U.S. Fish & Wildlife Service

Great Swamp National Wildlife Refuge

Draft Comprehensive Conservation Plan and Environmental Assessment

May 2014

Cover:
Fall on the refuge
USFWS

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* 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 150-million-acre National Wildlife Refuge System comprised of more than 560 national wildlife refuges and thousands of waterfowl production areas. It also operates 70 national fish hatcheries and 81 ecological services field stations. The agency enforces Federal wildlife laws, manages migratory bird populations, restores nationally significant fisheries, conserves and restores wildlife habitat such as wetlands, administers the Endangered Species Act, and helps foreign governments with their conservation efforts. It also oversees the Federal Assistance Program which distributes hundreds of millions of dollars in excise taxes on fishing and hunting equipment to state wildlife agencies.

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

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Refuge Vision Statement

Great Swamp National Wildlife Refuge is a rich natural oasis immersed within the bustling New Jersey-New York metropolitan area. At Great Swamp migrating birds feed and rest amongst whispering trees while butterflies flitter through wildflower-laced meadows. Turtles bask in the warm summer's sun, as the drum of a red-headed woodpecker echoes across an expansive marsh. Barred owls break the evening silence with unmistakable calls from deep within the forest while frogs chorus in excited trills and croaks in the wet meadows. These sights and sounds are the very same ones that were heard by the Lenape Tribes centuries before.

Great Swamp is an ecological treasure that invites people to engage with the natural world in ways that are educational, memorable, and rewarding. Visitors are refreshed by the beauty, peace and solitude of this wild and natural setting, where wildlife comes first. Vital partners continue working together to protect the Great Swamp and its watershed to ensure its myriad of benefits for future generations.

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Summary

Type of Action:	Administrative—Development of a Comprehensive Conservation Plan
Lead Agency:	U.S. Department of the Interior, Fish and Wildlife Service
Location:	Great Swamp National Wildlife Refuge Basking Ridge, NJ
Administrative Headquarters:	Great Swamp National Wildlife Refuge Basking Ridge, NJ
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This comprehensive conservation plan for the Great Swamp National Wildlife Refuge (refuge) is the culmination of a planning effort involving the U.S. Fish and Wildlife Service, New Jersey State agencies, local partners, refuge neighbors, private landowners, and the local community. This CCP establishes 15-year management goals and objectives for the refuge's wildlife and habitats, public use programs, and administration and facilities.

This plan sets forward the management direction that we think best achieves the refuge's purposes, vision, and goals; addresses issues and concerns identified throughout the planning process; responds to public comments and inquiries; and are feasible to implement in accordance with applicable laws, regulations, policies, and guidance.

Under this plan, we will emphasize the management of specific refuge habitats to support species of conservation concern in the Great Swamp region. In particular, we will emphasize forest biodiversity and ecosystem function. This includes the consolidation of managed grasslands and shrublands and restoration of forested areas. We will emphasize the refuge position to reach new urban audiences. In addition, we will strive to promote wildlife-dependent public uses, while allowing for non-wildlife-dependent uses. We will promote higher quality hunting and fishing programs; expand wildlife observation, viewing, and photography opportunities; and initiate new interpretive program and environmental education opportunities.

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Chapter 1

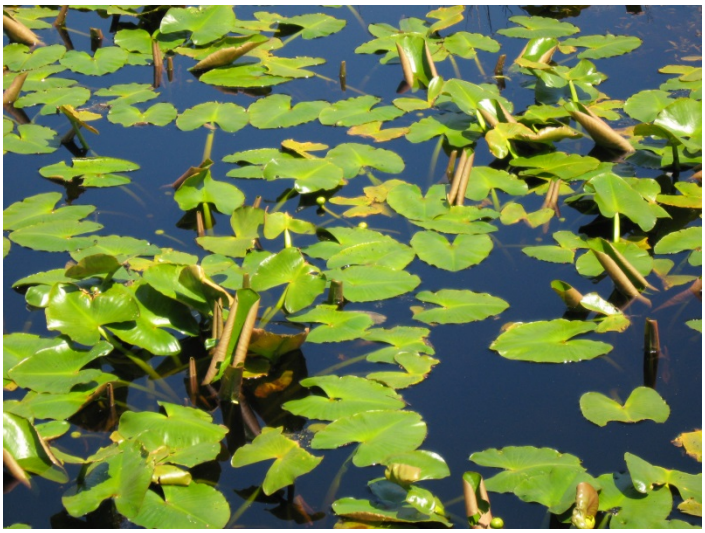
Deborah Lewinson

Purpose of, and Need for, Action

- Introduction
- The Purpose of, and Need for, the Proposed Action
- Refuge Overview
- The Service, its Policies and Legal Mandates
- Conservation Plans and Initiatives Guiding the Proposed Action
- Refuge Establishment, History, and Purpose
- Refuge Administration
- Refuge Operational Plans (“Step-Down” Plans)
- Refuge Vision Statement
- Refuge Goals
- The Comprehensive Conservation Planning Process
- Issues, Concerns, and Opportunities
- Decisions to be Made

1.0 Introduction

This draft comprehensive conservation plan (CCP) was prepared for the Great Swamp National Wildlife Refuge (NWR) pursuant to the National Wildlife Refuge System Administration Act of 1966 (Administration Act), as amended by the National Wildlife Refuge System Improvement Act of 1997 (16 U.S.C. 668dd, Improvement Act). This document also serves as an environmental assessment (EA), in compliance with the National Environmental Policy Act of 1969 (NEPA).



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The CCP presents and analyzes the environmental effects of alternative combinations of management goals, objectives, and strategies. Our proposed action is alternative B, which we believe will best achieve our vision for the refuge; contribute to the mission of the National Wildlife Refuge System (Refuge System); achieve refuge purposes; fulfill legal mandates; address key issues; incorporate sound principles of fish and wildlife management; and serve the American public. This CCP will guide management decisions and actions on the refuge over the next 15 years. It will also help us communicate our priorities to the natural resources agencies of the State of New Jersey, our conservation partners, local communities, and the public. As part of this process, we have met our requirements to coordinate, interact, and cooperate with adjoining landowners and State fish and wildlife agencies under the Administration Act, as amended, 16 U.S.C. 668dd(e)(3).

This CCP includes five chapters and five appendixes.

Chapter 1, “The Purpose of and Need for Action,” explains the purposes of and need for preparing a CCP, and sets the stage for five subsequent chapters and five appendixes. Specifically, chapter 1:

- Defines our planning analysis area;
- Presents the mission, policies, and mandates affecting the development of the CCP;
- Identifies other conservation plans we used as references;
- Lists the purposes for which the refuge was established and its land acquisition history;
- Clarifies the vision and goals that drive refuge management;
- Describes the planning process we followed, including public and partner involvement in developing the CCP;

- Describes our compliance with NEPA regulations; and
- Identifies public issues or concerns that surfaced as we developed the CCP.

Chapter 2, "The Existing Environment," describes the physical, biological, and human environments of the refuge.

Chapter 3, "Alternatives Considered Including the Preferred Alternative," includes an alternatives summary comparison matrix and describes goals and objectives for specific conservation targets and visitor programs, as well as the management actions for achieving the objectives.

Chapter 4, "Environmental Consequences," provides an analysis of environmental effects associated with implementing the various management actions prescribed under the alternatives in chapter 3.

Chapter 5, "Consultation and Coordination," summarizes how we involved the public and our partners in the planning process and lists the members of the core planning team and other U.S. Fish and Wildlife Service (FWS) personnel who provided assistance in the development of this CCP. Our partners' involvement is vital for future management of this refuge and all national wildlife refuges.

This CCP also includes a Glossary of Terms with Acronyms, Bibliography of Literature Cited, and five appendixes that provide additional documentation and references to support the narratives and analyses within this plan.

1.1 The Purpose of, and Need for, the Proposed Action

The purpose of the CCP is to provide reasonable, scientifically grounded guidance for management of refuge habitats and wildlife, and administration of public uses on refuge lands. This draft CC, including the preferred alternative, was developed for the refuge and best achieves the purposes, vision, and goals of the refuge; contributes to the mission of the Refuge System; adheres to FWS policies and other mandates; addresses identified issues of significance; and incorporates sound principles of fish and wildlife science.

There are several reasons why there is a *need* for a CCP for Great Swamp NWR. First, the Improvement Act requires all national wildlife refuges to complete a CCP to help fulfill the mission of the Refuge System. Second, new FWS policies providing specific guidance on implementing the Administration Act, as amended have been developed since the refuge was established. A CCP incorporates those policies and develops strategic management direction for the refuge for the next 15 years, by:

- Providing a comprehensible statement of desired future conditions for habitat, wildlife, visitor services, staffing, and facilities;
- Providing State agencies, refuge neighbors, visitors, partners, and other stakeholders with a clear understanding of the reasons for management actions;
- Ensuring refuge management is consistent with the purposes of Great Swamp NWR, the policies and goals of the Refuge System and legal mandates;

- Ensuring that present and future public uses are appropriate and compatible;
- Providing long-term continuity and consistency in management direction; and
- Justifying annual budget requests and providing direction for staffing, operations, and maintenance.

Third, the refuge's 1987 Master Plan Final Environmental Impact Statement is outdated. Since its publication, management priorities have changed. For example, the northern population of the bog turtle [*Glyptemys (Glyptemys) muhlenbergii],* which inhabits the refuge, was listed as threatened in accordance with the Endangered Species Act (ESA) in 1997, and is now managed as a priority species. In addition, Indiana bat [*Myotis sodalis,* federally endangered (listed in 1967)] maternity colonies were discovered at Great Swamp NWR in 2005. The Indiana bat has also become a management priority at the refuge. Other species that are managed as priority species include the wood turtle [*Glyptemys (formerly Clemmys) insculpta,* State-threatened (1979)] and blue-spotted salamander [*Ambystoma laterale*, State-endangered (1974)]. New conservation plans have been developed, which influence refuge management. The priority of habitat management and restoration to control invasive species has grown. Residential development in the surrounding area continues to increase, which has resulted in changes to water quality and quantity in Great Swamp NWR. Additionally, warming of the climate system is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level (USFWS 2010a). Climate change has increased the need for research, monitoring, and adaptive management techniques and strategies.

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Lastly, as responsible stewards of Federal lands, conveying our vision and priorities for the refuge to our partners, local communities, and interested and affected individuals is imperative.

All of these reasons clearly emphasize the need for the strategic direction a CCP provides. To help resolve management issues and public concerns, the planning process incorporated input from natural resource agencies of New Jersey, affected communities, individuals and organizations, partners and other stakeholders, and the public.

1.2 Refuge Overview

Great Swamp NWR encompasses 7,768 acres and is located 26 miles from New York City within the Townships of Chatham, Harding, and Long Hill of Morris County in north-central New Jersey (Map 2-1). Great Swamp NWR is situated north of Interstate 78 and east of Interstate 287. The refuge has an approved acquisition boundary that would allow for refuge expansion to a maximum of 9,429 acres (Map 2-2).

The surrounding area is heavily suburbanized, and as a result, the refuge has become an island of wildlife habitat in a sea of development. The refuge provides vital brooding, nesting, feeding, and resting habitat for a variety of migratory bird species, including waterfowl. Although established primarily for migratory birds, the refuge's mosaic of forested wetlands, emergent wetlands, and various successional stages of upland vegetation provides habitats for a diversity of wildlife species. The refuge has five major impoundments, totaling approximately 570 acres. These impoundments are managed for marsh habitat that contains wetland plant diversity similar to natural marsh habitat in northern New Jersey.

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

This section highlights the U.S. Fish and Wildlife Service (FWS, we, our), the Refuge System, FWS policy, and the laws, regulations, and mandates that directly influenced the development of this CCP.

1.3.1 The U.S. Fish and Wildlife Service and its Mission

The FWS, a bureau of the Department of the Interior (the Department), administers the Refuge System. The FWS's 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."* Congress entrusts the FWS with the conservation and protection of natural resources, such as migratory birds and fish, federally listed endangered or threatened species, interjurisdictional fish, and certain marine mammals. The FWS also manages national wildlife refuges and national fish hatcheries, enforces Federal wildlife laws and international treaties on importing and exporting wildlife, assists with state fish and wildlife programs, and helps other countries develop wildlife conservation plans.

The FWS manual contains the directives to implement its authorities, responsibilities, and activities. The manual can be viewed on the Web at *http://www.fws.gov/policy/manuals/.* Special FWS directives affecting the rights of citizens or the authorities of other agencies are published separately in the Code of Federal Regulations (CFR); the FWS manual does not duplicate these directives (see 50 CFR 1-99 at *http://www.access.gpo.gov/nara/cfr/index.html*).

1.3.2 The National Wildlife Refuge System and its Mission and Policies

The Refuge System is the world's largest collection of lands and waters set aside specifically for the conservation of wildlife and the protection of ecosystems. Since its establishment in 1903, the Refuge System has grown to 562 national wildlife refuges encompassing more than 150 million acres of lands and waters in all 50 states and several island territories. The Refuge System also includes waterfowl production areas in ten states and four marine national monuments in the Pacific Ocean. Each year, more than 44 million visitors hunt, fish, observe and photograph wildlife, or participate in environmental education and interpretation on refuges (USFWS 2010b).

Of all the laws governing activities on refuges, the Administration Act exerts the greatest influence. In 1997, President Clinton signed into law the Improvement Act, which amended the Administration Act by including a unifying mission for the Refuge System, a new process for determining compatibility of public uses on refuges, and a requirement that each refuge be managed under a CCP developed in an open public process. The Improvement Act states that first and foremost, the Refuge System must focus on

wildlife conservation. It also states that the mission of the Refuge System, coupled with the purpose(s) for which each refuge was established, will provide the principal management direction for that refuge.

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"* – National Wildlife Refuge System Improvement Act; Public Law 105-57.

The Refuge Manual contains policies governing the operation and management of the Refuge System that the FWS manual does not cover, including technical information on implementing refuge policies and guidelines on enforcing laws. The Refuge Manual can be reviewed at refuge headquarters, and the policies that played an instrumental role in developing this CCP can be viewed at *http://www.fws.gov/policy/manuals/part.cfm?series=600&seriestitle=LAND%20USE%20AND%20MANAGEMENT%20SERIES.*

The *Policy on the National Wildlife Refuge System Mission, Goals and Purposes* (601 FW 1) sets forth the Refuge System mission noted above, how it relates to the FWS mission, and explains the relationship of the Refuge System mission and goals, and the purpose(s) of each unit in the Refuge System (USFWS 2006a). In addition, this policy identifies the goals of the Refuge System, as follows:

- 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 is 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 under-represented in existing protection efforts;
- Provide and enhance opportunities to participate in compatible wildlife-dependent recreation (hunting, fishing, wildlife observation and photography, and environmental education and interpretation); and
- Foster understanding and instill appreciation of the diversity and interconnectedness of fish, wildlife, and plants and their habitats.

This policy also establishes management priorities for the Refuge System:

- Conserve fish, wildlife, and plants and their habitats;
- Facilitate compatible wildlife-dependent recreational uses; and
- Consider other appropriate and compatible uses.

The *Policy on Refuge System Planning* (602 FW 1 through 4) establishes the requirements and guidance for Refuge System planning, including CCPs and other step-down management plans (USFWS 2000a). It states that all refuges will be managed in accordance with an approved CCP that, when implemented, will help:

- Achieve refuge purposes;
- Fulfill the Refuge System mission;
- Maintain and, where appropriate, restore the ecological integrity of each refuge and the Refuge System;
- Achieve the goals of the National Wilderness Preservation System (NWPS) and the National Wild and Scenic Rivers System; and
- Conform to other applicable laws, mandates, and policies.

The planning policy provides explicit directions and identifies the minimum requirements for developing CCPs. As part of this process, any existing special designation areas, such as Wilderness and Wild and Scenic Rivers, must be reviewed; the potential for any new special designations must be addressed; a wilderness review must be conducted; and a summary of that review must be incorporated into each CCP (602 FW 3) (USFWS 2000b). In addition, this policy also requires the FWS to prepare step-down management plans when required by policy or when necessary to provide strategies and schedules for meeting goals and objectives identified in the CCP (602 FW 4) (USFWS 2000c).

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Federal law and FWS 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. The *Policy on the Appropriateness of Refuge Uses* (603 FW 1) provides a national framework for determining appropriate refuge uses to prevent or eliminate those that should not occur in the Refuge System (USFWS 2006b). 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:

1. The use is a wildlife-dependent recreational use as identified in the Improvement Act.
2. The use contributes to fulfilling the refuge purpose(s), the Refuge System mission, or goals or objectives descried in a refuge management plan approved after October 7, 1997, the date the Improvement Act became law.
3. The use follows state regulations for the take of fish and wildlife.

4. The use has been found to be appropriate after concluding a specified process. The refuge manager will base the finding of appropriateness on the following 10 criteria:

    a. Does the FWS have jurisdiction over the use? If not, the FWS has no authority to consider the use.

    b. Is the proposed use consistent with all applicable laws and regulations? Uses prohibited by law are not appropriate.

    c. Is the use consistent with applicable Executive Orders and Department and FWS policies? If the proposed use conflicts with an applicable Executive Order or Department or FWS policy, the use is not appropriate.

    d. Is the use consistent with public safety? If the proposed use creates an unreasonable level of risk to visitors or refuge staff, or if the use requires refuge staff to take unusual safety precautions to assure the safety of visitors or other refuge staff, the use is not appropriate.

    e. Is the use consistent with refuge goals and objectives in an approved management plan or other document? If the proposed use, either itself or in combination with other uses or activities, conflicts with a refuge goal, objective or management strategy, the use is generally not appropriate.

    f. Has the proposed use been previously determined not appropriate? Unless circumstances or conditions have changed significantly, no further analysis is required. If this is the first time the use has been proposed, the FWS may further consider the use.

    g. For uses other than wildlife-dependent recreational uses, is the proposed use manageable within available budget and staff? If the proposed use diverts management efforts or resources away from proper and reasonable management of a refuge activity or wildlife-dependent recreation use, the use is typically not appropriate. The refuge manager may consider volunteers or refuge support groups in evaluating resources available.

    h. Will the use be manageable in the future within existing resources? If the use can be managed to reduce or eliminate impacts to natural and cultural resources, or if limits are clearly established, the use may be further considered by the FWS.

    i. Does the use contribute to the public's understanding and appreciation of the refuge's natural or cultural resources, or does the use benefit the refuge's natural or cultural resources? If not, the use is generally not appropriate (USFWS 2006b).

This policy can be accessed on the Web at *http://www.fws.gov/policy/603fw1.pdf.*

The *Policy on Compatibility* (603 FW 2) complements the *Policy on the Appropriateness of Refuge Uses* (603 FW 1). Once a refuge manager finds a use appropriate, the use is further evaluated through a Compatibility Determination (CD). The policy provides guidelines for determining compatibility of uses and procedures for documentation and periodic review of existing uses (USFWS 2000d). Highlights of the guidance in that chapter follows:

- The Improvement Act and its regulations require an affirmative finding by the refuge manager on the compatibility of a public use before it is permitted on a national wildlife refuge.

