southern portion of Unit IV will not be open to any public use. Waterfowl hunting will stop at 3:00 pm in all hunting areas and will be limited to four days per week to reduce disturbance to waterfowl feeding patterns, which in turn will result in high quality hunting experiences. We will also decrease disturbance by closing the Oak Island Area in Unit II, the area south of Fowler Beach Road in Unit II, and disabled deer hunting area in Unit IV in late November to hunting and by closing the Deep Branch Trail to non-consumptive users from September 1 through March 15. 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 Service's Southeast Region (DeLong 2002).

The term "sanctuary", as used in the context of the CCP, indicates an area free from hunting and other uses. A key feature of a sanctuary is to make it large enough that intrusions on its borders do not unduly disturb the normal lifecycle functions (e.g., feeding, resting, preening, and courtship), or cause the birds to take flight. We believe the areas designated for sanctuary are sufficiently large to reduce the detrimental effects of all forms of disturbance, including those resulting from hunting activity. Sanctuaries also allow birds to have adequate "escape distances", which are defined as the shortest distance at which they flush or otherwise move away from the approaching person or other disturbing stimulus. Many factors influence escape distances such as hunting, flock size, hunger, migratory motivation, etc. Laursen et al. (2005) suggested providing a mean escape distance of the largest escape distances of a bird species plus one to two standard deviations to calculate the size of the core area or buffer zone. In their study, the largest escape distance was 1,000 meters for wigeon (other species included mallard, teal, pintail, waders, and gulls) and would be approximately 1,700 meters with two standard deviations. Based on this information, refuge sanctuary areas can accommodate the escape distances of most species.

More specifically, hunting on adjacent private property causes disturbance to waterfowl every year in the following areas: Unit I along the western boundary, Unit II along Cods Road and Fowlers Beach Road, Unit III along the southeastern portion near Broadkill Beach, along Prime Hook Creek, and in the state managed Prime Hook Wildlife Area, and Unit IV along the Broadkill River, Petersfield Ditch, and in salt marshes on the western boundary. Hunting has been open in all four units of the refuge and Unit I has been hunted for years by free-roaming hunters seeking deer and upland game in refuge salt marshes. Despite disturbance of waterfowl from vehicular traffic, refuge staff observe visitors year after year viewing and photographing waterfowl within 20 yards of vehicle even during the hunting season.

Comment: The Humane Society of the United States and the Delaware Audubon Society were concerned with the impacts on refuge habitats from removing waterfowl blinds. The Human Society writes, "1,723 acres of marsh areas that would be subject to lottery hunting, and where roam hunting would not be allowed, would be subject to serious habitat degradation and widespread elimination of habitat values (see Map 4-17, page 4-121 [of the draft CCP/EIS]). This would occur for two reasons. First, Alternative B requires that the permanent duck blinds in place be destroyed and removed from the refuge. Eliminating these structures will result in serious habitat degradation and destruction because multiple trips back and forth through the marsh would be necessary. In addition, habitat degradation would be accelerated because each blind removed would be replaced by a stake; some new stakes also will be added for a total of 24. Each of these stakes will be the point around which hunters, within a certain radius of the center stake, will be required to set up their hunting site each day that hunting is allowed."

> **Response**: We respectfully disagree. Providing elevated deer stands, and to a lesser degree waterfowl blinds, is relatively unique to Delaware. There are many areas on the Delmarva Peninsula, other than the refuge, that offer public hunting opportunities in free-roam areas where the hunter is required to provide the blind or stand, if desired (refer to previous comment/response regarding free-roam hunting for more information). In fact, deer hunters have been free-roam hunting in Unit I of the refuge for years and upland game hunters free roam hunt in areas in Unit I, Unit II, and Unit III with negligible impacts to habitat. Free-roam hunting of deer was permitted in all deer hunting areas between 9am and 3pm up until the 2002-2003 hunting season, but was prohibited due to complaints of unethical hunting behavior such as harvesting deer from the stands of other hunters. Access to existing waterfowl blinds is by boat and the majority of new blind site locations will also require a boat to access them, which would result in the same negligible disturbance currently observed under the current hunting program. In fact, many of the hunters may opt to hunt from their boat, using it as a blind. Some vegetative disturbance is expected around blind site markers and is expected to be negligible.

Turkey Hunting
(Letter ID#: 15, 26, 28, 29, 67, 71, 73, 81, 90, 93, 107)

Comment: We received many comments on turkey hunting. The Delaware Division of Fish and Wildlife and a few individuals supported the proposal to offer turkey hunting. The Delmarva Ornithological Society and four individuals opposed the proposed turkey hunt, while another felt like there needed to be better turkey population counts before allowing hunting to occur. Those who opposed turkey hunting cited the following reasons:

- Concerns that "turkeys are not in sufficient abundance to warrant hunting" and that the Service and Delaware Fish and Wildlife "are understaffed" and may not be able to get an accurate count of turkeys on the refuge.