- A compatible use is one "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 Improvement Act defines six wildlife-dependent uses that are to receive enhanced consideration on refuges: "hunting, fishing, wildlife observation and photography, and 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 CD, it will stipulate the required maximum re-evaluation dates: 15 years for wildlife-dependent recreational uses; or, 10 years for other uses.

- However, the refuge manager may re-evaluate the compatibility of a use at any time. For example, sooner than its mandatory date, or even before the CCP process is complete, if new information reveals unacceptable impacts or incompatibility with refuge purposes (603 FW 2.11, 2.12).

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

The *Policy on Wildlife-Dependent Public Uses* (605 FW 1) of the FWS manual presents specific guidance on implementing a quality, wildlife-dependent recreation program (USFWS 2006c). "Quality" is defined as a program that:

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;

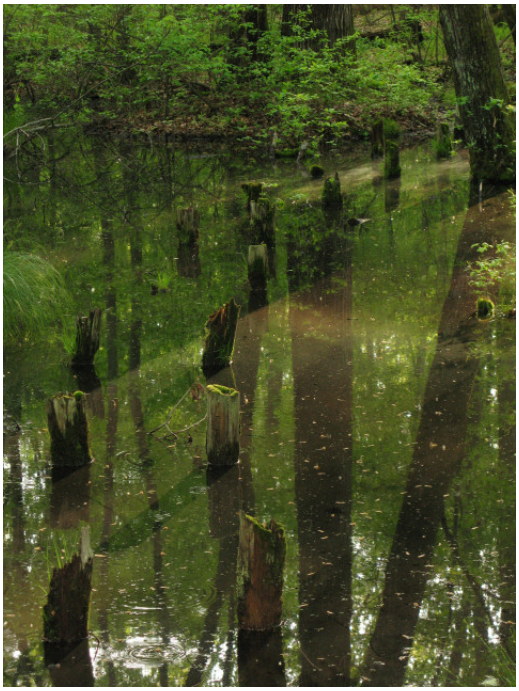
8. Promotes public understanding and increases public appreciation of America's natural resources and our role in managing and conserving these resources;

9. Provides reliable and 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.

The *Policy on Maintaining Biological Integrity, Diversity and Environmental Health* (601 FW 3) 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 in refuge ecosystems (USFWS 2001a). It provides refuge managers with a process for evaluating the best management direction to prevent the additional degradation of environmental conditions and restore lost or severely degraded components of the environment. It also provides guidelines for dealing with external threats to the BIDEH of a refuge and its ecosystem.



Alexandra Ratay

1.3.3 Other Mandates

Although FWS and Refuge System policy and the purpose(s) of each refuge provide the foundation for its management, other Federal laws, Executive Orders, treaties, interstate compacts, and regulation on conserving and protecting natural and cultural resources also affect how we manage refuges. The "Digest of Federal Resource Laws of Interest to the U.S. Fish & Wildlife Service" describes many of these laws at *http://www.fws.gov/laws/Lawsdigest.html*. Below are some noteworthy Federal resource laws that influence the management of Great Swamp NWR.

In response to public demand, the *Refuge Recreation Act of 1962* (16 U.S.C. 460K–460K–4; Public Law 87-714) was established to assure present or future recreational uses by the public on areas within the national wildlife refuges, game ranges, national fish hatcheries, and other conservation areas administered by the Secretary of Interior for fish and wildlife purposes, given that the recreational uses are compatible with the primary purposes of the conservation area. The Act also provided for public fees, permits, and penalties for violations of regulations, and also authorized the acceptance of donations of funds and property to assist in carrying out its purpose(s). The Act also authorized the acquisition of land and interests suitable for (1) fish and wildlife-oriented recreation; (2) protection of natural resources; (3) conservation of endangered or threatened species; or (4) carrying out two or more of the above. These lands must be adjacent to or within an existing conservation area (Refuge Recreation Act of 1962).

Executive Order 12996 was signed by President Clinton in 1996 "to set new direction and ensure new opportunity for wildlife-dependent recreational uses" (USFWS 2008b). This Executive Order defined the conservation mission of the Refuge System, provided guiding principles for management and public use of the refuge system, and identified six compatible wildlife-dependent recreational uses, including hunting, fishing, photography, wildlife observation, environmental education, and interpretation (USFWS 2008a).

The *National Wildlife Refuge System Centennial Act* was passed as part of Public Law 106-408 on November 21, 2000. The purpose of this Act was to establish a commission to promote awareness by the public; develop a long-term plan to meet the priority needs; require an annual report addressing the needs of the Refuge System; and improve public use programs and facilities (National Wildlife Refuge System Centennial Act).

Of particular note are the Federal laws that require the FWS to identify and preserve its important historic structures, archaeological sites, and artifacts. NEPA mandates our considerations of cultural resources in planning Federal actions. The Improvement Act requires the CCP for each refuge to identify its archaeological and cultural values. Following is a highlight of some cultural and historic resource protection laws that relate to the development of CCPs.

- The *Archaeological Resources Protection Act* (16 U.S.C. 470aa-470ll; Public Law 96-95, ARPA), approved October 31, 1979 (93 Statute 721) largely supplanted the resource protection provisions of the *Antiquities Act of 1906* for archaeological items. ARPA establishes detailed requirements for issuance of permits for any excavation or removal of archaeological resources from Federal or Native American lands. It also establishes civil and criminal penalties for the unauthorized excavation, removal, or damage of those resources; for any trafficking in those removed from Federal or Native American land in violation of any provision of Federal law; and for interstate and foreign commerce if such resources were acquired, transported, or received in violation of any state or local law (Historic Preservation Acts).

- The *Archaeological and Historic Preservation Act* (16 U.S.C. 469-469c; Public Law 86-523), approved June 27, 1960 (74 Statute 220), as amended by Public Law 93-291, approved May 24, 1974 (88 Statute 174), carries out the policy established by the *Historic Sites Act* (see below). This Act directs Federal agencies to notify the Secretary of the Interior whenever they find that a Federal or federally assisted licensed or permitted project may cause the loss or destruction of significant scientific, prehistoric, or archaeological data. The act authorizes the use of appropriated, donated or transferred funds for the recovery, protection, and preservation of that data (Historic Preservation Acts).

- The *Historic Sites, Buildings, and Antiquities Act* (16 U.S.C. 461-462, 464-467; 49 Statute 666) of August 21, 1935, popularly known as the *Historic Sites Act*, as amended by Public Law 89-249, approved October 9, 1965 (79 Statute 971), declares it a national policy to preserve historic sites and objects of national significance, including those located on refuges. The Act provides procedures for designating, acquiring, administering, and protecting these sites and objects of national significance. Among other things, National Historic and Natural Landmarks are designated under the authority of this act (Historic Preservation Acts). In 1966, the National Park Service (NPS) designated Great Swamp NWR a registered National Natural Landmark under the provisions of the *Historic Sites Act of 1935*. The refuge was chosen for the registry as an "exceptional example of the natural history of the United States" (USFWS 1987).

- The *National Historic Preservation Act of 1966* (16 U.S.C. 470-470b, 470c-470n), Public Law 89-665, approved October 15, 1966 (80 Statute 915), and repeatedly amended, provides for the preservation of significant historical features (buildings, objects, and sites) through a grant-in-aid program to the states. It establishes a *National Register of Historic Places* and a program of matching grants under the existing *National Trust for Historic Preservation* (16 U.S.C. 468-468d). This Act establishes an *Advisory Council on Historic Preservation,* which became a permanent, independent

agency in Public Law 94-422, approved September 28, 1976 (90 Statute 1319). The Act created the *Historic Preservation Fund*, which directs Federal agencies to take into account the effects of their actions on items or sites listed or eligible for listing on the National Register (Historic Preservation Acts).

- FWS also has a mandate to care for museum properties it owns in the public trust. The most common are archaeological, zoological, and botanical collections, historical photographs, historic objects, and art. Each refuge maintains an inventory of its museum property. Our Regional museum property coordinator guides refuges in caring for that property and helps us comply with the *Native American Grave Protection and Repatriation Act* and Federal regulations governing Federal archaeological collections. Our program ensures that those collections will remain available to the public for learning and research.

Other Federal resource laws are also important to highlight as they are integral to developing a CCP. The *Wilderness Act of 1964* (16 U.S.C. 1131-1136; Public Law 88-577) establishes a NWPS that is composed of federally owned areas designated by Congress as "Wilderness Areas." The Act directs each agency administering designated wilderness to preserve the "wilderness character" of areas within the National Wilderness Preservation System (NWPS), and to administer the NWPS for the "use and enjoyment of the American people in a way that will leave those areas unimpaired to future use and enjoyment as wilderness". The Act also directs the Secretary of the Interior, within 10 years, to review every roadless area of 5,000 acres or more and every roadless island (regardless of size) within national wildlife refuges and units of the NPS for inclusion in the NWPS (Wilderness Act of 1964). FWS planning policy requires that we evaluate the potential for wilderness on refuge lands, as appropriate, during the CCP planning process. The *Great Swamp Wilderness Act of 1968* designated the eastern portion of the refuge, comprised of 3,660 acres, as Wilderness Area. The Great Swamp NWR wilderness was the first Wilderness Area designated within the Department.

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The *Wild and Scenic Rivers Act of 1968*, as amended, selects certain rivers of the nation possessing remarkable scenic, recreational, geologic, fish and wildlife, historic, cultural, or other similar values, preserves them in a free-flowing condition, and protects their local environments (Wild and Scenic River Act of 1968). FWS planning policy requires that we evaluate the potential for wild and scenic rivers designation on refuge lands, as appropriate, during the CCP planning process.

Although the *Endangered Species Act of 1973* (ESA) does not have specific application to the Refuge System, it does affect resource management activities within the Refuge System and intra-agency consultation in accordance with Section 7 of the ESA is conducted as a part of the CCP. The Act encourages the development of state programs and directs Federal agencies to take actions to ensure that actions they carry out, authorize, or fund do not jeopardize any endangered species or their critical habitat (Endangered Species Act of 1973). The Act also provides

the authority to acquire land for the conservation of listed threatened or endangered species, using Land and Water Conservation Fund (LWCF) monies.

The *Emergency Wetlands Resources Act of 1986* (Public Law 99-645; 100 Stat. 3582), approved on November 10, 1986, authorized the purchase of wetlands from LWCF monies, removing a prior prohibition on such acquisitions. The Act required the Secretary of the Interior to establish a *National Wetlands Priority Conservation Plan*, required the states to include wetlands in their *Comprehensive Outdoor Recreation Plans*, and transferred to the Migratory Bird Conservation Fund amounts equal to the import duties on arms and ammunition (Emergency Wetlands Resources Act of 1986).

In 1990, the FWS Northeast Region completed a *Regional Wetlands Concept Plan* to provide more specific information about wetlands resources in the Northeast. The plan identifies 850 privately owned wetland sites in 13 northeastern and Mid-Atlantic states that warrant consideration for acquisition using the LWCF. The plan is intended to provide guidance to focus acquisition efforts on vulnerable, scarce, and important wetlands in the Northeast Region (USFWS 1990). Appendix A of the *Regional Wetlands Concept Plan* consists of a list of these wetlands, organized by state, which were identified by the FWS and met the Wetlands Assessment Threshold Criteria. Although wetlands associated with Great Swamp NWR were not identified in appendix A, the list does not represent the only "important" wetland sites in the Northeast. Additionally, the absence of a wetland site in the list does not make it ineligible for acquisition using LWCF monies (USFWS 1990).

1.4 Conservation Plans and Initiatives Guiding the Proposed Action

1.4.1 U.S. Fish and Wildlife Service Migratory Bird Program Strategic Plan

The Migratory Bird Program completed a 10-year strategic plan in January 2004 (USFWS 2004a). The strategic plan seeks to conserve and manage migratory bird populations and their habitats, and refuges can provide high quality habitat for many migratory birds. Two strategies to achieve these goals are bird population monitoring and habitat management. Refuges contribute to these strategies by conducting biological surveys and managing habitat on a local scale. Great Swamp NWR will use, to the maximum extent practicable, standardized monitoring protocols and habitat assessments, thus contributing to regionwide assessments of population trends and habitat management effects on migratory birds.

1.4.2 U.S. Fish and Wildlife Service Birds of Conservation Concern (2008)

In 1988, an amendment to the Fish and Wildlife Conservation Act of 1980 (100 Public Law 100-653, Title VIII) mandated the FWS "to identify nongame migratory birds that, without additional conservation action, are likely to become candidates for listing under the Endangered Species Act of 1973" (USFWS 2008b). The overall goal of the Birds of Conservation Concern (BCC) report is to accurately identify migratory and non-migratory bird species, which are not currently designated as federally threatened or endangered, that are of highest conservation concern.

The BCC is derived from these major nongame bird conservation plans: Partners in Flight (PIF, species scoring >21), U.S. Shorebird Conservation Plan (species ranking 4 or 5), and North American Waterbird Conservation Plan (species ranking 4 or 5). The BCC encompasses three geographic scales: North American Bird Conservation Initiative (NABCI) Bird Conservation Regions (BCR), FWS Regions, and

Nationwide. Bird species included in the report include nongame birds, gamebirds without hunting seasons, subsistence-hunted nongame birds in Alaska, and ESA candidate, proposed endangered or threatened, and recently delisted species. Population trends, threat distribution, abundance, and relative density were all factors considered (USFWS 2008b). Great Swamp NWR is situated within USFWS Region 5 and BCR 29, and in close proximity to BCR 28 (see section 1.4.3 below).

This report is intended to stimulate coordinated and collaborative proactive conservation actions among Federal, state, tribal, and private partners. It is hoped that by focusing attention on these highest-priority species, this report will promote greater study and protection of the habitats and ecological communities upon which these species depend, thereby contributing to healthy avian populations and communities. The plan can be viewed at:

http://www.fws.gov/migratorybirds/NewReportsPublications/SpecialTopics/BCC2008/BCC2008.pdf

This is one of the plans we used in identifying species of concern in appendix A, and in the development of management objectives and strategies in Goals 1, 2 and 3.

1.4.3 North American Bird Conservation Initiative

NABCI brings together the landbird, shorebird, waterbird, and waterfowl plans into a coordinated effort to protect and restore all native bird populations and their habitats in North America. Conservation partnerships reduce redundancy in the structure, planning, and implementation of conservation projects. The Initiative utilizes BCRs to guide landscape scale, science-based approaches to conserving birds and their habitats (NABCI 2010a). Great Swamp NWR is situated within BCR 29, known as the Piedmont region. BCR 29 extends from northern New Jersey southwest to northeastern Alabama. The Piedmont is a transitional area located between the mountainous Appalachians and the flat coastal plain. This region contains a patchwork of pasture, woodlots, and suburban sprawl, which results in significant bird conservation challenges. Specific bird conservation plans for BCR 29 that apply to Great Swamp NWR include the *Partners in Flight Bird Conservation Plan for the Mid-Atlantic Piedmont* and the *North American Waterfowl Management Plan – Atlantic Coast Joint Venture Waterfowl Implementation Plan* (see below).

BCR 28, known as the Appalachian Mountains region, is situated approximately 7,300 feet northwest of Great Swamp NWR; therefore, priority bird species and habitats identified in this region should also be considered. BCR 28 extends from southern New York southwest to northeastern Alabama and includes the Blue Ridge, the Ridge and Valley region, the Cumberland Plateau, the Ohio Hills, and the Allegheny Plateau. The rugged terrain of this region is dominated by oak-hickory and other deciduous forest types at lower elevations and by various combinations of pine, spruce, hemlock, and fir in higher elevations. Although flatter areas are utilized for agriculture, a majority of this region is covered by forest. The Appalachian Mountain region contains several major rivers which are utilized by various waterfowl species during migration. Specific bird conservation plans for BCR 28 that apply to Great Swamp NWR include the *North American Waterfowl Management Plan – Atlantic Coast Joint Venture Waterfowl Implementation Plan* (see below).

1.4.4 Partners in Flight Landbird Conservation Plan: Physiographic Area 9, Southern New England, and Area 10, Mid-Atlantic Piedmont

PIF was established in 1990 due to increasing concerns for population declines in various species of land birds and to encourage the conservation of bird species not incorporated in existing conservation initiatives. Initially, PIF's focus was on neotropical migratory birds, specifically those species that breed in the Nearctic and winter in the Neotropics; however, its focus was later broadened to include most land birds and other species requiring terrestrial habitat. PIF is a joint effort involving partnerships among Federal, state, and local government agencies, conservation groups, professional organizations, industry, the academic community and private individuals. The three primary concepts underlying PIF's mission are (1) helping species at risk before they become imperiled, (2) keeping both resident and migratory natives birds common in their natural ranges, and (3) encouraging voluntary partnerships for birds, habitats, and humans. PIF's goal is to focus resources on improving monitoring and inventory, research, management, and educational programs for birds and habitats in North America and the Neotropics (Ruth 2006).

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PIF utilizes Physiographic Areas to identify priority bird species and habitats in the United States, as well as to provide conservation recommendations and needs for each of these areas. Great Swamp NWR is situated within PIF Physiographic Area 9 (Southern New England) and PIF Physiographic Area 10 (Mid-Atlantic Piedmont). PIF Physiographic Area 9 encompasses portions of Maine, Massachusetts, New Hampshire, Connecticut, Rhode Island, New York, and New Jersey. This physiographic area identifies four priority habitat types, including grassland and agricultural fields, mature deciduous forest, early successional fields and pitch pine barrens, and maritime marsh, and 14 priority bird species, including American black duck and American woodcock (Dettmers and Rosenburg 2000). PIF Physiographic Area 10 encompasses portions of New Jersey, Pennsylvania, Maryland, Virginia, and West Virginia. This physiographic area identifies three priority habitat types, including deciduous and mixed forests, scrub-shrub and barrens, and agricultural grasslands, and 11 priority bird species, including the American woodcock (Kearney 2003).

We used both plans to identify species of concern in appendix A, and in the development of management objectives and strategies in Goals 1, 2, and 3.

1.4.5 North American Waterfowl Management Plan: Atlantic Coast and Appalachian Mountains Joint Venture Waterfowl Implementation Plans

The North American Waterfowl Management Plan (NAWMP), which was originally signed in 1986 by the United States and Canada and later by Mexico in 1994, was the first continental conservation plan developed in response to the significant decline in waterfowl populations observed during the mid-1980s (NAWMP 2004). The plan recognized the need for a collaborative effort to conserve wetlands and waterfowl habitats in North America to sustain and eventually restore waterfowl populations. The plan describes a 15-year strategy to restore and sustain waterfowl populations by protecting, restoring, and enhancing habitat. The plan committee, including representatives from each nation, has modified the 1986

plan twice to account for biological, sociological, and economic changes that influenced the status of waterfowl and the conduct of cooperative habitat conservation. The most recent modification (2004) updates the needs, priorities, and strategies for the next 14 years, increases stakeholder confidence in the direction of its actions, and guides partners in strengthening the biological foundation of North American waterfowl conservation (NAWMP 2004). The plan is currently being updated with a target date of 2011-2012 for completion (NAWMP 2009).