- Concerns that turkey hunting would conflict with other users by closing roads, trails, and other refuge areas during the hunting season and lowering the refuge's turkey population or changing their behavior, ultimately resulting in reduced wildlife viewing opportunities. One individual feels the draft CCP/EIS fails to consider the negative impacts of turkey hunting on birdwatchers and other users. He also points out that many more people come to the refuge to bird and watch wildlife than to hunt. Another writes the opening over 3,000 acres of the refuge to turkey hunting will, "severely impact…birding due to closed areas in April/May for hunting. This is prime birding time. Will the office area be closed during hunting?"

- Concerns about the impacts of turkey hunting on refuge habitats. One individual states that allowing turkey hunting in refuge salt marshes "will have significant adverse impacts on salt marsh vegetation during a critical time of the year when new and vulnerable wetland plants emerge."

> **Response**: We respectfully disagree. Turkey hunting, which occurs in April and May, is expected to have negligible impacts on birding because only designated areas of the 3,729 acres will be open. We would only issue five or fewer turkey hunting permits and the vast majority of the refuge would remain open to wildlife observation and other non-consumptive uses during the turkey hunting season. We will post notices of any closures (i.e., on designated dates until the end of legal shooting hours, which is 1:00pm).on the refuge's website and in press releases.

Turkey hunting is not expected to have direct, indirect, and cumulative impacts on refuge salt marsh habitats because hunter numbers are limited to less than five and are scattered over 1,732 acres. The preferred habitat of wild turkeys is mature or old growth forests due to both the structural characteristics and food production in such habitats. We believe that the salt marsh in Unit I would seldom be used by turkey during any stage of it lifecycle and consequently seldom hunted. Wild turkeys take advantage of different habitats throughout the year based on their food and nesting needs. In the fall, turkeys forage in mast-producing stands of oak/hickory, oak/pine, and hardwoods. Turkeys favor hardwood stands with south-facing slopes are favored in winter and need large softwood or hardwood trees for roosting. In winter, turkeys often forage on agricultural lands. We aware that free-roam areas for turkey hunting will provide hunters greater access and may also increase the potential for marsh disturbance. However, hunters are aware of the species habitat preferences and would direct their hunting efforts accordingly within the defined hunt unit. Any potential disturbances are mitigated by creating salt marsh sanctuary areas where no hunting occurs.

Comment: The Delaware Division of Fish and Wildlife writes, "The CCP indicates that there will be a $10 daily fee for a turkey permit and a $5 application fee for the preseason turkey lottery. Since the Division will be administering the preseason turkey lottery, how will these fees be implemented?"

Response: The partnership between the Delaware Division of Fish and Wildlife and the Service provides unique opportunities to lower costs for both agencies across many of the programs that they share, such as the hunting program. Since the Division may be administering the turkey lottery, the Service plans to waive the application and permit fee for the hunter. In the event that unanticipated circumstances prevent the Division from administering the lottery during the next 15 years of the CCP, then the Service will conduct this lottery and the fee structure presented in the CCP and Hunting Management Plan will take effect.

Comment: The Delaware Division of Fish and Wildlife "recommends allowing turkey hunting on the refuge till 1:00 pm, as this would be consistent with management on State areas (both wildlife areas and state forests) providing familiarity and reducing complexity to turkey hunting regulations within the State. A noon closure would create a confusing situation."

Response: The Service agrees that consistency with state hunting regulations reduces complexity. We have revised the final CCP/EIS to allow turkey hunting on the refuge until 1:00 p.m.

Comment: One individual writes, "What is a 'huntable' population [of wild turkey]? Who determines this?"

Response: As used in the draft CCP/EIS, a "huntable" population of turkey is a population of sufficient size to support harvest of a limited number of male birds each spring without jeopardizing population viability. Wild turkey is a resident game species managed by DNREC's Division of Fish and Wildlife. Prime Hook NWR falls within Zone 9 of DNREC's Wild Turkey Management Regions and the refuge will work closely with DNREC to evaluate the status of the turkey population and its hunting potential. Zone 9, which includes the State-owned Prime Hook Wildlife Area that is adjacent to the refuge, is currently open during the spring turkey hunting season. To ensure a sustainable harvest of the state's turkey population, DNREC biologists track their health, distribution, and reproductive success. Current efforts include a volunteer-based survey used to generate an index of annual turkey productivity and recruitment, monitoring turkey harvest and hunter efforts, tracking turkeys with radio transmitters to evaluate their reproductive ecology, habitat use, and survival, and evaluating the genetic diversity of turkeys.

Comment: Several respondents wondered if it was worth all the planning "to open up 3,000 acres for turkey hunting for an extremely small number of refuge users."

Response: Hunting is one of the priority public uses mandated by the National Wildlife Refuge System Improvement Act of 1997 and hunters will benefit from a new hunting opportunity. The refuge hunt program is expected to have an overall beneficial impact on wildlife as hunting provides opportunities for visitors to become interested in and enjoy quality wildlife and outdoor experiences and potentially learn about, understand, and support natural resource protection and management.

Hunting for Individuals with Disabilities
(Letter ID#: 5, 13, 28, 32, 36, 57, 107, 108–Form Letter)

Comment: Some commenters asked that the refuge find a way to provide specific hunting opportunities for non-ambulatory disabled hunters separately from ambulatory disabled hunters, because under the current system ambulatory disabled hunters can get equal access to handicapped-accessible blinds, leaving non-ambulatory disabled hunters with very limited hunting opportunity on the refuge."

Response: The refuge's proposed action in the CCP offers opportunities for all disabled individuals. We propose to reestablish hunting areas for disabled hunters permanently confined to wheelchairs for movement to ensure that these individuals have opportunities for quality deer and waterfowl hunting experiences. This is proposed in Objectives 5.1a and 5.1b in alternative B. Hunters confined to wheelchairs have limited mobility and there are no opportunities on the refuge to hunt unless refuge staff provides them with accessible infrastructure such as ground blinds with vehicular access. These hunters do not have the option to hunt other areas, as they are limited by the accessibility that the refuge provides them. Since there are no other reasonable accommodation options for non-ambulatory individuals to hunt in other areas of the refuge, we feel it is important to provide specific areas for them. Other disabled, yet ambulatory hunters are provided opportunities to hunt in the free-roam areas, are not required in any fixed location, and may choose how far they are capable or willing to travel to hunt. Because these proposed changes do not exclude hunters with other types of disabilities from the refuge's hunting program, these methods comply with the intent of the Americans with Disabilities Act.

Non-ambulatory hunters have commented about their frustration with the current hunting system. The number of non-ambulatory hunters on the refuge has decreased since 2005, when access was granted to all individuals with any permanent disability (not just non-ambulatory hunters) to hunt in the disabled hunting area along with additional hunting days. Hunter success rates for deer have also decreased from an average of 32% from 2000-2005 to an average of 18% from 2005 to present.

Comment: One individual suggests, "Keeping the stands in to allow these to be for the helpers of the disabled hunters"

Response: Although we recognize the important assistance that these helpers provide for disabled hunters, we do not plan to offer them a special privilege over and above other hunters.

Table M.1. Letter ID Numbers and Respondents

Letter ID Number	Name/Organization
1	Robert Sylvester
2	James W. Bailey
3	Lester (Rusty) Pride
4	James D. Gormley
5	Michael Joswick
6	Melaine Hoff
7 (see also 19)	William H. Meredith
8	Marjorie Snee
9	Scott H. Willey
10	Barry V. Hollingsworth
11	John Mitrisin
12	Pat Nicosia
13	John Joswick
14	Jordan L. Reynolds
15	Derek Anderson
16	Scott Riniker
17	Anonymous
18	Larry Brown and Vicki Brown
19 (see also 7)	William H. Meredith
20	Amy J. Reed Parker
21	Lucy Huffman
22	"Jean Public"
23	Robert Hughes
24	Richard Weiner, John Chirtea, John Nicosia, Raymond Medvedik, Richard Rogers, and Jeff Mahle
25	Gabi Gail
26	Lee Noles
27 (see also 82)	Prime Hook Beach Organization – Richard S. Allan, Cindy Miller, David Allwood, Thomas Burke, Richard Capoasso, Carson, Huffman, Joe McCann, Diance McConnell, John Robinson, and Barbara Vandegrift
28	Charles N. Darling
29	David Weber
30	C. Kersey
31	Ricky Chorman
32	Ron Krakowski
33	Alliance of Bay Communities – Lisa Jones, James W. Bailey, Cindy Miller, Amy Parker, Caroline Schwartz, Kelly Reavis, James Krikbride, and Glenn Gauvrey

Letter ID Number	Name/Organization
34	Canoe Cruisers Association of Washington, D.C. – Edward Gertler
35	Broadkill Beach Preservation Association – James W. Bailey, James Bartlett, Bob Betts, Ray Burton, Robert Conte, William Fisher, Elvin Hold, Tony Keen, William Lawson, Mandell Much, George Naegele, Chales Sammartino, Richard Snyder, and Theodore Wallius
36	John Joswick, Jr.
37	Ralph W. Holston, Jr.
38	Delaware Riverkeeper Network – Jane P. Davenport
39	Sussex County Councilwoman Joan Deaver
40	Andrew (Drew) Miller
41	Jeff Horvat
42	Cathy McCarthy
43	Tyler Brown
44	The Delaware Nation – Jason Ross
45	Richard Weiner
46	Karolyn Schrufer
47	Ethan Boden
48	Kevin Nichols and Laura Nichols
49	Milton H. Maslin, Jr. and Dorothy K. Maslin
50	Anna Kavalauskas
51	The Center for Food Safety – Ryan L. Crumley, George Kimbrell, Paige Tomaselli, and Sylvia Wu
52	Cynthia Lyons and John Lyons
53	Keith Calvert
54	Ducks Unlimited – Bernie Marcyzk
55	Mark J. Wells
56	Keith Snyder
57	Scott R. Ward and Wayne Carter
58	Anonymous
59	James P. Offutt
60	Jarrod Gormley
61	Chris Argo and Jackie Argo
62	Terri T. DeVore and Lawrence M. DeVore
63	Timothy Donofrio
64	Town of Slaughter Beach – Mayor Amy J. Reed Parker
65	Jack B. Gingrich
66	G. Ronald Shoop and Christiane Shoop
67	William A. Fintel
68	Reginald D. Hill