The NAWMP developed self-directed, regionally based partnerships known as joint ventures. These joint ventures were originally created for specific "Waterfowl Habitat Areas of Major Concern in the United States and Canada." Great Swamp NWR is located within the Atlantic Coast Joint Venture (ACJV). The ACJV encompasses 17 states in the Atlantic Flyway of the United States, extending from Maine south to the Commonwealth of Puerto Rico. The ACJV Waterfowl Implementation Plan further defines important geographic areas for waterfowl conservation in the ACJV, including focus areas and planning areas. Great Swamp NWR is partially located within a focus area designated as the Passaic River Basin. Although the primary focus of the ACJV is habitat conservation for waterfowl, the mission of the ACJV continues to evolve to include a more comprehensive method that emphasizes the conservation of all birds (ACJV 2009).

The Appalachian Mountains Joint Venture (AMJV) is located approximately 7,300 feet northwest of Great Swamp NWR; therefore, priority bird species identified for this region are considered in the Great Swamp Habitat Management Plan (HMP). The AMJV is dedicated to the conservation of all native bird populations and their habitats, consistent with major national and international bird conservation plans and the NABCI. The AMJV was originally established in 2003 as a BCR partnership. In 2006, the partnership launched actions to gain recognition, and ultimately to be declared a joint venture. The AMJV was formally recognized as a habitat joint venture by the Service in 2008. The AMJV Implementation Plan was submitted to FWS Division of Bird Habitat Conservation for review on May 30, 2008, and was approved in October 2008 (AMJV 2008).

1.4.6 U.S. Fish and Wildlife Service Strategic Plan for Responding to Accelerating Climate Change

According to the Intergovernmental Panel on Climate Change's (IPCC) *Fourth Assessment Report* (2007), "(w)arming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level… (m)ost of the observed increase in global average temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic greenhouse gas concentrations" (IPCC 2007). The global atmospheric concentration of carbon dioxide (CO_2), a major greenhouse gas, has increased approximately 35 percent since 1750, primarily due to human activity (IPCC 2007). In New Jersey, long-term data document an increase in average temperature and a rise in sea level that is consistent with observed and predicted global trends (NJDEP 2010). During the 20th century, average global temperatures have risen approximately 1 degree Fahrenheit and sea levels rose approximately 4 to 8 inches. Carbon dioxide emissions due to human activity are projected to further increase global temperatures by 2.5 degrees Fahrenheit to 10.4 degrees Fahrenheit over the period of 1990 to 2100. Global mean sea level is likely to rise an additional 4 to 35 inches over the same time period (NJDEP 2010). Rising ambient temperatures are expected to have direct and indirect impacts to human health, natural ecosystems, agriculture, and water supply in New Jersey (NJDEP 2010).

In response to accelerating climate change, FWS prepared a plan entitled "Rising to the Urgent Challenges of a Changing Climate: A Strategic Plan for Responding to Accelerating Climate Change in the 21st Century," which was finalized in September 2010 (USFWS 2010a). The goals and objectives of the Strategic Plan fall under three major strategies:

- Adaptation – *the use of management techniques and strategies, including reactive and anticipatory, to reduce impacts to fish, wildlife and habitats as a result of climate change.*

- Mitigation – *involves reducing the FWS "carbon footprint" by using less energy, consuming fewer materials, and altering land management practices with the ultimate intent to become carbon neutral by the year 2020.*

- Engagement – *reaching out to FWS employees; our local, national, and international partners in the public and private sectors; our key constituencies and stakeholders; and citizens to join forces with them in seeking solutions to the challenges and threats to fish and wildlife conservation posed by climate change* (USFWS 2010a).

The primary purposes of the plan are to present a vision for accomplishing the FWS mission in the face of accelerating climate change and to provide direction for our organization and its employees, defining our role within the context of the Department and the larger conservation community (USFWS 2010a).

1.4.7 National Invasive Species Management Plan and the New Jersey Strategic Management Plan for Invasive Species

Executive Order 13112 requires the National Invasive Species Council (Council) to produce a National Invasive Species Management Plan (Invasives Plan) every 2 years. In January 2001, the Council released the first Invasives Plan, which serves as a blueprint for all Federal action on invasive species. Collaboration between the Council and the *Fulfilling the Promise* team, also known as the National Invasive Species Management Strategy Team, furthered the Invasives Plan to focus on invasive species control and management efforts in the Refuge System. This National Strategy, developed in 2003, provides precise guidance to Regional and field offices, and identifies four primary goals, including (1) increase awareness; (2) reduce impacts to refuge habitats; (3) reduce impacts to neighboring lands; and (4) utilize and develop new integrated pest management approaches (USFWS 2003a). The Invasives Plan focuses on those non-native species that cause or may cause significant negative impacts and that do not provide an equivalent benefit to society.

The New Jersey Strategic Management Plan for Invasive Species sets forth recommendations pursuant to New Jersey Executive Order #97, which created the New Jersey Invasive Species Council (NJISC) with the responsibility of completing a comprehensive invasive species management plan for the State of New Jersey. NJISC's vision statement is "*to reduce the impacts of invasive species on New Jersey's biodiversity, natural resources, agricultural resources and human health through preservation, control and restoration, and to prevent new invasives species from becoming established.*" The mission of NJISC is to provide coordination and guidance for invasive species activities throughout the State and to act as a liaison for regional and national cooperative efforts. The plan provides a "blueprint" for a cooperative effort among stakeholders to put into practice the actions needed to reduce and manage the invasive species problem in the State.

1.4.8 The Nature Conservancy Eco-Regional Plan

The Nature Conservancy has delineated the continental United States into 63 ecoregions, which are large geographic areas that share similar geologic, topographic, ecological, and climatic characteristics. These ecoregions are a modification of the U.S. Forest Service's "Bailey System." Great Swamp NWR is located within the Lower New England/Northern Piedmont (LNE/NP) Ecoregion. This ecoregion extends from southern Maine to northern Virginia, and includes 12 states and the District of Columbia. This ecoregion is characterized by extensive low-relief plains, with low mountains in the north and rolling hills in the south. The till covered north includes glacial features such as former lake basins, eskers and drumlin fields, as well as numerous streams, small lakes, and wetlands (Barbour 2003).

The goal of the LNE/NP Ecoregional Planning Team is to "maintain the long-term viability of all native plant and animal species and examples of all natural communities across their natural ranges of occurrence and variation within the ecoregion while maintaining the natural processes critical to ensuring long-term ecological integrity" (Barbour 2003). Particularly, the conservation objectives adopted by the planning team are:

- To ensure the continued existence of the matrix communities found in the ecoregion and restore the natural processes, including succession, to promote the development of mature (old growth) stands;
- To protect multiple viable examples of all the region's natural communities through the development of a portfolio of conservation areas. The examples should represent the range of variability found within each of the communities in the ecoregion;
- To incorporate into the portfolio viable examples of all declining, disjunct, or otherwise vulnerable species, with the goal of protecting multiple viable populations of each species in the variety of habitats and ecological contexts in which it naturally occurs; and
- To protect the full array of aquatic species found within the ecoregion.

The LNE/NP Ecoregion is further classified into subregions and subsections. Eighteen subsections have been characterized within the ecoregion, each of which was utilized in the planning process to set geographic distribution goals for species targets (Barbour 2003). The Great Swamp NWR is located within the Northern Piedmont Subregion and the Gettysburg Piedmont Lowland Subsection (221Da).

1.4.9 Significant Habitats and Habitat Complexes of the New York Bight Watershed

The FWS Southern New England-New York Bight Coastal Ecosystems Program prepared this report for the purpose of assessing the status of regionally significant native fish, wildlife, and plant populations and their essential habitats in the New York Bight region, especially those requiring immediate or long-term protection, conservation, enhancement and/or restoration (USFWS 1997a). The study also determined, delineated and described specific habitats or habitat complexes of regional importance or significance. Significance of a site or resource refers to its "relative regional importance to one or more life history stages or seasonal use periods of Federal or State trust species and other species of special emphasis or concern" (USFWS 1997a). The FWS worked closely with resource agencies of New York and New Jersey, including fish and wildlife agencies and endangered, non-game, and natural heritage programs, to develop target species lists for each state and to compile comprehensive list of species of special emphasis specific

to the watershed as a whole (USFWS 1997a). The list of species of special emphasis developed for the New York Bight study area includes 114 species of invertebrates; 232 species of birds; 31 species of amphibians and reptiles; 38 species of mammals; 99 species of fish; nearly 500 species of plants; and 82 natural communities (USFWS 1997a). These species include a number of focus groups of Federal and State trust species in the Bight.

Great Swamp NWR is located in the southwest portion of the Passaic Meadows Habitat Complex (Complex #24), which is situated within the Piedmont Lowlands Physiographic Region (Northern Triassic Lowlands) of the New York Bight watershed. The wetlands within this complex support regionally significant populations of fish and wildlife, and are particularly significant for seasonal concentrations of waterfowl and waterbirds (USFWS 1997b). The New Jersey Natural Heritage Program recognizes four Priority Sites of Biodiversity within the habitat complex, including Great Swamp, all of which have a biodiversity rank of B4 (moderate biodiversity significance) (USFWS 1997b). This report also identifies threats and special problems, as well as conservation recommendations, for this habitat complex.

1.4.10 National Fish Habitat Action Plan

The National Fish Habitat Action Plan (NFHAP) was originally prepared in 2001 through the Association of Fish and Wildlife Agencies (AFWA) and in collaboration with FWS, the National Oceanic and Atmospheric Administration (NOAA) National Marine Fisheries Service and other key partners. The mission of the NFHAP is to protect, restore and enhance the nation's fish and aquatic communities through the establishment of Fish Habitat Partnerships (NFHAP 2006). The NFHAP set a goal of developing at least 12 strong partnerships, similar to scale as the NAWMP. Fish Habitat Partnerships are established around important aquatic habitats and distinct geographic areas, keystone fish species, and/or system types. In 2010, 17 Fish Habitat Partnerships are established and working, while four candidate partnerships are awaiting formal recognition (NFHAP 2010). Great Swamp NWR is situated within the Eastern Brook Trout Joint Venture (EBTJV), which was formally established in 2005 and encompasses 17 states from Maine to northern Georgia. The management priorities of EBTJV's Mid-Atlantic Region, which includes northern New Jersey, Pennsylvania, Maryland, West Virginia, and Ohio, are as follows (Eastern Brook Trout Joint Venture, 2010):

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- Protect the 23 intact watersheds remaining;
- Improve water quality;
- Promote and restore riparian forest; and
- Remove and prevent exotic fish.

Development in the Mid-Atlantic Region has resulted in warmer water temperatures due to the loss of forest shading along streams, heated runoff from paved surfaces, over-widening of streams, and loss of physical habitat and cover in streams (Eastern Brook Trout Joint Venture, 2010). EBTJV's "Conserving the Eastern Brook Trout: Action Strategies" report (2008) provides rangewide, regional, and state-level goals, objectives, and strategies designed to achieve the overall principle goals of the EBTJV.

1.4.11 New Jersey Wildlife Action Plan

In November 2001, Congress signed the Department of the Interior and Related Agencies Appropriations Act of 2002, which established the State Wildlife Grants (SWG) program. The SWG program provides funds to state wildlife agencies for the conservation of fish and wildlife and their habitats. The program required that each state develop a Comprehensive Wildlife Conservation Strategy by October 1, 2005 in order to qualify for and ensure future Federal grant funding (NJDEP 2008a). The 2002 Act was later replaced by the 2007 Administrative Guidelines for SWG due to emerging issues that would require additional review and because the original guidelines became obsolete (USFWS 2006d).

The New Jersey Division of Fish and Wildlife (NJDFW), in collaboration with the general public, New Jersey conservation groups, and other stakeholders including the FWS, developed the New Jersey Wildlife Action Plan (NJWAP) for the conservation of the State's species of greatest conservation need. This plan, formerly known as the Comprehensive Wildlife Conservation Strategy, was originally submitted on October 1, 2005; however, due to a limited public comment period, the plan received conditional approval and was later resubmitted to the FWS on August 4, 2006. Since then, several revisions have occurred for clarification and enhancement to ensure necessary conservation objectives are not overlooked. The most recent version is dated January 23, 2008 (NJDEP 2008a).

The NJWAP identifies Great Swamp NWR as a "significant natural area" in New Jersey (NJDEP 2008a). To better assess conservation needs, goals, and priorities, the NJWAP uses the five ecoregions and 26 conservation zones already identified in the New Jersey Department of Environmental Protection (NJDEP) Landscape Project (NJDEP 2008b). Great Swamp NWR lies within the Piedmont Plains ecoregion and the Northern Piedmont Plains conservation zone. Of the nearly 200 species identified as Wildlife of Greatest Conservation Need in the NJWAP, 90 species are known to occur within Great Swamp NWR and two have been extirpated but are potential candidates for reintroduction (sedge wren and ruffed grouse). In addition to sensitive species, the NJWAP identifies habitat needs and priorities for each ecoregion and conservation zone. Forests are identified as a high priority for the Northern Piedmont Plains conservation zone. Great Swamp NWR has the largest forested patch in this conservation zone. In addition, Great Swamp NWR also has significant areas of forested, scrub-shrub and emergent wetlands that serve as habitat for a variety of birds, reptiles, and amphibians, including the federally listed threatened bog turtle.

1.4.12 Partners in Amphibian and Reptile Conservation, National State Agency Herpetological Conservation Report (Draft 2004)

Partners in Amphibian and Reptile Conservation (PARC) was created in response to the increasing, well-documented national declines in amphibian and reptile populations. Many consider it the most comprehensive effort in herpetofaunal conservation. PARC members come from state and Federal agencies, conservation organizations, museums, the pet trade industry, nature centers, zoos, the power industry, universities, herpetological organizations, research laboratories, forest industries, and

environmental consultants. Its five geographic regions – Northeast, Southeast, Midwest, Southwest, and Northwest – can focus on national and regional challenges in herpetofaunal conservation. Regional working groups allow for region specific communication. The Northeast working group has developed "Model State Herpetofauna Regulatory Guidelines," which provides specific habitat management prescriptions for the benefit of different taxonomic groups of herpetofauna (NEPARC 2010a). In addition, the working group also developed a "Northeast Amphibian and Reptile Species of Regional Responsibility and Conservation Concern" report (NEPARC 2010b). These guidance documents were consulted during the development of strategies for this CCP.

The National State Agency Herpetological Conservation Report (NHCR) is a draft summary report (PARC 2004) sponsored by PARC that provides a general overview of each state wildlife agency's support for reptile and amphibian conservation and research through September 2004. The report identifies amphibian and reptile species of concern for each state. Each state report was compiled in cooperation with its agency's lead biologist on herpetofaunal conservation. The purpose of the report is to facilitate communication among state agencies and partner organizations throughout the PARC network to identify and address regional and national herpetological priorities. The report can be accessed at *http://www.parcplace.org/documents/PARCNationalStates2004.pdf*.

PARC intends to expand the scope of the NHCR to include other states, provinces, and territories. It will include other state agencies that are supporting herpetological conservation and research, such as transportation departments, park departments, and forest agencies. The next NHCR report will integrate a list of the Species of Conservation Concern into each state's comprehensive conservation wildlife strategy.

1.4.13 Bog Turtle Northern Population Recovery Plan

Public Law 100-478 (102 Stat 2306), enacted in October 1988 under the ESA, requires the Secretary of Interior to develop and review recovery plans for listed species, unless such a plan would not promote the conservation of a particular species (USFWS 2008c). The northern population of the bog turtle was listed as a federally threatened species in November 1997. As a result, the Bog Turtle Northern Population Recovery Plan was developed and later approved on May 15, 2001. The overall objective for the recovery plan is to protect and maintain existing populations of this species and its habitat, enabling its eventual removal from the Federal list of endangered and threatened wildlife and plants.

To facilitate recovery, the northern population is divided into five recovery units and their subunits. The Great Swamp NWR bog turtle population lies within the Hudson River/Housatonic Unit, Hudson River Watershed Subunit. Four recovery criteria were established to set the threshold for determining when the recovery objective has been met. Those criteria pertain to population and habitat goals, monitoring programs, illicit trade, and habitat management. One criterion for the Hudson River Watershed Subunit is to protect at least 10 viable bog turtle populations and sufficient habitat to ensure they can be sustained. In addition to listing goals and criteria and describing bog turtle ecology and life history, the Recovery Plan identifies nine specific recovery tasks. The tasks are specific actions that, when fully implemented, should lead to meeting the recovery objective. Refuge staff will contribute to the following recovery tasks on the Great Swamp NWR, within their authority and in cooperation with the recovery team:

1) Protect known and extant populations and habitat using existing regulations.

2) Secure long-term protection of bog turtle populations.

3) Conduct surveys of known, historical, and potential bog turtle habitat.

4) Investigate the genetic variability of the bog turtle throughout its range.

5) Reintroduce bog turtles into areas from which they have been extirpated or removed.

6) Manage and maintain bog turtle habitat to ensure its continuing suitability for bog turtles.

7) Manage bog turtle populations at extant sites, where necessary.

8) Conduct an effective law enforcement program to halt illicit take and commercialization of bog turtles.

9) Develop and implement an effective outreach and education program about bog turtles (USFWS 2001b).

1.4.14 Indiana Bat Recovery Plan

In 1967, the FWS listed the Indiana bat as federally endangered due to significant population declines documented at their seven major hibernacula in the Midwest. At the time of their listing, the Indiana bat population was approximately 883,300 (USFWS 2007a). Surveys conducted in 2007 estimated the rangewide population at approximately 468,184. Winter surveys conducted in 2007 at known Priority 1 and 2 hibernacula sites in New Jersey estimated the population at 659 (USFWS 2008d). As of October 2006, FWS had records of existing winter populations at approximately 281 hibernacula in 19 states and 269 maternity colonies in 16 states (USFWS 2007a). In 1992, Indiana bats were found hibernating in three areas near Hibernia, New Jersey. Great Swamp NWR confirmed the occurrence of maternity colonies in 2005.

Similar to the original recovery plan, the 2007 Revised Draft Indiana Bat Recovery Plan continues emphasize protection of hibernacula, but also increases the focus on summer habitat and proposes use of four Recovery Units: Ozark-Central, Midwest, Appalachian Mountains, and Northeast. Great Swamp NWR is located within the Northeast Recovery Unit and within the Eastern Broadleaf Forest Ecoregion Division (USFWS 2007a).