Letter ID Number	Name/Organization
69	Delaware Chapter of the Sierra Club – Amy Roe
70	Bill Krause
71	Public Employees for Environmental Responsibility – Jeff Ruch
72	U.S. Environmental Protection Agency – Jeffrey D. Lapp
73	James B. Remaily
74	Fred A. Bennett, III
75	Kris O. Battaglini
76	John Pleisse
77	Matt Burton
78	Dale Lindsay and Eleanor Lindsay
79	George Walker and Laurel Walker
80	Save Our Beach Petition – Cheryl C. Myers, Pamela M. Schaefer, Bill Krause, Ellen Barag, Carol Ramos, and Patricia Catanzariti
81	George F. O'Shea
82 (see also 27)	Prime Hook Beach Organization – Cindy Miller
83	David R. Kemper
84	Michael Short
85	Suzie
86	Richard S. Huffman and Lucy T. Huffman
87	Terry Rahmeier
88	Lisa Jones
89	Rick McCorkle
90	Glenn L. Garner
91	Richard S. Allan
92	Richard Clifton
93	Delmarva Ornithological Society – Matthew Sarver
94	Dr. and Mrs. Robert Sutcliffe
95	Kyle Hamilton
96	Defenders of Wildlife – Julie Kates
97	Hank Draper
98	Delaware Department of Natural Resources and Environmental Control – Division of Fish and Wildlife, Mosquito Control Section – David E. Saveikis
99	John Nicosia
100	Kenneth Morris
101	Jana Hood
102	Delaware State Senator Gary Simpson
103	Anonymous

Letter ID Number	Name/Organization
104	Delaware Audubon Society – Mark Martell
105 (see also 106)	The Humane Society of the United States – John W. Grandy
106 (see also 105)	The Humane Society of the United States, The Pegasus Foundation, and Delaware Votes for Animals – John W. Grandy
107	Delaware Department of Agriculture, Delaware Department of Natural Resources and Environmental Control, and Delaware Department of Transportation – Edwin Kee, Collin O'Mara, Shailen Bhatt
108	State of Delaware Historical and Cultural Affairs – Craig Lukezic

Table M.2. Public Meeting Speakers ID Numbers and Names

Speaker ID Number	Name/Organization
S1	Joe McCann
S2	Richard Huffman
S3	Prime Hook Beach Organization - Rick Allan
S4	Jim Bailey
S5	Richard Rogers
S6	Michael Volzone
S7	Karl Schweiger
S8	Larry Devore
S9	John Nicosia
S10	Otis Clifton
S11	Doug Sentman
S12	David Harris
S13	Bill Krause
S14	Mike Charney
S15	DNREC, Division of Fish and Wildlife, Mosquito Control Section - Bill Meredith
S16	Hank Draper
S17	David Webber
S18	Humane Society of the United States and Delaware Votes for Animals - John Grandy
S19	Sussex County Councilwoman - Joan Deaver

Appendix N

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Eastern towhee

Record of Decision

Prime Hook National Wildlife Refuge

Sussex County, Delaware

Record of Decision

for the

Final Comprehensive Conservation Plan and Environmental Impact Statement

U.S. Fish and Wildlife Service

March 2013

Record of Decision

For the

Final Comprehensive Conservation Plan and Environmental Impact Statement

U.S. Department of the Interior, Fish and Wildlife Service

Prime Hook National Wildlife Refuge

Sussex County, Delaware

This Record of Decision (ROD) presents the decision regarding the selection of a Comprehensive Conservation Plan (CCP) for Prime Hook National Wildlife Refuge (NWR). It includes a brief summary of the alternatives considered, public involvement in the decision-making process, and the reasons for selecting alternative B for implementation. The Prime Hook NWR CCP will provide management guidance for conservation of refuge resources and public use activities during the next 15 years.

Alternatives Considered

The U.S. Fish and Wildlife Service (Service) evaluated the following three alternatives contained in the final CCP and Environmental Impact Statement (EIS) for the management of Prime Hook NWR.