The primary goal of the recovery plan is to reclassify the Indiana bat to federally threatened, with an ultimate goal of removing the species from the Federal list of threatened and endangered wildlife. The reclassification of the Indiana bat will be attained through the achievement of the following objectives: (1) permanent protection of 80 percent of Priority 1 hibernacula; (2) a minimum overall population number equal to the 2005 estimate (457,000); and (3) documentation of a positive population growth rate over five sequential survey periods. Similarly, delisting of the Indiana bat will be attained by addressing the following: (1) permanent protection of 50 percent of Priority 2 hibernacula; (2) a minimum overall population number equal to the 2005 estimate; and (3) continued documentation of a positive population growth rate over an additional five sequential survey periods (USFWS 2007a).

During the winter of 2006-2007, the first documented case of White-Nose Syndrome (WNS) was reported in New York. WNS is characterized by the colonization of a psychrophilic, or “cold-loving,” fungus on the muzzle, ears, and flight membranes of hibernating bats (Blehert, et al., 2008); however, the presence of the fungus is typically only observable on approximately half of bats affected. The fungus has been identified

as *Geomyces destructans.* Affected bats may exhibit low body weights and abnormal behaviors, including early emergence from hibernation and movement to colder areas of caves. WNS quickly spread to hibernacula of several other New England states the following winter. During the time from 2008 to 2009, the syndrome spread as far south as Virginia and included the states of New Jersey and Pennsylvania. Since it was first documented, WNS has been confirmed in 20 states and 4 Canadian provinces (USFWS 2012d). WNS has been confirmed in states as far west as Oklahoma. More than 5.5 million hibernating bats have died since WNS was documented in 2006 (USFWS 2012d). In some hibernacula (caves or mines where bats hibernate in winter), approximately 90 to 100 percent of bats are dying (USFWS 2010c). The majority of bats dying in the Northeast have been little brown bats (*Myotis lucifugus*); however, WNS has also affected tri-colored (*Perimyotis subflavus*), Northern long-eared (*Myotis septentrionalis*), big brown (*Eptesicus fuscus*), Eastern small footed (*Myotis leibii*), and Indiana bats (USFWS 2010c).

In 2009, WNS was confirmed in five hibernacula in New Jersey, including Hibernia mine, both Mount Hope mines, and Upper and Lower Copper mines (NJDEP 2009a). Data suggests that at least some of the refuge's Indiana bats winter in Hibernia and Mount Hope mines (Kitchell 2011). A majority of the bats hibernating in Hibernia mine are little brown bats, with lesser amounts of Indiana bats and Northern long-eared bats (Valent 2011). Visual signs of the fungus and behavioral changes were observed in Hibernia mine in January 2009 and mortality was evident from March to April 2009 (Valent 2011). In February 2010, NJDFW estimated 93 percent mortality in Hibernia mine (Valent 2011). The presence of WNS in New Jersey has resulted in at least a 50 percent decline in *Myotis* species (Valent 2011). Potential declines were documented at the refuge post-WNS; however, detecting WNS-related impacts on the maternity colony is extremely difficult in absence of substantial baseline data and significant mist netting survey efforts. Data collected at the refuge between 2006 and 2010 indicates that peak emergence counts showed a potential decline in Indiana bat colony size. Although few bats showed evidence of wing scarring, significant changes in both the bat population and in the proportion of reproductive females were evident following the onset of WNS. Survey results also indicated substantial declines in little brown bat populations; declines in Indiana bat and Northern long-eared bat populations; and significant increases in big brown bat populations after the onset of WNS (Kitchell and Wight undated).

A comprehensive understanding of WNS is essential for the development of management strategies for this threat to bats in the Northeastern United States (Blehert, et al., 2008).

1.4.15 American Woodcock Conservation Plan

Since surveys were first implemented in the mid-1960s, significant declines in both the central and eastern populations of American woodcock have been observed. Population declines are thought to be a result of early successional forest habitat loss and degradation. Long-term trends indicate that woodcock population declines for the Eastern region are 1.9 percent per year (Woodcock Task Force et al., 2008). In the parts of the Piedmont region (BCR 29) that are covered by the Singing-Ground Survey (Virginia, Maryland, Pennsylvania, and New Jersey), there have been long-term declines (1968-2004) of 3.25 percent per year for breeding woodcocks (Palmer 2008). The largest decline in singing males was recorded in New Jersey at 83 percent (population estimates: 1970-75 = 5,243; current = 909) (Palmer 2008).

The 2008 American Woodcock Conservation Plan documents woodcock population trends from the early 1970s through 2005 and provides landscape-level habitat management recommendations. The goal of this plan is to prevent further decline of woodcock populations and to eventually achieve positive population growth (Woodcock Task Force et al., 2008). According to the plan, 203,698 acres of manageable early

successional habitat must be created and/or maintained in New Jersey to provide suitable woodcock habitat, to eliminate the population deficit (4,334 singing males), and to return densities to those observed during the early 1970s (Palmer 2008).

1.4.16 Other Information Sources

The following plans and resources were also consulted as we refined our management objectives and strategies, especially those with a local context.

Continental or National Plans

- U.S. Geological Survey National Wetlands Research Center Strategic Plan: 2010-2015 (USGS 2010); available at *http://www.nwrc.usgs.gov/about/5-year-plan.htm.*
- National Audubon Society Watchlist (Audubon Society 2007); available at *http://birds.audubon.org/2007-audubon-watchlist.*

Regional Plans

- U.S. Fish and Wildlife Service Region 5 Strategic Plan, Fiscal Year 2007 to 2011, Partners for Fish and Wildlife Program, Coastal Program (USFWS 2007b); available at *http://www.fws.gov/partners/Strategic_Plans/Regions/Final_rR5_Partners_and_Coastal_Strategic_Plan%20.pdf.*
- Ducks Unlimited International Conservation Plan–Mid-Atlantic Coast (Ducks Unlimited 2005); available at *http://www.ducks.org/conservation/conservation-plan/international-conservation-plan.*

State Plans

- New Jersey Landscape Project, New Jersey Endangered and Nongame Species Program (Niles *et* al., 2008); available at *http://www.state.nj.us/dep/fgw/ensp/landscape/.*
- 2008-2012 New Jersey Statewide Comprehensive Outdoor Recreation Plan (NJDEP 2007a; available at *http://www.nj.gov/dep/greenacres/pdf/scorp.pdf.*
- New Jersey State Development and Redevelopment Plan–Final Draft (New Jersey State Planning Commission 2010); available at *http://www.nj.gov/dca/divisions/osg/.*

Local Plans

- Great Swamp Watershed Management Plan (Browne 1997); available at *http://www.greatswamp.org/Education/WatershedPlan.htm.*

1.5 Refuge Establishment, History and Purpose

In 1959, the Port Authority of New York and New Jersey announced plans to consider Great Swamp as a potential site for a commercial jet airport. As a result of major opposition, local citizens formed the Great Swamp Committee of the North American Wildlife Foundation, and through a national campaign, raised 1 million dollars to acquire nearly 3,000 acres. The Foundation began acquiring these lands in 1960 with the intention to donate this area to the United States. Great Swamp NWR was established by an act of Congress on November 3, 1960 and formally dedicated in 1964, primarily under the authorities of the Migratory Bird Treaty Act of 1918 (16 USC 703-711) and the Migratory Bird Conservation Act of 1929 (USC 715-715s, 45 Stat. 1222) as amended, for the following purpose:

Jerry Quinlan

> *"…for use as an inviolate sanctuary, or for any other management purpose, for migratory birds*".

Based upon land acquisition documents and authorities, additional refuge purposes were identified as follows:

> *"...suitable for (1) incidental fish and wildlife-oriented recreational development, (2) the protection of natural resources, (3) the conservation of endangered species or threatened species ..."* (16 U.S.C. 460k-1, Refuge Recreation Act);
>
> *"... the conservation of the wetlands of the Nation in order to maintain the public benefits they provide and to help fulfill international obligations contained in various migratory bird treaties and conventions ..."* (16 U.S.C. 3901(b), Emergency Wetlands Resources Act of 1986); and
>
> *"... to conserve (A) fish or wildlife which are listed as endangered species or threatened species .... or (B) plants ..."* (16 U.S.C. 1534, Endangered Species Act of 1973).

As stated in a letter, dated 1962, from FWS Director Daniel H. Janzen to U.S. Congressman, Peter H.B. Frelinghuysen, Jr. of the New Jersey Fifth Congressional District, which covered most of Morris County:

> *"The major objective of this refuge, other than to provide protection and preservation of the migratory waterfowl resource, is to provide an outdoor laboratory which will permit the people of the heavily populated surrounding area to engage in the above pursuits"* (USFWS 1987).

Personal communication with refuge staff and review of available records support that all tracts of land were acquired under the primary purposes of Great Swamp NWR. Any potential conflicts are researched and resolved by a FWS Solicitor prior to acquisition. No existing land acquisition uses conflicting with the refuge's purposes were identified.

1.6 Refuge Administration

The refuge staff currently consists of the following permanent positions: a Wildlife Refuge Manager; Deputy Wildlife Refuge Manager; Contaminants Biologist; Wildlife Biologist; Visitor Services Manager; Visitor Services Specialist; Engineering Equipment Operator; Land Management Law Enforcement Officer; and Maintenance Worker. The refuge also includes one temporary staff: an administrative assistant. The refuge also partially funds a temporary Fish and Wildlife Biologist stationed at Wallkill River NWR who also works at Great Swamp and Cherry Valley NWRs. An Administrative Officer located at Wallkill River NWR provides part-time support to Great Swamp NWR for budget, bill paying, purchases, and payroll.

1.7 Refuge Operational Plans ("Step-Down" Plans)

The FWS Manual's "Refuge Planning Policy" (Part 602, chapter 4) lists more than 25 step-down management plans that are generally required on refuges. Those plans contain specific strategies and implementation schedules for achieving refuge goals and objectives. Some plans require annual revisions, while others require revision every 5 to 10 years. Some require additional NEPA analysis, public involvement, and compatibility determinations before they can be implemented.

The following step-down plans are complete and up-to-date:

- Annual Wetlands & Water Management Program for Managed Wetlands (completed 2003).
- Upland Habitat Management Plan [completed 1988; will be superseded by the upcoming HMP.
- Wildlife Inventory Plan (completed 1987; to be updated after HMP and CCP completion).
- Wildland Fire Management Plan (updated in 2008).
- Deer Hunting Plan [updated in 2009 (draft)]
- Annual Deer Hunting Program (completed 2011).
- Chronic Wasting Disease Surveillance and Contingency Plan (completed 2008).
- Migratory Bird Disease Contingency Plan (completed 2003).
- Animal Control Management Plan (completed 1990).
- Disease Contingency Plan (year?).

The following plans are to be completed for the Great Swamp NWR:

- An HMP, immediately following CCP approval.
- A Wilderness Stewardship Plan, within 2 years of CCP approval.
- Visitor Services Plan (VSP), within 2 years of CCP approval.
- Fire Management Plan (FMP), within 5 years of CCP approval.
- Operation and Maintenance Plan, within 5 years of CCP approval.
- Hunting Plan, within 1 year of CCP approval.
- Population Management Plan, within 10 years of CCP approval.
- Law Enforcement Plan, within 5 years of CCP approval.

See section 3.1.1 for additional details regarding developing refuge step-down plans.

1.8 Refuge Vision Statement

Our planning team has developed this vision statement to provide a guiding philosophy and sense of purpose in the CCP.

Great Swamp National Wildlife Refuge is a rich natural oasis immersed within the bustling New Jersey-New York metropolitan area. At Great Swamp migrating birds feed and rest amongst whispering trees while butterflies flitter through wildflower-laced meadows. Turtles bask in the warm summer's sun, as the drum of a red-headed woodpecker echoes across an expansive marsh. Barred owls break the evening silence with unmistakable calls from deep within the forest while frogs chorus in excited trills and croaks in the wet meadows. These sights and sounds are the very same ones that were heard by the Lenape Tribes centuries before.

Great Swamp is an ecological treasure that invites people to engage with the natural world in ways that are educational, memorable, and rewarding. Visitors are refreshed by the beauty, peace and solitude of this wild and natural setting, where wildlife comes first. Vital partners continue working together to protect the Great Swamp and its watershed to ensure its myriad of benefits for future generations.

1.9 Refuge Goals

Our planning team has developed the following goals for the refuge after a review of legal and policy guidelines, the FWS mission, regional plans, refuge purposes, our vision for the refuge, and public comments. All of these goals fully conform to and support national and regional mandates and policies.

Goal 1: Provide high quality diverse freshwater emergent wetlands with naturally varying hydric regimes, including wet meadows, freshwater emergent marsh, and open water wetland habitats dominated by native plants for migratory birds, endangered and threatened species, and priority conservation species.

Goal 2: Create and maintain an interspersion of scrub-shrub, grassland and successional wet meadows comprised of native vegetation at various successional stages to enhance breeding and foraging habitat for priority species on conservation concern.

Goal 3: Maintain a mosaic of wetland and upland forest, consisting of native understory species of varying densities and structure, to maximize the potential utilization by priority resources of concern.

Goal 4: Provide opportunities for visitors of all ages and abilities to enjoy wildlife-dependent recreation, appreciate the cultural and natural resources of Great Swamp National Wildlife Refuge, and increase their understanding and support of the refuge's mission.

Goal 5: Collaborate with the local community and partners to complement biological and visitor services programs on the refuge and throughout the watershed.

1.10 The Comprehensive Conservation Planning Process

FWS Policy (602 FW 3) establishes an eight-step planning process that also facilitates compliance with NEPA (see figure 1-1 below). The full text of the policy and a detailed description of the planning steps can be viewed on the Web at *http://policy.fws.gov/602fw3.html.* We followed the process depicted in the figure below in developing this CCP.

Our refuge planning began informally in 2008 to become familiar with the planning process and to start collecting information on refuge resources and public use. Subsequently, we initiated State and Tribe involvement in September 2008. An initial strategy meeting between the refuge staff and Regional Office staff was held at the refuge in July 2009. We assembled our core planning team, which consists of refuge staff, Regional Office staff, and a representative from the NJDFW. One major outcome of this meeting was a timetable for accomplishing the major steps in the planning process.

In July 2010, our public scoping period began. We mailed approximately 500 copies of the initial CCP planning announcement newsletter to local conservation and interest groups; research organizations; local, State and Federal government agencies; federally recognized Tribes; and interested individuals. We also posted the July newsletter on the refuge's website to reach a broader audience. Announcement of the CCP/EA was published in the Federal Register on July 19, 2010 (Volume 75, Number 137). We also held two public scoping meetings at the Chatham Township Municipal Building on July 28, 2010 at 1 and 6. These meetings were advertised in news releases, our first newsletter, and local bulletin boards. A total of 31 attendees, including six organizations, participated in the public scoping meetings. A total of 21 written comments from both individuals and organizations were received, including seven comments via email and 14 comments via standard letter or comment card. Public comments included concerns and suggestions on maintenance, public use and access; natural resource management; endangered and threatened species; hunting and animal welfare; and regional or global environmental issues, including water quality, air quality and global warming. These comments influenced the development of issues and alternatives in the draft CCP/EA.

In September 2010, our core planning team was expanded to include Amy S. Greene Environmental Consultants, Inc. (Flemington, New Jersey).

In October 2010, the U.S. Geological Survey (USGS) began conducting a visitor survey at the refuge, which included two sampling periods, one of which was completed in the fall of 2010 and the other in the spring of 2011. The survey is designed to help us gain further insight into visitors' desires and concerns regarding public use opportunities and facilities at Great Swamp NWR. A total of 336 visitors agreed to participate in the survey during the two sampling periods. In all, 219 visitors completed the survey for a 67 percent response rate and ±5 percent margin of error at the 95 percent confidence level.

In January 2011, we released a second planning update newsletter to everyone on our mailing list. This update summarized the public comments we had received from meetings and by mail, and provided an update on the progress of the CCP planning process.

In March 2011, we hosted a 2-day alternatives workshop to discuss ideas, issues, and opportunities for the refuge as part of the planning process, with one day focusing on ecosystems and natural resources and the other focusing on public use and visitor services. Participants of the ecosystems and natural resources workshop included the core planning team, other refuge staff, and representatives from the Natural Resources Conservation Service, Friends of Great Swamp NWR, The Nature Conservancy, and The Land Conservancy of New Jersey. Participants of public use and visitor services workshop included the core planning team, other refuge staff, and representatives from the Somerset County Park Commission Environmental Education Center, The Raptor Trust, Friends of Great Swamp NWR, NPS Morristown National Historical Park, Alliance of New Jersey Environmental Education, and American Museum of Natural History. Comments from the workshops were carefully considered in the development of the CCP.

In February 2012, we distributed our third planning update newsletter. This newsletter provided a status update on the CCP planning process, a summary of draft alternatives, an updated vision statement, and a planning timeline.

In June 2012, we submitted the draft CCP/EA to the FWS Regional Office for review.

We will evaluate our accomplishments under the CCP each year. If future monitoring or new information results in the prediction of a significant impact, it will require further analysis.

1.11 Issues, Concerns, and Opportunities

We define an issue as "*any unsettled matter requiring management decision.*" That can be an "*initiative, opportunity, resource management problem, threat to a resource, conflict in use, or a public concern.*" Issues arise from many sources, including our staff, other FWS programs, state agencies, other Federal agencies, our partners, neighbors, user groups, or Congress. The following summary provides a context for the issues that arose during the planning process.

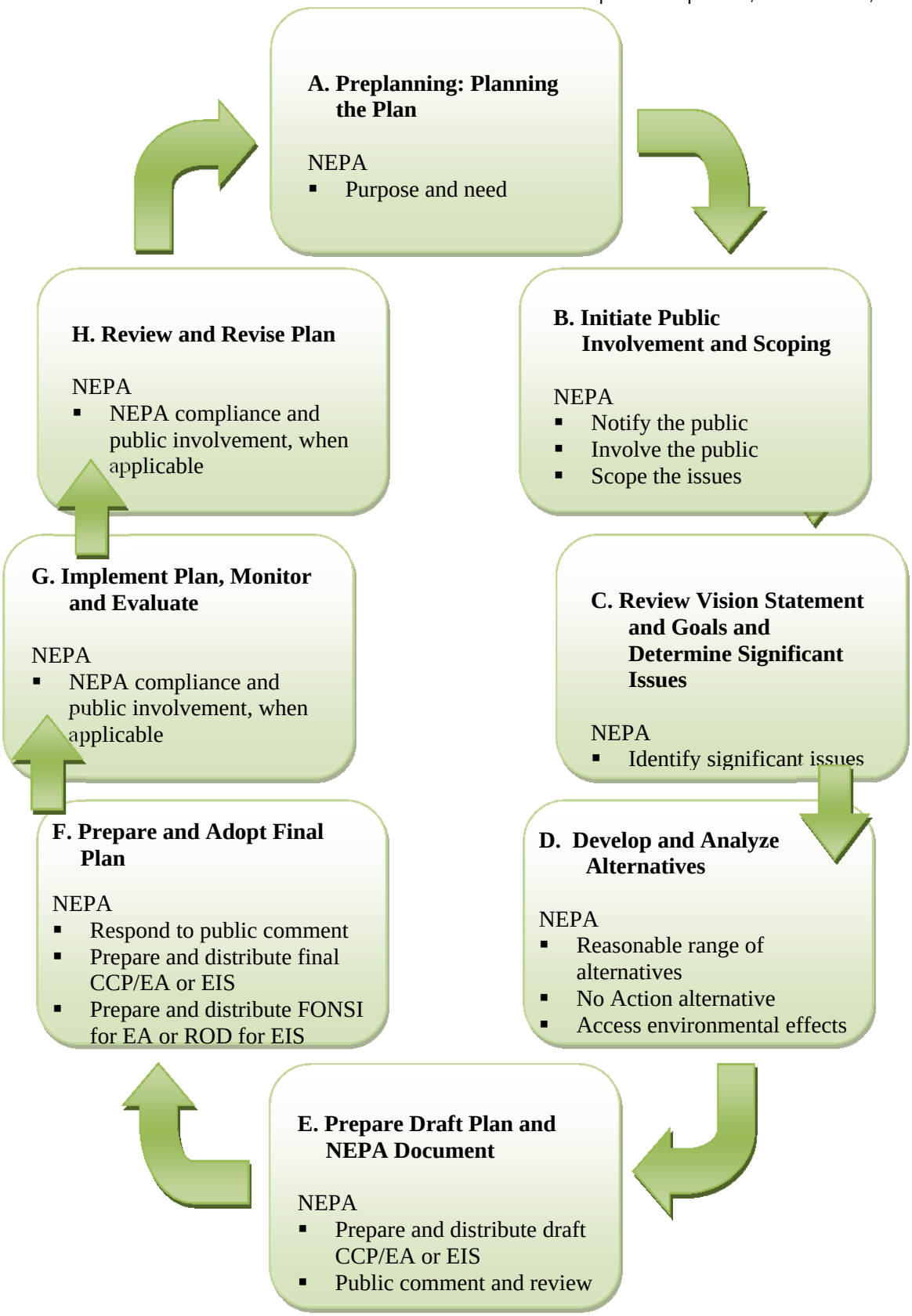


Figure 1-1: The Comprehensive Conservation Planning Process and its Relationship to the NEPA.

Habitat and Species Management

- How to manage and maintain habitat for priority species, such as waterfowl.
- How to balance management of and maximize the benefits from various habitat types, including opportunities to improve grassland bird habitat.
- How to best manage habitat for endangered and threatened species.
- How to prioritize invasive species management.

Public Use

- How to expand outdoor education opportunities, including opportunities to connect with regional urban populations.
- Whether or not to expand the trail system.
- How to achieve additional public outreach and connect with local populations that are not currently engaged with the refuge.
- Where there may be opportunities to improve wildlife viewing opportunities, especially waterfowl.
- Whether or not to expand existing hunting programs, including opportunities for additional hunted species or methods.

Regional Issues

- How can refuge management continue improve water quality in the region.
- What role does the refuge play in regional hydrology
- Identify/address climate change concerns impacting the refuge.

1.12 Decisions to be Made

The FWS Region 5 Regional Director will make the final determination of a preferred alternative to serve as the CCP for Great Swamp NWR. This final determination will be based on the FWS and Refuge System missions, the purposes for which the refuge was established, other legal mandates, and public and partner responses to this draft CCP/EA. The alternative selected could be the preferred alternative in the draft CCP/EA, the no action alternative, or a combination of actions or alternatives presented. The final decision will identify the desired combination of species protection, habitat management, public use and access, and administration for the refuge.

The FWS determined that an EA would be a more appropriate document than an environmental impact statement (EIS) to accompany the CCP. The need to prepare an EIS is a matter of professional judgment requiring consideration of all issues in question. If the EA determines that the CCP will constitute a major Federal action significantly affecting the quality of the human environment, an EIS will then be prepared. If not, a finding of no significant impact (FONSI) is prepared that briefly describes why the proposed action will not have a significant effect on the human environment. The FONSI would also 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 FONSI and we have completed the CCP for the refuge, we will notify the public in the Federal Register and implementation can begin.

Chapter 2

Michael Stadelmeier

Existing Environment

- Introduction
- Physical Landscape Setting
- Regional Demographic and Socioeconomic Setting
- Refuge Administration
- Soils, Vegetation, and Habitat Types
- Wildlife Resources
- Refuge Visitor Services Program
- Cultural, Archaeological, and Historical Resources

2.0 Introduction

This chapter describes in detail the current physical, biological, and social environment of the Great Swamp NWR. It provides descriptions of the physical landscape, the regional setting and its history, and additionally, the refuge setting, including its history, current administration, programs, and specific refuge cultural and ecological resources. This chapter provides context for current refuge goals, issues, alternatives, and management direction, which are discussed in subsequent chapters.

2.0.1 Refuge Location and General Description

The 7,773-acre Great Swamp NWR is located 26 miles from New York City within the Townships of Chatham, Harding, and Long Hill of Morris County in north-central New Jersey (map 2-1). Great Swamp NWR is situated north of Interstate 78 and east of Interstate 287. The refuge has an approved acquisition boundary that would allow for the refuge to expand to 9,429 acres (map 2-2).

The refuge headquarters is located along Pleasant Plains Road in Harding Township. The refuge Visitor Center, also located along Pleasant Plains Road in Harding Township, is situated within the northwest portion of the refuge. The refuge is surrounded primarily by residential development, as well as natural areas. Natural areas adjacent to the refuge include Somerset County Environmental Education Center and Lord Stirling Park on the western refuge boundary, Morris County Great Swamp Outdoor Education Center on the eastern boundary, four Farmland Preservation properties, and one New Jersey Natural Lands Trust managed property. Figure 2-3 shows regional protected lands. An estimated 156,500 visitors came to the refuge in 2010.

Although established primarily for migratory waterfowl, the refuge's mosaic of vegetation communities, including forested wetlands, emergent wetlands, and various successional stages of uplands, provides habitats for a diversity of wildlife species (see attached wildlife list in appendix A). The refuge contains five major impoundments, encompassing approximately 500 acres. These impoundments are managed for marsh habitat that contains wetland plant communities similar to those that occur naturally in northern New Jersey.

2.1 Physical Landscape Setting

2.1.1 Physiographic and Landform Features

Physiography is the relationship between a particular location and the underlying geology. New Jersey includes four major physiographic provinces, known as Piedmont, Valley and Ridge, Highlands, and Atlantic Coastal Plain. Great Swamp NWR is located entirely within New Jersey's Piedmont Province.

The Piedmont Province is a 1,600 square mile area occupying approximately one-fifth of New Jersey. It is situated in northern and central New Jersey between the Highlands Province and inner portion of the Coastal Plain Province. The Piedmont Province is generally characterized by gently rolling plains with elevations typically ranging between 200 to 400 feet above Mean Sea Level (MSL). These elevated plains are separated by a series of erodible ridges. It is predominantly comprised of mildly folded and faulted sedimentary rocks of Late Triassic and Early Jurassic age (230 to 190 million years old) (NJDEP 2005a). Long Hill, also known as the third Watchung Mountain, is underlain by basalt layers, which formed by the

cooling of magma that was released onto the surface as lava, while the valleys and lowlands are underlain by sandstone and shale (NJDEP 2005a).

Varying soil types have developed in the Piedmont Province as a result of glacial influences occurring at various periods over parts of the province. Vegetation communities within the region are more influenced by the specific hydrological regime than soil variation (Collins and Anderson 1994). Great Swamp NWR is underlain by two bedrock geology formations: Boonton Formation and Hook Mountain Basalt. Descriptions of these formations are as follows:

Boonton Formation (Lower Jurassic)

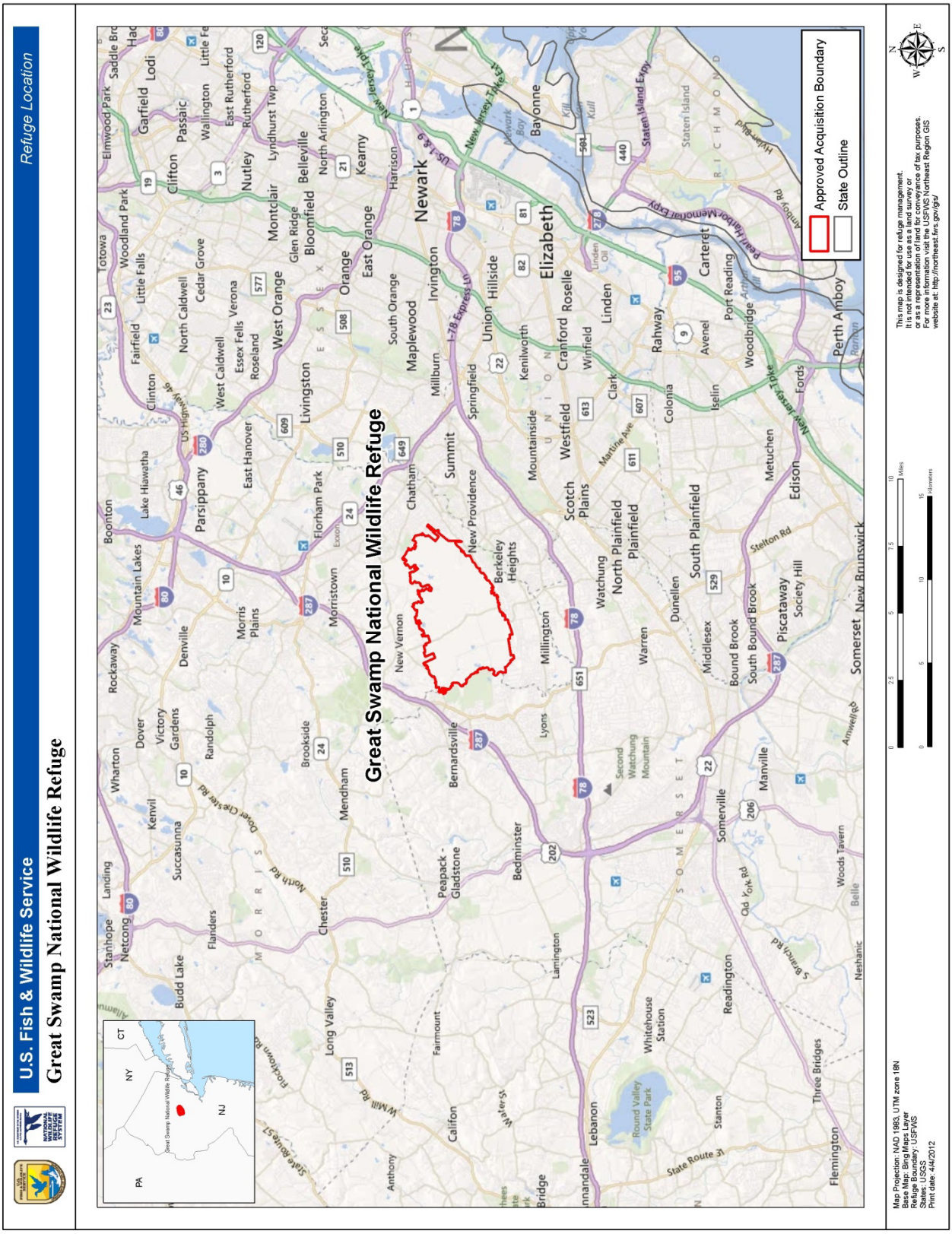
The Boonton formation consists of reddish-brown to brownish-purple, fine-grained, commonly micaceous sandstone, siltstone, and mudstone, in fining-upward sequences mostly 5 to 13 feet thick. Red, gray, and brownish-purple siltstone and black, blocky, partly dolomitic siltstone and shale are common in the lower part of Boonton unit. Irregular mud cracks, ripple marks, burrows, and evaporate minerals are abundant in Boonton's red siltstone and mudstone. The formation's gray, fine-grained sandstone may have carbonized plant remains and reptile footprints in middle and upper parts of the unit. Maximum thickness regionally is about 1,640 feet (Olsen 1980).

USFWS

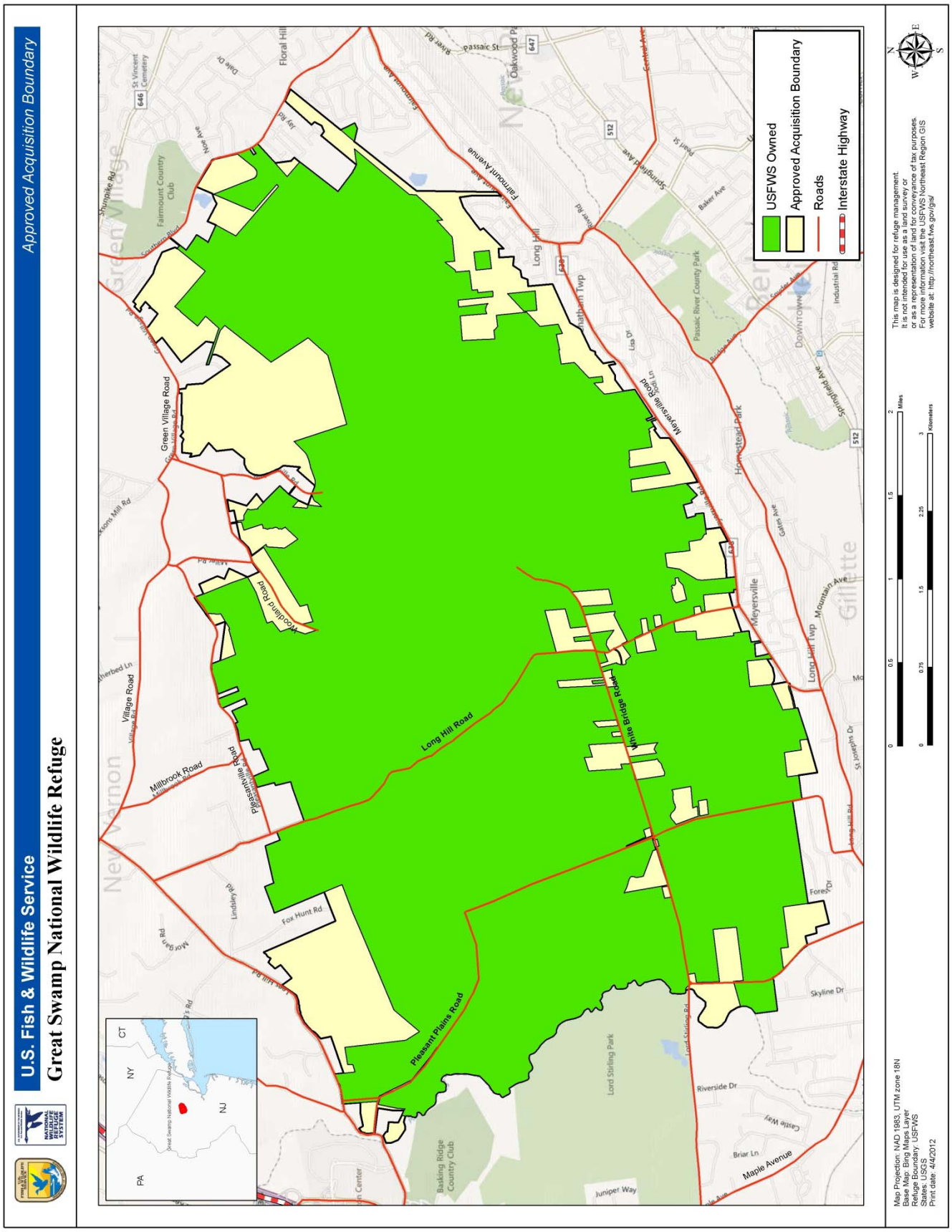
Hook Mountain Basalt (Lower Jurassic)

Hook Mountain Basalt consists of dark-greenish-gray to black, generally fine-grained and very locally medium- to coarse-grained, amygdaloidal basalt. It is comprised of plagioclase, clinopyroxene, and iron-titanium oxides. This formation contains small to large vesicles lined with prehnite. This unit consists of at least two, and possibly as many as three major flows. The base of the lowest flow within this basalt is highly vesiculated. Hook Mountain Basalt's maximum thickness is about 360 feet (Olsen 1980).

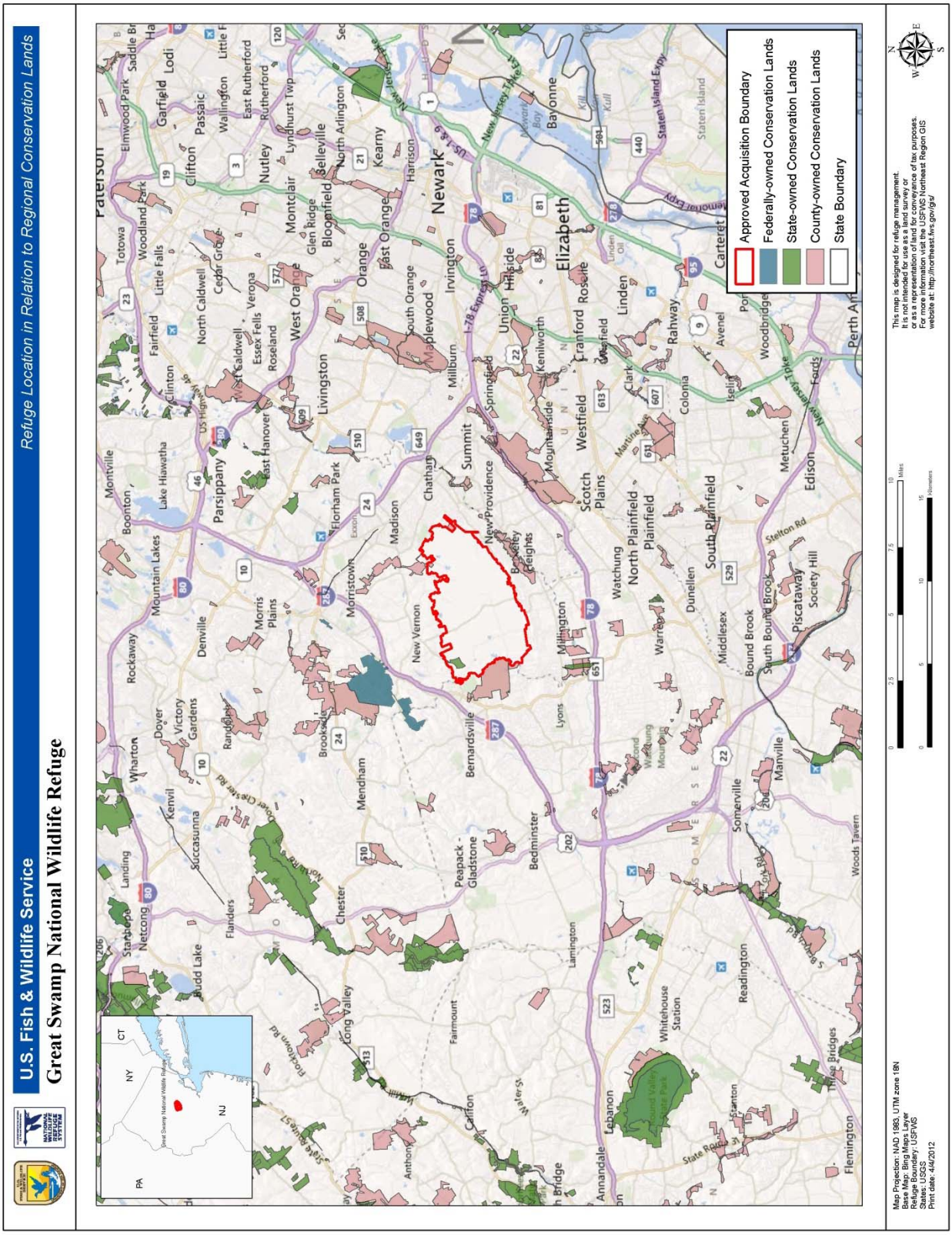
In addition to the two bedrock geologic formations, 14 surficial geology units are mapped as overlying the bedrock within the approved refuge acquisition boundary. Table 2-1 below identifies and describes the mapped surface geology units. These surface units are important in our understanding of the glacial and post glacial natural history of the refuge (Momsen, 2007).