Alternative A (Current Management): This "no action" alternative, required by regulations under the National Environmental Policy Act of 1969, would simply extend the way we now manage the refuge over the next 15 years. It also provides a baseline for comparing the two "action" alternatives. Our habitat management program would continue in its present manner, which involves no active management of wetlands due to recent extensive changes along the refuge shoreline, no active forest management, and no agricultural management of upland fields. This means that natural succession would occur in most upland habitats instead of proactive restoration actions, and that natural ecological processes would proceed with no human intervention. In this alternative's scenario, no attempts would be made to manage freshwater impoundments, nor would the refuge conduct any active restoration within impounded wetland areas. In summary, the only habitat manipulation we would continue would be the removal of invasive species and enhancement actions for federally listed endangered and threatened species. We would continue to offer hunting and fishing opportunities on refuge lands, and respond to requests for interpretive and environmental education programs. The refuge would continue to provide 6 miles of walking trails, 7 miles of canoe trails, and associated viewing and photography infrastructures.

Alternative B (Preferred Alternative): This alternative combines actions we believe would best meet the purpose and need for a CCP, most effectively achieve refuge purposes, vision and goals, and respond to public needs. Alternative B also incorporates the principles of strategic habitat conservation and focal species management, as both reflect the most recent advances in the fields of conservation science and delivery of conservation actions on the ground by the Service. Alternative B would include a combination of passive and active management approaches to foster or achieve more ecologically sustainable habitats than occur on the refuge at present. Under alternative B, the refuge would implement management actions that mimic natural processes to enhance habitat restoration where deemed most appropriate. At the same time, the refuge would strategically reduce management actions that detract from the resiliency and sustainability of a healthy system, such as artificial maintenance of extensive freshwater wetlands that are vulnerable to sea level rise. The refuge would also pursue careful sediment placement or marsh restoration to return previously managed wetlands to a natural salt marsh, which will be more sustainable in light of sea level rise. Alternative B would enhance visitor services through a proposed expansion of access facilities and new trails open for wildlife observation, photography, interpretation, environmental education, hunting, and fishing. The hunting program would be modified for greater administrative efficiency. Additional areas of the refuge would be opened for the hunting program, with careful consideration of public safety and balancing this expanded use with other options for non-consumptive wildlife-dependent public uses. With regard to mosquito control, the refuge would continue the use of larvicides, but would only use adulticides when there is a documented human disease threat.

Alternative C (Historic Habitat Management): Alternative C would return to habitat management programs that were conducted on the refuge through most of its existence, but which were stopped in recent years for a variety of reasons (e.g., changes in the environment, court decisions, updates in Service policy). These historic habitat management programs include the use of cooperative farming in upland refuge fields, and management of freshwater wetland impoundments, both originally conducted for the benefit of migratory birds. Under this alternative, the refuge, with partner assistance, would conduct infrastructure and duneline enhancements to

reestablish management of freshwater impoundments. Upland fields previously enrolled in the cooperative farming program would once again be managed through farming practices with the cooperation of local farmers. Alternative C would match alternative B in that initiating adult mosquito control would be triggered by documented mosquito-borne disease activity near the refuge. For visitor services programs and refuge uses, alternative C would expand opportunities for hunting and have a greater emphasis on public outreach and education. Fishing, wildlife observation, and wildlife photography would be similar to alternative A. We would further enhance local community outreach and partnerships, continue to support a Friends Group, and continue to provide valuable volunteer experiences.

In addition to the three alternatives discussed above, we considered four other actions but eliminated them from detailed analysis. These actions were refuge boundary expansion, certain shoreline stabilization techniques, no hunting, and reduced hunting. The full rationale for elimination of alternatives or actions can be found in chapter 4 of the final CCP/EIS.

Environmentally Preferable Alternative

The environmentally preferable alternative is the one which causes the least damage to the biological and physical environment and best protects, preserves, and enhances natural resources. We believe that alternative B, the Service-preferred alternative, is the most environmentally preferable alternative because it would assist in restoring the natural ecological values of Prime Hook's barrier island and salt marsh system and restore the natural hydrological function of these units thus providing valuable ecosystem services such as storm surge and flood protection. Alternative B also includes actively pursuing the largest amount of native reforestation which will increase Delmarva fox squirrel habitat acres and enhance the size of the refuge's population, and expand vital stopover sites and breeding habitat for migratory birds.

Public Involvement and Comments Received

Public comment has been requested, considered, and incorporated throughout the planning process in numerous ways. Public outreach has included open houses, public meetings, technical workshops, planning update mailings, and *Federal Register* notices. Five previous notices were published in the *Federal Register* concerning this CCP/EIS (70 FR 60365, October 17, 2005; 76 FR 26751, May 9, 2011; 77 FR 32131, May 31, 2012; 77 FR 47435, August 8, 2012; and 77 FR 76510, December 28, 2012). Numerous national, State, and local organizations; agencies; neighboring landowners; and interested citizens were involved in the review process. Comments and concerns received early in the planning process were used to identify issues and draft preliminary alternatives. We initially released the draft CCP/EIS for 69 days of public review and comment from May 31 to August 6, 2012. In response to public requests, we extended that period another 20 days, to August 27, 2012. During the draft CCP/EIS comment period, the Service received 106 separate written responses, 18 oral comments from the public meetings, 1,024 copies of a single form letter, and an online petition signed by 522 individuals. All substantive issues raised in the comments on the draft CCP/EIS have been addressed through revisions incorporated into the final CCP/EIS text or responses contained in appendix M of the final CCP/EIS.

Responses to Comments Received On the Final CCP/EIS

The Service issued a final CCP/EIS in December 2012 for a 30-day review period. We received a total of 14 comment letters; however, comments did not raise significant new issues, or result in changes to the analysis, or warrant any further changes to alternative B. All substantive comments were previously addressed in our response to public comments detailed in appendix M of the final CCP/EIS.

The U.S. Environmental Protection Agency stated they have no objection to the project, and recommends the Service to continue to work closely with Federal, State, and local stakeholders throughout implementation of the plan and any adaptive management decisions. The Delaware Department of Natural Resources and Environmental Control (DNREC), through the Delaware Coastal Management Program (DCMP), concurred with the Service's consistency determination that the selected alternative is consistent with the State's enforceable policies. DNREC further requests that the Service work collaboratively with the State to address concerns related to the habitat management, hunting program, and mosquito control aspects of the selected plan.

Decision

The Service has selected alternative B, the Service-preferred alternative specified in the final CCP/EIS for Prime Hook NWR. Alternative B is the most effective alternative at addressing the key issues and concerns identified during the planning process and will best achieve the purpose and need for developing the CCP, the purposes and goals of the refuge, as well as the mission and goals of the National Wildlife Refuge System (Refuge System). Implementation of the CCP will occur over the next 15 years.

Most of the management guidelines and actions in alternative B of the final CCP/EIS remain consistent with those presented in the draft CCP/EIS. The decision includes adoption of stipulations and mitigation measures referenced in the "Measures to Minimize Environmental Harm" section below. The most important modifications to alternative B that were made between draft and final documents in response to public comment are:

(1) We clarified under alternative B, objectives 1.1 and 3.1 that dune restoration is a potential, and even likely, first step in our proposal to restore marsh habitat. We also reiterated that we would only plan to restore the dunes as part of the comprehensive marsh restoration, not as a separate action.

(2) We revised the strategies under alternative B, objective 3.1 and our analysis in chapter 5 of the final CCP/EIS to provide some additional analysis of other shoreline modification and wave attenuation strategies, such as living shorelines and wave attenuation structures.

(3) We modified several hunting strategies to be responsive to public concerns, to be more consistent with State regulations, and to eliminate confusion for hunters and non-hunters alike.

(4) We revised alternative B, objective 5.1a to no longer propose opening the refuge to white-tailed deer hunting on Prime Hook Creek.

(5) We revised alternative B, objective 5.1b to allow waterfowl hunting 4 days per week until 3 p.m. in all waterfowl hunting areas to be consistent with State hunting regulations.

(6) We modified our proposed waterfowl hunting areas under alternative B, objective 5.1b. Open areas now include: Unit I (open to free-roam hunting), Unit III (south of Prime Hook Road–open to free-roam hunting; lottery hunt area that now includes the area south of the Headquarters Ditch), and Unit IV (non-ambulatory wheelchair blind only). Closed areas now include: free-roam hunting along the Broadkill River and hunting west of Foord's Landing on Prime Hook Creek, and the area near Prime Hook Beach for non-ambulatory wheelchair hunters. Non-ambulatory hunters are allowed to hunt in all hunt zones in accordance with refuge policy and regulations. Only non-ambulatory hunters may hunt in the Island Farm Unit, where we have provided non-ambulatory hunt blinds to accommodate hunters with this need.

(7) We revised alternative B, objective 5.1b to update information on the non-ambulatory waterfowl blinds on the Island Farm Unit. We now propose to issue permits by preseason lottery drawing for first 2 days of each waterfowl season split; days thereafter will be first-come, first-serve.

(8) We removed the number of proposed waterfowl blind sites under alternative B, objective 5.1b because the habitat is constantly changing. The number of blind sites will be a function of the habitat conditions when the CCP is implemented.

(9) We revised alternative B, objective 5.1 to permit snow goose conservation hunting in only wetland areas (no conservation order hunting in the uplands).

(10) We revised alternative B, objective 5.1d to allow turkey hunting until 1 p.m. on the refuge to be consistent with State hunting regulations, and to state that the number of turkey hunting numbers may be increased or decreased from the proposed five hunters based on trends in turkey population data.

(11) We revised alternative B, objective 5.1 to require that all wheelchair hunters have an assistant.

(12) We clarified our proposal for red fox hunting under alternative B, objective 5.1c. We propose to offer red fox hunting opportunities concurrent with the deer hunting season. We will not allow chase hunting and will not permit centerfire and rimfire rifles.