Map 2-1. Refuge location



Map 2-2. Refuge Acquisition Boundary



Map 2-3. Regional Conservation Lands

TABLE 2-1: SURFICIAL GEOLOGY OF GREAT SWAMP NWR[1]		
Symbol	Geologic Name	Description[2]
Qaf	Alluvial Fan Deposits	Sand, pebble-to-cobble gravel, silt; brown, yellowish-brown, gray; moderately sorted, stratified. As much as 15 feet thick (estimated).
Qal	Alluvium	Sand, silt, clay, pebble gravel, locally pebble-cobble gravel; dark brown, brown, reddish-brown, gray; moderately to well sorted, stratified to massive. Contains variable amounts of organic matter. Locally, in and downstream from urban areas, contains demolition debris and trash. As much as 15 feet thick.
Qcal	Alluvium and Colluvium, Undivided	Interbedded colluviums as in units Qcg, Qcb, Qcbl, and Qcsl, and alluvium consisting of dark brown to yellowish-brown or reddish-brown silty sand, sandy silt, to clayey silt, with beds and lag veneers of subangular basalt pebbles and cobbles (adjacent to unit Qwb), shale chips and flagstones (adjacent to unit Qws), or subangular to subrounded cobbles and boulders of gneiss (adjacent to unit Qwg). As much as 15 feet thick. Lag deposits dominate in steeper reaches of valleys. Fine sediment, with variable organic matter, dominates in gently sloping reaches.
Qcbl	Basalt Colluvium, Silty Phase	Reddish-yellow, reddish-brown, light gray, very pale brown clayey silt to silty clay, minor fine sandy silt, with few subangular basalt pebbles. As much as 10 feet thick, but generally more than 3 feet thick. At foot of long, gentle slopes or at distal edge of aprons of block colluviums. Deposited in part by groundwater seepage. Occurs discontinuously along lower parts of most slopes on basalt bedrock.
Qe	Eolian Deposits	Very-fine to fine sand, silty fine sand; yellowish-brown to very pale brown; unstratified to weakly stratified. As much as 5 feet thick. Thin, patchy windblown silt and fine sand occur elsewhere in the quadrangle, particularly in the Great Swamp lowland and the Dead River valley. Laid down shortly after postglacial lakes drained, when wind entrained newly exposed silt and fine sand from the lake bed and terrace surfaces and deposited it on adjacent uplands.
Qe/Qwb	Eolian Deposits Weathered Basalt	Thin deposits of Eolian sediments (Qe) overlie the weathered basalt unit (see Qe description above). Qwb – Reddish-yellow, reddish-brown, light gray, to yellowish-brown clayey silt, silty clay to clayey coarse sand with some to many angular pebbles and cobbles of basalt and , in places on Second Watchung Mountain, gabbro. Most clasts have weathering rinds. Includes mixed clast-and-matrix sediment, fractured rock rubble, and saprolite that preserves original rock structure. Generally less than 10 feet thick over fractured, slightly weathered bedrock, which may be as much as 60 feet thick.
Qpl	Lake Bottom Deposits	Silt, clay, minor very-fine to fine sand; gray, light gray, light reddish-brown; laminated. As much as 70 feet thick. Deposited chiefly during the Moggy Hollow stage. Uppermost parts may have been laid down in the Great Notch, Stanley, and Millington stages, lowermost parts in the Chatham stage.
Qpmd	Deltaic Deposits	Fine-to-coarse sand and pebble-to-cobble gravel, minor silt and very fine sand. As much as 70 feet thick. Includes deltas at Summit and along the front of the terminal moraine in Chatham and Madison. Deposited in the Moggy Hollow stage of Lake Passaic.

TABLE 2-1: SURFICIAL GEOLOGY OF GREAT SWAMP NWR[1]		
Symbol	Geologic Name	Description[2]
Qpml	Lake Bottom Deposits	Silt, clay, minor very-fine to fine sand. As much as 120 feet thick. Deposited chiefly during the Moggy Hollow stage. Uppermost parts may have been laid down in the Great Notch, Stanley, and Millington stages.
Qps	Deltaic and Lacustrine-Fan Deposits	Fine-to-coarse sand, pebble-to-cobble gravel, very-fine to fine sand and silt; reddish-yellow, very pale brown, yellow. Generally massive due to deep weathering, weakly bedded in places. The gravel consists chiefly of gneiss and some quartzite, basalt, sandstone, and siltstone. Most gneiss, sandstone, and siltstone clasts are deeply weathered or decomposed; most feldspathic sand grains are partially or fully weathered to white clay. As much as 80 feet thick.
Qs	Swamp and Marsh Deposits	Peat and organic silt, clay, and minor fine sand; black, dark brown, and gray. As much as 20 feet thick, but generally less than 10 feet thick. Pine, spruce, and birch pollen in the basal 1.5 feet of a 5-foot core taken in these deposits near Meyersville, about 1 miles east of White Bridge, indicate that peat began to accumulate here before 9,000 years before present, based on radiocarbon dates elsewhere of the youngest occurrence of these trees in this region.
Qst	Stream Terrace Deposits	Silt, very fine-to-fine sand, minor fine-to-coarse sand and pebbly sand, rare pebble-to-cobble gravel; brown, very pale brown, yellowish-brown, light reddish-brown, light gray; moderately to well sorted, well stratified to unstratified, horizontally laminated in places. As much as 15 feet thick and forms terraces with surfaces 5-15 feet above modern floodplains and wetlands in the Passaic and Dead River valleys and the Great Swamp lowland. In the Great Swamp, the postglacial lake drained and the terrace deposits were incised between about 14,000 and 10,000 years before present, based on the age at which peat deposition began in the incised channels.
Qwb	Weathered Basalt	Reddish-yellow, reddish-brown, light gray, to yellowish-brown clayey silt, silty clay, to clayey coarse sand with some to many subangular pebbles and cobbles of basalt and, in places, gabbro. Most clasts have clayey-silty reddish-yellow weathering rinds. Includes mixed clast-and-matrix sediment, granular decomposed rock, fractured-rock rubble, and saprolite that preserves original rock structures. As much as 50 feet, but generally less than 20 feet thick.
Qws	Weathered Shale	Reddish-brown, brown, yellowish-brown clayey silt to silty clay with many shale chips or subangular pebbles and cobbles of siltstone. As much as 20 feet, but generally less than 5 feet thick.

1 Surficial geology based upon the New Jersey Geological Survey, Scott D. Stanford, research supported by the U.S. Geological Survey, National Cooperative Geologic Mapping Program, 2007- 2008. Surficial geologic units identified include those within the approved refuge acquisition boundary.

2 Geologic descriptions (excerpts) obtained from New Jersey Department of Environmental Protection, Land Use Management, New Jersey Geologic Survey: Surficial Geology of the Bernardsville Quadrangle, Morris & Somerset Counties, New Jersey (Open-File Map OFM 74) and Surficial Geology of the Chatham Quadrangle, Morris, Union & Somerset Counties, New Jersey (Open-File Map OFM 69) (http://www.state.nj.us/dep/njgs/pricelst/geolmapquad.htm).

2.1.2 Major Natural Influences Shaping Landscape

Glacial Influence on Hydrology and Soils

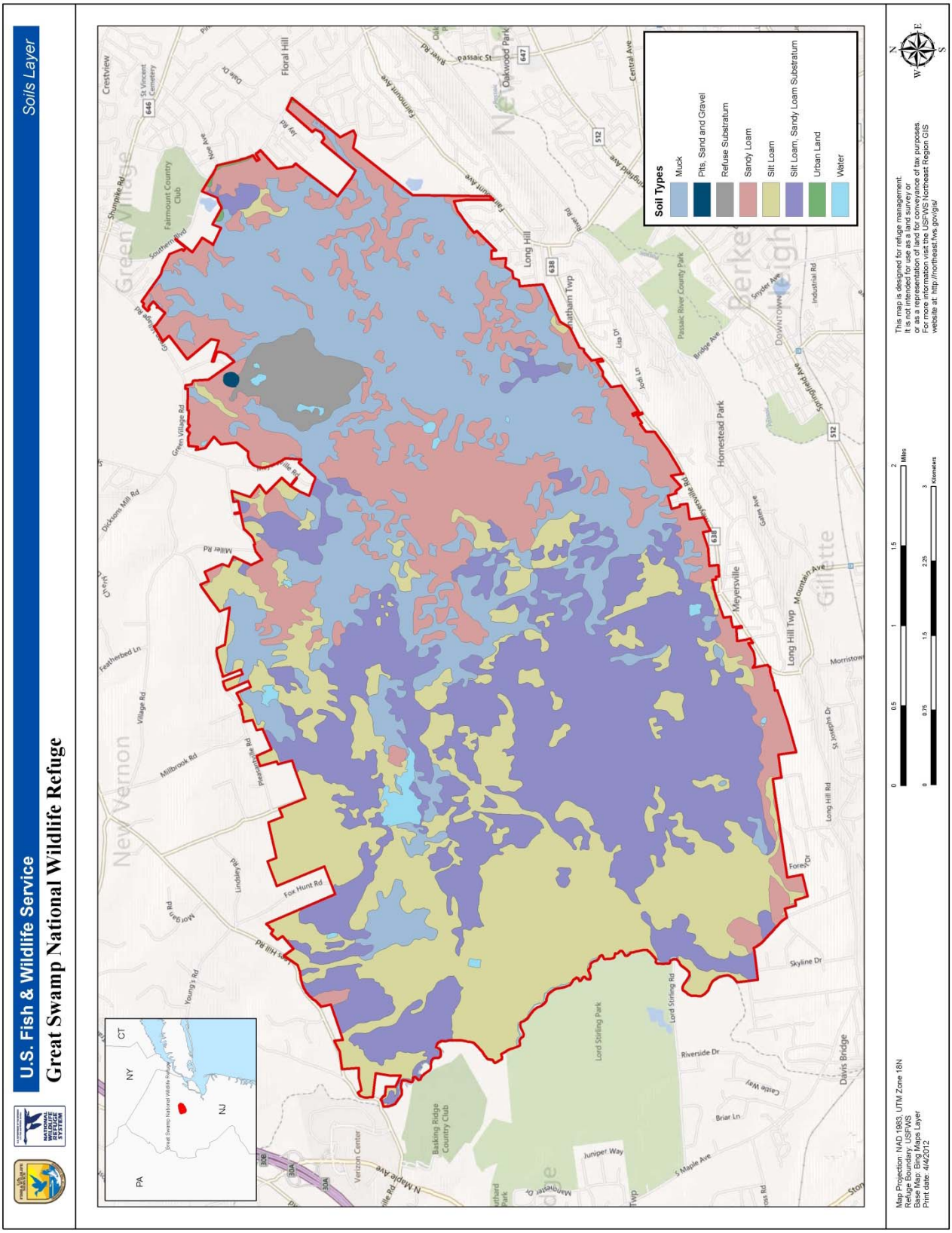
The Earth has experienced several glacial periods. Glaciers advanced and retreated over time as temperatures fluctuated. About one million years ago, the last ice age began, resulting in massive glaciers that transformed the shape of the earth. The fourth and last of these was known as the Wisconsin Glaciation. It is estimated that as this glacier approached the New York/New Jersey border, it was over one-half mile thick. As the Wisconsin Glacier advanced, it scraped and molded the valleys, slopes, and mountain tops of the region, leaving behind a landscape bare of vegetation. The ice sheet plowed through the earth carrying millions of tons of rock and soil, which was gradually deposited along its leading edge. This mass of glacial deposits stretched from Morristown to Madison to Chatham. Approximately 18,000 years ago, the leading edge of the glacier finally reached the Great Swamp watershed (GSW) area and stopped. The glacier remained relatively stationary for about 2,500 years until the global climate began to warm (Parrish and Walmsley 1997).

Approximately 15,000 years ago, the global climate warmed considerably, causing the Wisconsin Glacier to retreat northward at a rate of about 100 feet per year. As the glacier retreated it left behind piles or layers of sediments, rocks, and other debris, known as glacial drift. The meltwaters of the glacier formed Glacial Lake Passaic, a 30-mile long, 10-mile wide, 200 to 300 feet deep freshwater lake that encompassed a majority of the present day Passaic River watershed. Eventually, the retreating glacier uncovered an outlet near Little Falls Gap causing the glacial waters to drain and ultimately creating Millington Gorge and the Passaic River. Although most of the water in the lake drained, extensive marshes and swamps still remain in this ancient lake bed, including the Great Swamp. Approximately 10,000 to 11,000 years ago, the Great Swamp lowland would have been seasonally wet and possibly in permafrost during certain cold intervals (Harris and Ziesing 2010). Radiocarbon dates derived from sediment core samples and pollen profile studies suggest that an open shallow lake environment encompassed the Great Swamp until approximately 6,678 years ago (Harris and Ziesing 2010).

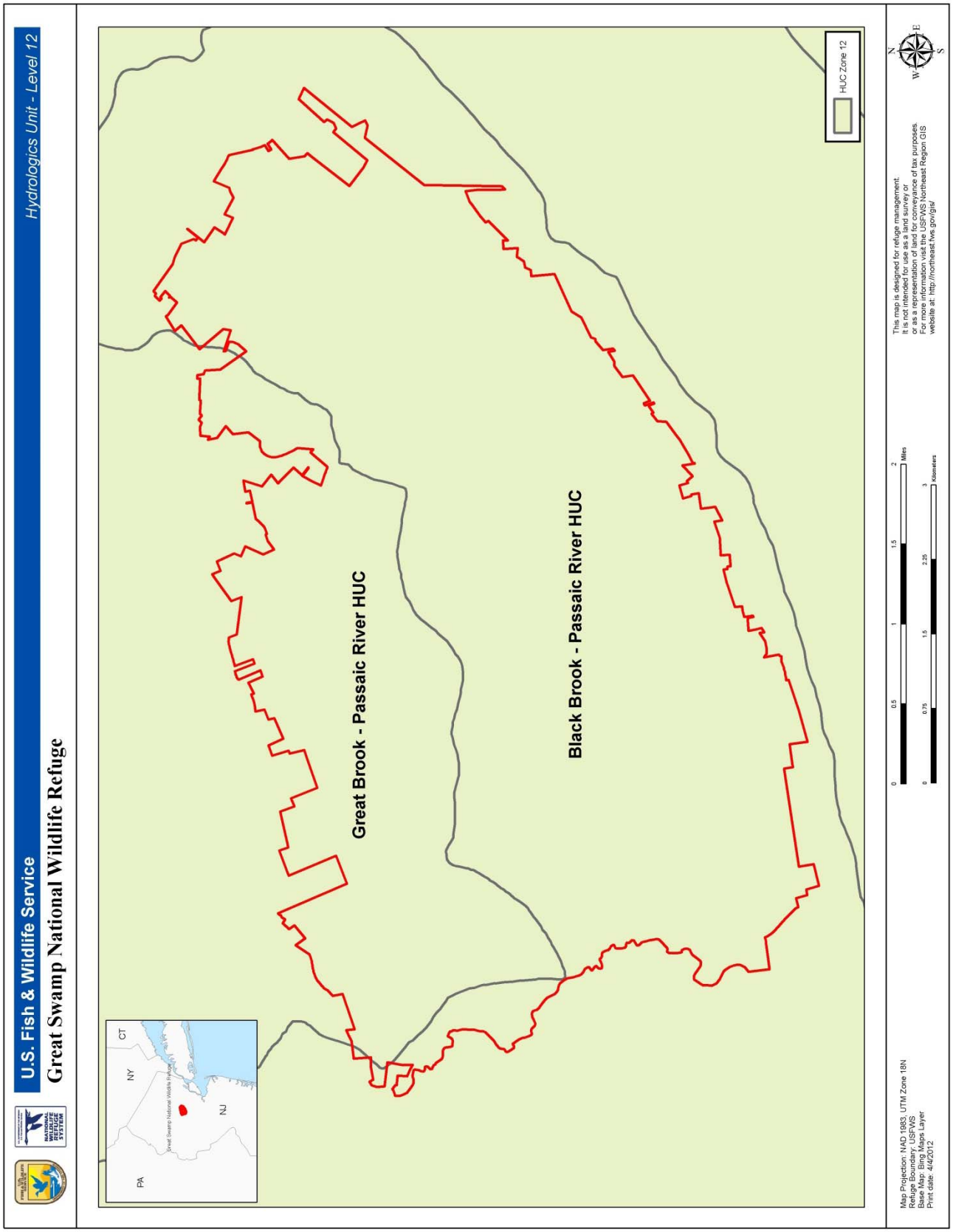
During the recession of the glacier, meltwaters carried large quantities of clay, silt, sand, and gravel into the glacial lake. More than 9,000 years ago, peat deposition began to accumulate as vegetation encroached upon the receding glacial lakeshore (Harris and Ziesing 2010). The western portion of the Great Swamp contains surficial clay deposits, which is covered by extensive thin deposits of peat. Thick deposits of clay, with interbedded glacial till and peat, underlie nearly the entire swamp (Waksman *et al*. 1943). Most of the peat deposits, generally ranging from 1 to 12 feet in depth, occur within the eastern portion of the refuge. Marked differences in landforms have been documented between the northeast and southwest halves of the refuge. The refuge contains a mosaic pattern of peat and swamp deposits and sand/gravel stream terraces (map 2-4), which were most likely a result of a complex interaction between wind, water, and post-glacier recession (Harris and Ziesing 2010).