(13) We revised alternative B, goal 5 to continue to allow year-round access to the western 4 miles of Prime Hook Creek for visitors engaged in uses such as wildlife observation, wildlife photography, and fishing.

(14) We updated alternative B, objective 5.2 to clarify that the number and length of existing and proposed trails will total 14 trails covering 9.9 miles. We also propose to reroute Slaughter Beach Trail due to changes in habitat, and add a new parking area on the existing interior road.

(15) We revised alternative B, objective 5.3 to allow fishing and crabbing on the pull-offs along Prime Hook Road. We also clarified that the regulations for catch and release and use of barbless hooks will only occur west of Foord's Landing on Prime Hook Creek. These regulations may be revised as fishery population dynamics change.

(16) We have decided to permit the use of adulticides for mosquito control when there is a documented human disease threat, instead of only when a public health emergency is declared. We modified strategies under alternative B, objectives 1.2 and 1.3 to state that we will allow the use of adulticides on the refuge once the Delaware Mosquito Control Section (DMCS) surveillance program has detected and documented a mosquito-borne human disease threat on or near the refuge.

Factors Considered in Making the Decision

This decision to adopt alternative B for implementation was made after considering the follow factors:

- The impacts identified in Chapter 5, Environmental Consequences, of the draft and final CCP/EIS.
- The results of public and other agency comments.
- How well the alternative achieves the stated purpose and need for a CCP and the six goals presented in the final CCP/EIS chapter 1.
- How well the alternative addresses the relevant issues, concerns, and opportunities identified in the planning process.
- Other relevant factors, including fulfilling the purposes for which the refuge was established, contributing to the mission and goals of the Refuge System, and statutory and regulatory guidance.

Compared to the other two alternatives, alternative B includes the suite of actions that best meet the factors above using the most balanced and integrated approach, and with due consideration for both the biological and human environment. Alternative B will best fulfill the CCP's biological goals, by managing for particular Federal trust species and habitats that are of regional conservation concern. It clearly defines which Federal trust species and habitat will be a management priority in both uplands and wetlands, and details specific objectives and strategies for their management. The refuge's establishment purposes emphasize the conservation of migratory birds; thus, protecting the biological integrity, diversity, and environmental health of Prime Hook NWR and its habitat and wildlife, particularly migratory birds, is paramount.

Future management of Unit III is still tentative until hydrological modeling is completed; however, we believe that our proposal under alternative B to restore refuge impoundments to healthy, brackish marsh and salt marsh will encourage the conditions most resilient to sea level rise, while providing valuable habitat for waterfowl, salt marsh obligate passerines and waterbirds, shorebirds, and other wildlife. Furthermore, restoring salt marsh will provide long-term benefits to neighboring human communities because it can reduce erosion and reduce saltwater intrusion. The freshwater impoundments maintained under alternative C, and the lack of salt marsh protection and restoration under alternative A, would not provide these benefits in a self-sustaining manner over the long-term.

The costs associated with salt marsh restoration were also a consideration. The Service understands that initial up-front planning costs associated with specific strategies of alternative B could be costly, and this amount will be more clearly defined once all monitoring data is collected. However, the total cost of a self-sustaining salt marsh would be minimal when compared to the projected cost of the continuous year-after-year maintenance required in alternative C.

The Service also considered the changes in wildlife and plant communities that would occur under alternative B in comparison to the other two alternatives. Under alternative B, the abundance, distribution, or composition of the refuge's wildlife and plant communities are likely to shift as habitats change to a more natural, self-sustaining salt marsh system. The species characteristic of the freshwater marshes present today, will eventually transition to species that live in native brackish marsh and salt marsh. Allowing passive conversion to salt marsh and open water in refuge coastal wetland habitats as proposed in alternative A, or proactive salt marsh restoration as proposed in alternative B, will both result in emergent wetland vegetation changing from freshwater plants to halophytic (salt tolerant) marsh plants. However, alternative A is likely to result in a system dominated mostly by open water, and thus lacking in salt marsh habitat and the wildlife habitat and ecosystem services it provides. While the resulting salt marsh community may have less plant species diversity, this community type is among the most degraded of all habitats, there has been a substantial amount of salt marsh lost in the mid-Atlantic over the past 200 years, and many species of high conservation concern depend on the salt marsh community.

While alternative C maintains or increases the freshwater wetlands and the wildlife and plant diversity associated with it, the manipulation associated with those freshwater wetlands represent a major impact on local hydrology. These freshwater impoundments also require a major commitment of resources, and are not resilient to climate change impacts. Climate change and accelerated sea level rise have already, and will continue to, inhibit our ability to manage salinity and water levels in our freshwater wetlands and control salinity intrusion into our upland habitats. Even once necessary infrastructure repairs and upgrades are made, impoundment management will be challenging and will contribute to marsh elevational deficiencies within the impounded marsh complex, further altering hydrology. Adverse impacts resulting from the inherent instability of the freshwater impoundments could offset any beneficial impacts considerably. Lost elements of coastal wetland integrity and environmental health of impounded marsh areas due to significant accretion deficiencies indicate that impounding refuge coastal areas cut off sediment supplies needed for marsh platforms to keep up with local sea level rise rates.