Historic Natural Influences Shaping Vegetation and Wildlife Patterns

Great Swamp NWR and the surrounding region have undergone various vegetation community changes over the past 20,000 years. These changes, both natural and anthropogenic in nature, have been driven by soils development, hydrology, keystone species impacts, and agriculture. Although fires did occur within Great Swamp NWR, they were not thought to be a major factor driving the regional ecology (Momsen 2007).


U.S. Fish & Wildlife Service
Great Swamp National Wildlife Refuge
Soils Layer
Soil Types
Muck
Pits, Sand and Gravel
Refuse Substratum
Sandy Loam
Silt Loam
Silt Loam, Sandy Loam Substratum
Urban Land
Water
This map is designed for refuge management.
It is not intended for use as a land survey or
or as a representation of land for conveyance of tax purposes.
For more information, please visit the USFWS Northeast Region GIS
website at: http://northeast.fws.gov/gis/
Map Projection: NAD 1983, UTM Zone 18N
Refuge Boundary: USFWS
Base Map: Bing Maps Layer
Print date: 4/4/2012
Miles
Kilometers
New Vernon
Green Village
Long Hill Twp
Meyersville
Homestead Park
Gillette
Davis Bridge
Basking Ridge Country Club
Lord Stirling Park
Fox Hunt Rd
Millbrook Rd
Miller Rd
Long Hill Rd
Passaic St
Fairmount Country Club
Passaic River County Park
Verizon Center
Floral Hill
Crestview
Oakwood Park
Downtown
Morristown
Skyline Dr
Riverside Dr
Briar Ln
Juniper Way
Castle Way
Forest Dr
Mountain Ave
Springfield Ave
Bridge Ave
Industrial Rd
Central Ave
Southern Blvd
Stoupike Rd
Dickons Mill Rd
Featherbed Ln
Village Rd
Millbrook Rd
Morgan Rd
Young's Rd
Lindsley Rd
Passaic St
Fairmount Ave
Lyons Ave
Gates Ave
Snyder Ave
St Joseph's Dr
Long Hill Rd
Lord Stirling Rd
S Maple Ave
N Maple Ave
Manchester Dr
Lyons Rd
Stone
CT
NY
PA
NJ
Great Swamp National Wildlife Refuge

Map 2-4. Soils



Map 2-5. Hydrologic Units

The retreat of the Wisconsin Glacier was characterized by a long period of tundra that was present until about 12,000 years ago. Continual weathering and erosion of rock over time released nutrients and created new soils for plants to grow. Pollen evidence supports the post-glacial existence of treeless, or tundra-like, vegetation along much of the southern margin of the receding glacier (Spurr and Barnes 1980), including Great Swamp. Tundra-like conditions were followed by a shorter interval of transitional, open, spruce-hardwood woodland, which was succeeded by open spruce woodland. Subsequently, a mixed deciduous-coniferous forest replaced the spruce woodland approximately 9,500 years ago. This mixed forest occurred before a boreal forest could establish (Spurr and Barnes 1980). Additional pollen profile studies conclude that pine, spruce, and birch species inhabited the Great Swamp approximately 9,000 years ago (Harris and Ziesing 2010). During the post-glacial warming trend, hardwood forests from the south advanced to the north and a migration of new animals and plant species arrived in the northeast, while herds of large mammals (such as mastodons and wooly mammoth) traveled north, eventually dying out. The new surroundings attracted much smaller animals, such as rabbit, turkey, waterfowl, and white-tailed deer.

The post-glacial hydrologic changes of Great Swamp initially drove vegetation succession and the development of diverse wetland habitats (Momsen 2007). Evidence of the post glacial influence on community characteristics, including peat and soil development and vegetation patterns, is currently evident primarily in the Wilderness Area. The western managed portions of the refuge had undergone intense post-colonial agricultural disturbances that impacted vegetation patterns to the present day (Momsen 2007).

2.1.3 Great Swamp Watershed and Subwatersheds

The refuge lies within the GSW, which is situated within the southern portion of the Upper Passaic River watershed [Hydrologic Unit Code (HUC) 11] (map 2-5). The GSW refers to a collection of adjoining subwatersheds (HUC 14) that feed the hydrology of Great Swamp. The GSW spans approximately 55 square miles (35,200 acres) and is bound by a ridge of the Appalachian Mountains to the northwest, the third Watchung Mountain to the south, and the Loantaka Moraine to the northeast (Parrish and Walmsley 1997). The GSW includes the subwatersheds listed in table 2-2.

TABLE 2-2: SUBWATERSHEDS OF THE GREAT SWAMP WATERSHED (GSW)

Subwatershed	HUC-14 Subwatershed #	% of GSW	Square Miles (Acres)
Black Brook	02030103010060	27	14.85 (9,504)
Great Brook (above and below Green Village Rd)	02030103010030; 02030103010050	25	13.75 (8,800)
Loantaka Brook	02030103010040	10	5.5 (3,520)
Primrose Brook	02030103010020	10	5.5 (3,520)
Upper Passaic River (above Osborn Mills; Dead River to Osborn Mills)	02030103010010; 02030103010070	28	15.4 (9,856)

Black Brook, Great Brook, Loantaka Brook, and Primrose Brook flow through the refuge, generally in an east to west direction, before draining to the Passaic River, located along the western refuge boundary. The Passaic River forms the western refuge boundary.

Subwatershed Descriptions

The *Passaic River* meanders through seven counties and 45 municipalities before draining to Newark Bay. The Passaic River originates in Mendham Borough, Mendham Township, and Bernardsville. A relatively undeveloped portion of the river's watershed is adjacent to Great Swamp NWR. As the river continues to flow south, it traverses more refuge communities than any of the other local streams (GSWA 2009). The Passaic is joined by the Black Brook, Great Brook, Loantaka Brook, and Primrose Brook within the refuge and then flows through the Millington Gorge downstream of the refuge.

The *Great Brook* originates in multiple areas, with four tributaries forming its headwaters. The headwaters of Great Brook are bordered by ecologically rich wetlands, mature forests, meadows and floodplains, as well as heavily developed regions of Morris Township. The Great Brook enters the refuge just beyond Village Road in Harding Township (GSWA 2009).

The *Primrose Brook* originates in the Jockey Hollow section of Morristown National Historical Park and flows through the least developed subwatershed of Great Swamp NWR. Eventually, the brook enters the refuge near Lee's Hill Road in Harding Township (GSWA 2009).

Michael Stadelmeier

The *Black Brook* originates east of the refuge boundary and receives waters from five tributaries, which are bordered by heavily developed shopping plazas, recreational ball fields, golf courses, an apartment complex, the Rolling Knolls Landfill, forested wetlands, and the Tanglewood Lane Wastewater Treatment Plant. The brook flows through Great Swamp NWR and eventually into the Passaic River north of the intersection of White Bridge Road and Carlton Road.

The *Loantaka Brook* headwaters originate in the Township of Morris, where it is bordered by various land uses, including residential and commercial developments, recreational fields and the Woodland Wastewater Treatment Plant. The brook enters Great Swamp NWR just downstream of the 574-acre Loantaka Brook Reservation.

2.1.4 Water Quality and Quantity

Impoundments

Through the mid-1900s, the hydrology of Great Swamp NWR was historically disturbed by repeated attempts of draining and ditching for farming activities and stream alterations for flood and mosquito control purposes. In the 1960s, refuge staff began plugging the previously constructed drainage ditches and creating short dikes with small water control structures in attempt to restore more than 1,000 acres of previously drained wetlands. Five major impoundments, encompassing a total of approximately 500 acres, were constructed in the 1970s and early 1980s in order to provide wildlife habitat and influence plant composition and abundance (see table 2-3 below). This resulted in an increase in use by many wetland-dependent wildlife species (USFWS 1987a).

TABLE 2-3: IMPOUNDMENTS AT GREAT SWAMP NWR	
Impoundment Name	Acreage
Pool 1	114
Pool 2	295
Pools 3A & 3B	55 & 88, respectively
Middle Brook Pool	17

Between 1994 and 2001, moist soil units were maintained through periodic drawdown, which increased the presence of certain invasive species (see Modern Hydrological Influences in section 2.1.4). The current hydrologic processes on the refuge are a combination of natural fluvial, groundwater influence, and impoundment management. The refuge currently manages for marsh habitat that contains a diversity of wetland vegetation similar to natural marsh habitat in northern New Jersey. Draw-downs are conducted periodically to mimic a more natural drought cycle, which results in significant germination of annual plants and high seed production (USFWS 2003b).

Bimonthly water levels were recorded until 2005 at most water control structures to verify prescribed water levels in managed impoundments and at certain brooks and tributaries to document water level fluctuations in major waterways. Significant water level fluctuations between bimonthly readings were sometimes encountered due to storm events or drought conditions.

Surrounding Streams Influencing Great Swamp NWR

Upstream development within the GSW continues to increase, resulting in hydrologic changes and water quality degradation through elevated silt loads, higher floods, greater non-point pollution loads, faster peak flows, and reduced areas and periods of low-flow (minimal flow depth) characteristics. According to a *Water Quality Monitoring Report for Great Swamp Watershed,* prepared by Princeton Hydro and dated March 2007, the most "impacted" streams in the watershed are the Loantaka Brook, Great Brook, and Black Brook. These streams, located in the most developed areas of the watershed, generally failed to meet the State's water quality standards under both baseflow and storm flow conditions (N.J.A.C. 7:9B). Conversely, the Upper Passaic River and Primrose Brook were consistently the most "healthy" streams. These streams typically met or exceeded the State's water quality standards under both baseflow and storm flow conditions. The following is a summary of each of the five major rivers and streams impacting Great Swamp NWR:

Passaic River

Water quality monitoring indicates the upper portion of the Passaic River meets or exceeds every NJDEP Surface Water Standard (GSWA 2009). Although the nutrient concentrations during baseflow conditions are slightly higher than Primrose Brook, the Passaic River has much lower nutrient concentrations during stormflow events than any other stream in the watershed. However, based upon macroinvertebrate sampling conducted downstream of Route 287 between 1999 and 2001, the Passaic River is considered impaired even though the water chemistry data indicates the river is a reference stream. The poor results of the macroinvertebrate study may be a result of survey site location (i.e., downstream of Osborne Pond Impoundment), where water temperatures are elevated above normal and pH can fluctuate over the course of the day (i.e., photosynthetically driven pH; Lieb and Browne 2002).

Primrose Brook

Although some stream monitoring results indicate elevated concentrations of phosphorus, total Kjeldahl nitrogen and total suspended solids during some storm events, Primrose Brook is relatively pristine in nature and based upon macroinvertebrate surveys, the brook is highly ranked in overall stream health (Lieb and Browne 2002).

Great Brook

The overall water quality of Great Brook is "slightly impaired" based on the NJDEP Surface Water Quality Standards, U.S. Environmental Protection Agency (EPA) reference criteria, and in comparison to the watershed's reference streams (Lieb and Browne 2002). Biotic and water sampling results indicate that Great Brook is third in overall stream health when compared to the other streams of the watershed. Because Great Brook originates in areas that are suburbanized, where it is intensively subject to non-point pollutants and continuous development pressures, the preservation, protection and restoration of the upper reaches of this brook are critical for the ecological integrity of the refuge. Ongoing stream monitoring of Great Brook indicates that the water quality is variable from year to year (GSWA 2009).

David Barbara

Black Brook

The overall baseflow water quality in Black Brook is "somewhat impaired" based on NJDEP Surface Water Quality Standards, EPA reference criteria, and in comparison to the watershed's reference streams. Of the five major streams in the watershed, Black Brook is fourth in terms of overall water quality due to elevated levels of phosphorus and total Kjeldahl nitrogen (Lieb and Browne 2002). The headwaters of the brook are impacted by the use of chemical fertilizers on adjacent lawns and from the nearby Fairmont Country Club (GSWA 2009).

Loantaka Brook

The headwaters of the Loantaka Brook originate in the Township of Morris, where it is bordered by various residential and commercial developments, recreational fields, and a municipal park. The Loantaka Brook is the most impaired stream in the GSW, primarily due to non-point pollutants, including nitrogen and phosphorus, and excess water volume in the stream channel. The overall water quality in Loantaka Brook during both baseflow and stormflow is "impaired" based on NJDEP Surface Water Quality Standards, EPA reference criteria, and nutrient concentrations as compared to the other watershed streams (Lieb and Browne 2002). In addition, macroinvertebrate studies indicated the brook is ranked "very poor" and along with Black Brook, Loantaka Brook is one of the most biologically impaired streams in the watershed (Lieb and Browne 2002). Stormwater runoff from nearby roadways and effluent from the Woodland Wastewater Treatment Plant is resulting in increased sedimentation, turbidity, scour and channel widening (GSWA 2009). In a 2005-2007 study, the Great Swamp Watershed Association (GSWA) identified elevated concentrations of sodium and chloride in Loantaka Brook during base-flow conditions. Although high concentrations of sodium and chloride were detected at all sample locations, chloride exceeded the NJDEP

chronic toxicity standard in the upper reach of the brook (i.e., above the discharge point of the wastewater treatment plant). The study concluded the elevated salt concentrations are most likely a result of the application of deicing agents to nearby roads and parking lots (Edwards and Curran 2008).

Great Swamp Watershed Protection

Extensive research, advocacy, and protection efforts have been actively pursued throughout the GSW since the establishment of the refuge. Watershed research has been conducted by several agencies and conservation groups, including the EPA, the U.S. Department of Agriculture (USDA), GSWA, Ten Towns Great Swamp Watershed Management Committee (Ten Towns Committee), and others.

Research conducted in the 1960s by Vechioli, Gill and Lang (1962) and Miller (1965) evaluated the relationship of the GSW to stream flows and flooding (USDA 1996). Early water quality studies conducted by the refuge primarily evaluated water chemistry and included biweekly water quality sampling between 1976 and 1980. The Great Swamp Research Institute evaluated various parameters of water quality in the early 1980s (USDA 1996).

Throughout the 1980s, studies within GSW became more comprehensive and widespread as various scientific organizations and community partnerships developed and general concern for the watershed's health increased. In 1981, the GSWA was formed and dedicated to the preservation and enhancement of the natural resources within the watershed.

In August 1984, the FWS, in partnership with the Morris County Soil Conservation District, completed a hydrology study of the GSW. The study evaluated potential land use changes within the watershed and associated water quality and quantity impacts on the refuge. The study concluded that the current rates of development in surrounding municipalities would have major implications on the refuge (USFWS 1984). In 1984-1985, an additional comprehensive water quality study was performed as a joint effort between the EPA and NJDEP. This study revealed that upstream land use changes and development since the 1960s were the primary causes of water quality degradation and flow changes, including increased silt load, higher floods, greater pollution loads, faster peak flows and smaller low flow characteristics (USFWS 1987). The study's findings played an important role in the development of the Final Environmental Impact Statement/Master Plan for the refuge in 1987.

During the late 1980s and early 1990s, it became evident that regionwide cooperation would be required to effectively protect the watershed. In September 1989, the Great Swamp Watershed Advisory Committee (GSWAC) was established by Administrative Order #51 of the NJDEP to generate public attention and resources for the refuge, as well as to create a specific program to protect the refuge (GSWAC 1993).

A 5 year study (1991 to 1995), known as the USDA Great Swamp Hydrologic Unit Area (HUA) Project, was conducted by the USDA Natural Resources Conservation Service, Rutgers Cooperative Extension, and Consolidated Farm Services Agency to "provide local public officials and community leaders (i.e., Ten Towns Committee) with the tools to evaluate, recommend, and implement strategies to reduce impacts of existing and proposed development on water quality and quantity as it impacts the Great Swamp NWR" (USDA 1996). A 25-member HUA Technical Advisory Committee was created to provide technical support to the project, review results, and determine logistics for the dissemination of results. The team also coordinates efforts between the USDA, GSWA, GSWAC, and other regional and local efforts.

Several reports in the 1990s, including the 1993 Final Report of the GSWAC and the 1996 Final Report of the USDA Great Swamp HUA Project, provided a foundation of data and a series of recommendations required for watershed protection. The 1993 study provided a series of Federal, State, local regulatory and policy recommendations to be considered. Recommendations were made for wetlands, streams and floodplains, surface water quality and discharge, nonpoint source pollution and stormwater management, soil erosion and sediment control, septic systems, vegetation protection, and environmental analysis. The HUA Project provided data on water quantity, sediment and water quality and included a series of technical, institutional and social recommendations (USDA 1996).

One of the most significant partnerships formed in the 1990s was the creation of the Ten Towns Committee in 1995. The Ten Towns Committee was a 501(c) non-profit organization formed by agreement between the municipalities within the GSW. Participating municipalities included Bernards Township, Bernardsville, Chatham Township, Harding Township, Long Hill Township, Madison Borough, Mendham Township, Mendham Borough, Morris Township, and Morristown. Its primary purpose was to create a Watershed Management Plan for the GSW that would provide guidance and direction for watershed protection. Utilizing the USDA study recommendations and in partnership with the FWS, the Ten Towns Committee developed the Great Swamp Watershed Management Plan developed by F.X. Browne Inc. (Ten Towns 2003). The plan consisted of the following components: Development of Watershed Management Organization, Watershed Based and Open Space Planning, Public Education, Riparian Buffers, Watershed Investigations and Water Quality Monitoring, Stormwater Management, Model Ordinances, and Best Management Practices (BMPs).

The Ten Towns Committee represented a highly successful municipal partnership. Although the Ten Towns Committee disbanded in June 2010, the legislation and protections that resulted from the organization remain in place and are continued to be used by the GSWA. Community efforts through the GSWA led to the development of an extensive volunteer water monitoring network within the GSW and the establishment of specific water quality standards based on those findings in June of 2002 (GSWA 2011). The water quality standards are especially useful in identifying problem locations and targeting areas for restoration. Technical practices and land acquisitions are coupled with extensive outreach, education and advocacy with the watershed by the GSWA, the refuge and their multiple watershed partners.

AMNET Monitoring (Aquatic Invertebrate Populations)

In order to determine the health of the streams that comprise the watersheds, the NJDEP performs monitoring of benthic macroinvertebrate populations using the EPA's Rapid Bio assessment Protocols – Level II procedure. Using this method, aquatic communities are examined for pollution tolerant and intolerant life forms and the results are used to compute a New Jersey Impairment Score and Biological Condition. The program is termed the Ambient Biological Monitoring Network (AMNET). Biological condition of a stream sample is based on 100 organism samples taken at a specific site. The benthic macroinvertebrate samples examined include representatives of various taxonomic families of insects and insect larvae; mollusks, such as mussels, clams and snails; and crustaceans, such as crayfish. Ratings of the stream condition are based on the level of pollution tolerance of the families collected, the ratio of pollution tolerant to pollution intolerant families, and the biodiversity of the system (percentage of single species dominance). In New Jersey, over 800 locations are sampled on a 5-year rotating schedule. Biological impairment of streams may be caused by several major factors, including nonpoint source pollution, point source pollution, and/or a lack of stream corridor (riparian) buffers (NJDEP 2008f).