In the upland habitats, the diversity of wildlife and plants will increase under alternative B due to the conversion of hundreds of acres of row-cropped agricultural fields to native plant communities, including forest, grassland, and shrubland. For example, it will provide habitat for breeding grassland, shrubland-dependent, or forest-interior dwelling landbird species, and migrating and wintering landbirds. The elimination and restoration of agricultural fields, as proposed under alternative B, is the alternative most consistent with the Service's guidance on maintaining biological diversity, integrity and health on refuges, and the recommendations on managing overabundant populations of light geese. While alternative A also eliminates agricultural fields, active restoration of those lands would not occur. Alternative C would resume the cooperative farming program, although its value as wildlife habitat is limited. The original objective of the agricultural program, to provide food for a diversity of waterfowl, has not been realized. Monitoring has shown that ducks prefer the native forage in the refuge's wetlands.

Under alternative B, there will be an important change to the mosquito control program which will help protect the diversity and abundance of native insects and benefit the migratory birds, bats, and other wildlife that forage on them. The refuge will reduce the application of adulticides and use them only when there is a documented human disease threat. Alternative C would make the same change as alternative B, but alternative A would continue to allow the State to apply adulticides under a wider range of conditions, with the potential for greater impacts to native insect populations.

For visitor services, alternative B will best enhance public use opportunities through a proposed expansion of access facilities and new trails open for wildlife observation, photography, interpretation, environmental education, hunting, and fishing. The hunting program will be modified for greater administrative efficiency. Additional areas of the refuge will be opened for the hunting program, with careful consideration of public safety, staff and resource commitments, and balancing hunting with other wildlife-dependent public use opportunities. The existing hunt program (alternative A) requires extensive staff time and resources. The proposed changes in the hunt program under alternative B will reduce the cost of administering the hunt, reduce the cost to hunters, and be more consistent with State regulations.

In summary, we selected alternative B for implementation because it best meets the factors identified above when compared to alternatives A and C and was identified as the most environmentally preferable alternative. Alternative B provides the greatest number of opportunities for Prime Hook NWR to contribute to the conservation of fish, wildlife, and habitat in the Region, will increase the capacity of the refuge to meet its purposes and contribute to the Refuge System mission, and will provide the means to better respond to changing ecological conditions within the surrounding environment.

Measures to Minimize Environmental Harm

Public concerns, potential impacts, and measures or stipulations to mitigate those impacts are addressed in the final CCP/EIS. All practicable measures to avoid or minimize environmental impacts that could result from implementation of alternative B have been identified and incorporated into chapter 4 (Alternatives), chapter 5 (Environmental Consequences), and appendix E (Compatibility Determinations) (CD) of the final CCP/EIS. The stipulations identified in the CDs in appendix E ensure that public and other uses are compatible with the purposes for which the refuge was established. These CD stipulations and other mitigation measures identified for alternative B in chapters 4 and 5 are adopted by the Service in this ROD and will be followed or enforced by refuge staff or their designee.

Findings Required by Other Laws and Executive Orders.

The final CCP/EIS complies with all Federal laws and Executive Orders (EO) related to the planning process and Prime Hook NWR. These include, but are not limited to, the National Wildlife Refuge System Improvement Act of 1997 (Public Law 105–57); the National Environmental Policy Act of 1969 (Public Law 91-190, as amended); the Endangered Species Act of 1973 (Public Law 93-205, as amended); the National Historic Preservation Act of 1966 (Public Law 89-665); the Coastal Zone Management Act (Public Law 92-583, as amended); EO 12898, Environmental Justice; EO 11988, Floodplain Management; EO 11990, Protection of Wetlands; EO 12372, Intergovernmental Review; EO 13186, Protection of Migratory Birds; and EO 13175, Consultation and Coordination with Indian Tribal Governments.

For Further Information

For further information, contact Refuge Planner Thomas Bonetti, U.S. Fish and Wildlife Service, Northeast Regional Office, 300 Westgate Center Drive, Hadley, Massachusetts, 01035, Phone (413) 253-8307. Copies of the final CCP/EIS and subsequent CCP may be viewed at Prime Hook NWR and at the following libraries in the State of Delaware: Milton Public Library, 121 Union Street, Milton, Delaware, 19968; Milford Public Library, 11 SE Front Street, Milford, Delaware, 19963; and Lewes Public Library, 111 Adams Avenue, Lewes, Delaware, 19958. The final CCP/EIS and this ROD will be available for viewing and downloading online at: *http://www.fws.gov/northeast/planning/Prime%20Hook/ccphome.html.*

29 March 2013

Date

Acting Wendi Weber
Regional Director, Region 5

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