Non-impaired streams are represented by maximum taxa richness, balanced groups and a good representation of pollution intolerant species. Moderately impaired communities are characterized by reduced richness of what is known as EPT taxa [*Ephemeroptera* (mayflies), *Plecoptera* (stoneflies), and *Trichoptera* (caddisflies)]; reduced community balance of various species; and reduced number of pollution intolerant taxa. Severely impaired communities are benthic communities that are drastically different from those in less impaired situations, including a few dominant pollution tolerant macroinvertebrate taxa (NJDEP 2004 Ambient Stream Metadata). Pollution tolerant groups include worms (*Oligochaeta*), midges (*Simulidae*), leeches (*Hirudinia*), and various snails (*Gastropoda*). The scoring system for impairment is listed in table 2-8 and is based on three basic categories: Non-Impaired (24 to 30), Moderately Impaired (9 to 21) and Severely Impaired (0 to 6).

The second round of sampling of New Jersey streams included a habitat score system developed from recently revised EPA criteria (Barbour 1997). Parameters considered in the evaluation include in-stream substrate, channel morphology, bank structural features, and riparian vegetation. The area evaluated includes the sample site and the adjacent area within a 100- to 200-foot radius. Qualitative habitat assessment scores include four condition categories, rating each parameter as: Optimal (160 to 200), Sub-Optimal (110 to 159), Marginal (60 to 109) and Poor (less than 60). Scores within the State range between 53 and 197.

The habitat conditions in the waterbodies within and immediately surrounding Great Swamp NWR are rated as sub-optimal to optimal (see table 2-4). AMNET results indicate that the streams within and immediately surrounding Great Swamp NWR are moderately to severely impaired, indicating a combination of low macroinvertebrate diversity and high numbers of a few pollution tolerant species.

TABLE 2-4: NJDEP AMNET BIOLOGICAL CONDITION OF STREAMS INFLUENCING GREAT SWAMP NWR

AMNET #	Stream Name	Municipality	Road	1998-1999 Impairment Score/Rating[a]	2003 Impairment Score/Rating[b]	Habitat Score[b]
AN0230	Passaic River	Chatham	Summit Ave	12/Moderately Impaired	21/Moderately Impaired	154
AN0229	Passaic River	Chatham	Stanley Ave	15/Moderately Impaired	15/Moderately Impaired	141
AN0223	Black Brook	Meyersville	New Vernon Rd	12/Moderately Impaired	6/Severely Impaired	151
AN0222	Black Brook	Chatham	Southern Blvd	3/Severely Impaired	12/Moderately Impaired	139
AN0221	Loantaka Brook	Green Village	Green Village Rd	9/Moderately Impaired	15/Moderately Impaired	131
AN0219	Great Brook	Harding	Woodland Rd	9/Moderately Impaired	12/Moderately Impaired	164

Notes:
[a] – Derived from NJDEP Ambient Biomonitoring Network, Watershed Management Areas 3, 4, 5, and 6, Passaic Region, 1998 Benthic Macroinvertebrate Data, Water Monitoring Report, prepared by NJDEP Bureau of Freshwater and Biological Monitoring, updated June 2000 (NJDEP 2000).
[b] – Derived from NJDEP Ambient Biomonitoring Network, Northeast Water Region, Passaic River Drainages, Watershed Management Areas 3, 4, 5, and 6, Round 3 Benthic Macroinvertebrate Data, Volume 1 of 2, Water Monitoring Report, prepared by NJDEP Bureau of Freshwater and Biological Monitoring, updated February 2008 (NJDEP 2008f).

Federal Clean Water Act Section 303(d)

Under the Federal Clean Water Act Section 303(d), each state in the United States is required to list impaired waterbodies. New Jersey is required to list impaired waterbodies as part of the water quality planning process in the State pursuant to the Water Quality Planning Act (N.J.S.A. 58:11A-7). New Jersey uses chemical and biological stream monitoring to determine these impaired waters. Waterbodies cannot be removed from the 303(d) list until the water quality standards are met.

The 303(d) list is divided into ***sublists*** or ***categories*** depending on the condition of the waterbody. When a designated use assessment is complete and results for the assessment indicate non-attainment, it is added to Sublist 5 for non-attainment.

The Clean Water Act requires that each Sublist 5 (non-attaining for pollutants) waterbody is given a ***priority ranking*** of high (H), medium (M), or low (L) with the goal of lowering Total Maximum Daily Load (TMDL). The prioritization process takes into account various environmental, social and political factors. Evaluated criteria include source and parameters of impairment; additional data needs; TMDL complexity and nature; waterbody use and cultural or historic importance; efficiency concerns; watershed management activities; sensitive species concerns; and public interest. Table 2-5 below provides the most recent available (2010) data for waterbody conditions for Sublist 5. Streams or portions of streams surrounding Great Swamp NWR are most impacted by issues related to dissolved solids and sediment levels, low dissolved oxygen, and pathogens.

TABLE 2-5: 2010 303(d) LIST (SUBLIST 5) IMPAIRED WATERS WITHIN AND ADJACENT TO GREAT SWAMP NWR[a]

Assessment Unit #	Location	Parameter	Rank
NJ02030103010020-01	Primrose Brook	*Escherichia coli*	M
NJ02030103010020-01	Primrose Brook	Dissolved Oxygen	M
NJ02030103010020-01	Primrose Brook	pH	M
NJ02030103010020-01	Primrose Brook	Water Temperature	M
NJ02030103010020-01	Primrose Brook	Total Suspended Solids	M
NJ02030103010030-01	Great Brook (above Green Village Road)	Cause Unknown	M
NJ02030103010040-01	Loantaka Brook	Cause Unknown	M
NJ02030103010040-01	Loantaka Brook	*Escherichia coli*	M
NJ02030103010040-01	Loantaka Brook	Total Dissolved Solids	M
NJ02030103010050-01	Great Brook (below Green Village Rd)	Dissolved Oxygen	M
NJ02030103010060-01	Black Brook (Great Swamp NWR)	Dissolved Oxygen	M
NJ02030103010060-01	Black Brook (Great Swamp NWR)	Total Dissolved Solids	M
NJ02030103010070-01	Passaic River - Upper (Dead Rd to Osborn Mills)	Arsenic	L
NJ02030103010070-01	Passaic River - Upper (Dead Rd to Osborn Mills)	Cyanide	L
NJ02030103010070-01	Passaic River - Upper (Dead Rd to Osborn Mills)	Dissolved Oxygen	M

Notes:
[a] – Derived from 2010 New Jersey Integrated Water Quality Monitoring and Assessment Report (appendix B), prepared by NJDEP Division of Water Monitoring and Standards, Bureau of Water Quality Standards and Assessment, dated June 2011.

Chemical Contaminants

Both non-point and point sources of contamination have been and continue to be problematic at Great Swamp NWR.

Non-point sources of contamination originate from suburban and urban stormwater runoff, which can carry nutrients from fertilizers, hydrocarbons, heavy metals, and deicing agents, such as road salts. Ten Towns Committee and GSWA have focused much effort on non-point source contaminant monitoring.

The primary point source of contamination on the refuge is the Rolling Knolls Landfill (formerly known as Miele's Dump), a 200-acre, unlined and uncapped landfill located within the Green Village section of Chatham Township. Approximately 30 to 35 acres of the landfill are located within the Wilderness Area of the refuge. Surface water from the landfill drains to Loantaka Brook, located to the west, and eventually to Black Brook and Great Brook, both of which ultimately drain to the Passaic River. Rolling Knolls Landfill operated from the early 1930s through December 1968, during which time it primarily received municipal solid waste and construction debris, as well as septage and industrial wastes. In 1959, herbicide and pesticide applications were conducted in order to comply with new health code regulations. Additionally, application of oil was performed to minimize dust on facility roadways. Initial remedial investigations conducted in 1999 indicated elevated levels of heavy metals, phthalates, and polychlorinated biphenyls (PCBs) in surface soil, subsurface soil, and wetland sediment. This landfill was included on the National Priorities List (NPL) on September 29, 2003 (EPA ID No. NJD980505192). Remedial investigation of the landfill is ongoing (USEPA 2011a).

USFWS

Other point sources of contamination at Great Swamp NWR are several asbestos dumps. These asbestos dumps are collectively part of the Millington Superfund Site, which includes the Millington site and three separate satellite dumps. These satellite dumps were addressed under three operable units, two of which are located in the refuge. Operable Unit 2 (OU2), which includes the New Vernon Road Property and White Bridge Road Site, are adjacent to the refuge on private property and Operable Unit 3 (OU3) is located entirely on the refuge. OU3 was an approximate 7-acre asbestos dump that also contained numerous buried drums of unknown substances. The Department completed remedial action by removing small areas of asbestos contaminated materials, buried drums and heavy metal-impacted soils that may have been a potential exposure threat to refuge visitors. In 1999, the EPA approved the Final Remedial Action Report documenting that all remediation is complete for OU3 (USEPA 2008). OU3 was delisted from Superfund status in 2010 (USEPA 2011b).

The New Vernon Road Property is part of OU2 and was an approximate 30 acre asbestos dump. The EPA conducted remedial action activities on this property in 1998 and 1999. In September 2000, the EPA

approved the Final Remedial Action Report. In September 2002, the remediated 25-acre portion of the New Vernon Road property was formally acquired by Great Swamp NWR and was also delisted from Superfund status in 2010 (USEPA 2011b). Concurrently, the remaining 5 acres, which is comprised of a remediated asbestos fill area, was transferred to the State of New Jersey (USEPA 2008).

The White Bridge Road Site is the remaining piece of OU2. These dump sites are located adjacent to the Wilderness Area of Great Swamp NWR. Various remedial investigation and remedial actions were performed between 1991 and 2000. On February 8, 2002, the EPA removed the White Bridge Road property from the NPL list (USEPA 2008).

The Harding Township Landfill, encompassing approximately 1 acre, is located west of Long Hill Road in the management area of the refuge. This landfill primarily received municipal waste, as well as minimal industrial waste, until 1968. Remedial investigation activities revealed sediments contaminated with heavy metals. Remedial action activities were complete in September 2000 (Horne 2009).

Numerous other asbestos fill areas are located throughout the refuge, many of which have been remediated. The remaining non-remediated fill areas are usually buried and rarely encountered (Horne 2009).

2.1.5 The Cultural Landscape Setting and Land Use History

Early Native American and European Influences

Wildlife populations ebb and flow as habitat conditions vary in space and time. Natural and human disturbances intervene, shifting species abundance and diversity. Change is inevitable and natural, although human activities in the last 400 years have significantly altered the landscape compared to the previous 12,000 years when humans first appeared in the Northeast (Foss 1992).

As the Wisconsin Glacier advanced south, ocean levels dropped as increasingly more water was locked into ice formation. As a result, previously submerged land formations surfaced, including *Berengia,* a 1,500 mile-wide land bridge between Siberia and Alaska (NOAA 1999). This land bridge allowed early Paleo-Indians to migrate from Asia to North America possibly as early as approximately 30,000 years ago (Bonatto et al., 1997) with expanded habitation likely occurring across the Americas between 13,500 and 16,000 years ago.

Archaeological evidence gathered from the area confirms that Paleo-Indians occupied the Great Swamp basin as early as 12,000 years ago. The Paleo-Indian men may have hunted species such as mastodon, caribou, and giant beaver in the lower elevations of Great Swamp, while the women collected berries, roots and birds eggs (Parrish and Walmsley 1997). Circa 8,000 B.C., the climate began to warm, causing certain ecological shifts including the predominance of deciduous forests. These changes resulted in an alteration of Native American way of life, including expanding food-gathering techniques to include fishing and gathering of nuts and wild plants. By the Late Woodland Period (900 A.D.-1650), Native Americans began practicing farming (Parrish and Walmsley 1997). During this time period, Native Americans were known as the Lenape or Delaware Indians.

The Lenape Indians occupied various sections of New Jersey, concentrating in areas accessible by water such as the valleys of the Delaware, Passaic, Hackensack, and Raritan Rivers. Prior to European

settlement, Native Americans disturbed the natural landscape in order to clear sites for villages and for cultivation of crops, such as maize. Native Americans cut forests to acquire wood and bark to make utensils, weapons, canoes, shelters, and for fuel. The Lenape intentionally burned woods during the spring and fall to improve travel and hunting for game (Collins and Anderson 1994).

Prior to European settlement, the composition and density of forests within the region may have been modified through Indian-set fires; however, fire was likely only a minor factor on the ecology of Great Swamp NWR. Several land surveys were conducted in the early 1700s, which documented tree species such as swamp white oak, maple, poplar, beech, elm, and ash (Harris and Ziesing 2010).

The most significant anthropogenic impact to New Jersey's landscape, including the refuge, was undoubtedly caused by European settlers and their descendents. The first European settlers were living in Great Swamp by 1720 (Cavanaugh 1978). European colonists introduced new land use concepts, such as permanent settlements and political boundaries. Small villages and hamlets were created along the perimeter of the swamp, including New Vernon, Green Village, New Providence, Meyersville, Stirling, Millington, Basking Ridge, and Bernardsville (Cavanaugh 1978).

Prior to the Revolutionary War, early settlers logged the land that presently encompasses the refuge, particularly in the eastern portion (present day Wilderness Area), and farmed much of the open and shrub communities of the western portion of the refuge (Momsen 2007). By the 18th century, farming and logging became so intensive that New Jersey became known as "The Garden of North America." Grassland species, such as Eastern meadowlarks, bobolinks, upland sandpipers, woodchucks, and voles, increased as hayfields and pastures expanded during the early 19th century (Foss 1992; Foster and Motzkin 2003).

Local logging was productive enough to support the wagon wheel manufacturing industry and contributed to the success of the ironworks industry in Morris County. A constant supply of charcoal was required for the furnaces, and as a result, over-logging occurred in the area leading to the closure of some local forges. By 1778, no extensive areas of land well suited for farming remained wooded in the central part of the State (Collins and Anderson 1994). According to a visitor's observation in 1790, Chatham Township was "utterly treeless."

Records suggest that by the mid-1800s, a majority of the lowest elevations in the Great Swamp basin may have been logged. By 1844, farmers were draining the marshlands and began planting crops, such as foul meadow hay; however, logging activities resulted in flooding, which led to crop failure. In a report prepared by the New Jersey State Geologist, dated 1899, "cutting was most severe about 1850, and from 1850 to 1860 was the period of maximum deforestation" (Collins and Anderson 1994). During the late-1800s, Great Swamp's woodlands were further logged in response to the demand for lumber to construct boats for the Morris Canal; pitch, turpentine, and rosin for shipyards; railroad ties, shingles, and fruit baskets; and fuel for mills and iron forges (Cavanaugh 1978).

The 1800s witnessed the demise of many forest wildlife species from loss of habitat (forest clearing), bounty and market hunting, millinery trade, and natural history specimen collecting (Foster et al., 2002). Mountain lion, gray wolf, and elk were extirpated by the mid-1800s or early 1900s and have not re-colonized the region. The passenger pigeon became extinct at the hand of humans during the same period (DeGraaf and Yamasaki 2001; Foster et al., 2002). In contrast, coyotes expanded eastward and were first sighted in New Jersey in the 1950's.

Plant and animal species that prefer open land reached their peak abundance in the mid-1800s; however, the historical record is unclear on the abundance and distribution of these species prior to the surge in farming. Foster and Motzkin (2003) suggest that species that prefer open land were opportunistic, expanding into newly cleared lands from small, scattered populations in the pre-settlement era. Other species expanded their range into New England from the Midwest. DeGraaf and Yamasaki (2001) consider grassland and shrubland birds as specialists that occupied native grasslands and shrublands in the region prior to the massive land clearing.

The soil disturbances resulting from agriculture result in soil homogeny (mixing) and depletion of key elements, such as carbon and nitrogen, that can last for decades or longer (Momsen 2007). In addition, late season harvests left agricultural soils exposed to elements and subject to erosion. These soil impacts may have influenced the current vegetation structure and composition. The dichotomy of vegetation patterns in the eastern (Wilderness Area) and western portions (management area) of the refuge reflect the differences in historic land use and land cover. The eastern portion of the present day refuge, while disturbed through logging, was not subject to the intensive soil and hydrologic alteration that result from agricultural practices. The western portion of the refuge had undergone soil disturbance from the clearing, ditching, and plowing associated with farming. As a result, the present day Wilderness Area vegetation patterns are consistent with the influence of post-glacial deposits that characterize the geologic history of the region. The pin-oak swamps and other vegetation communities of the western portion of the refuge reflect the post-colonization agricultural use (Momsen 2007).

Post–Industrial Influences

Habitat loss, due to post-industrial influences, is the major threat to wildlife in the United States. Habitat loss can be defined by three major components:

- Habitat fragmentation – habitats being divided into smaller land components by roads and other development practices;
- Habitat destruction – the complete loss of a habitat by clearing or other drastic change in land cover and use; or
- Habitat degradation – the compromising of the ecological quality of habitat by exposure to stressors. Examples of stressors include pollutants, invasive species, or climate changes (NWF 2011).

On a global scale, land use and climate changes result in destruction, fragmentation and degradation of habitats (see section 2.1.7). Remaining degraded and fragmented habitats are more conducive to a lower diversity of generalist predators and species (species that can thrive in a wider range of ecological conditions) and less conducive to a higher diversity of habitat specialists (species that thrive in a very narrow range of ecological conditions) (Litvaitis 2003; Devictor et al*.,* 2007). Shifts from many specialist species to fewer generalist species has been specifically studied and identified across taxa of plants and animals within variety of ecosystems ranging from forests to coral reefs (DeVictor et al., 2007; Clavel et al., 2011).

The explosion of population growth during the 20th century drastically altered the landscape of northern New Jersey and resulted in wide-scale habitat loss. A recent dramatic shift in development pressure from urban to rural areas has and continues to result in the development of valuable farmland, forestland, open space and wetlands (Collins and Anderson 1994). The amount of timberland (i.e., forest cover) in New Jersey has increased since 1987; however, an inventory conducted by the U.S. Forest Service, in

cooperation with the NJDEP, indicated that forest regeneration is actually declining. Forest succession toward climax stage, white-tailed deer herbivory and invasive species may limit the establishment and growth of many tree species throughout New Jersey (NJDEP 2008c).

Locally, the regional land use shift has caused the refuge to become an “island of habitat” within a highly developed landscape. As with many natural areas within New Jersey, the fragmentation of Great Swamp NWR from similar adjacent landscapes results in various issues associated with habitat degradation from encroaching urban development.

Modern Hydrological Influences

Repeated attempts of draining, ditching and stream alteration of Great Swamp NWR occurred through the mid-1900s. In the 1920s, the U.S. Army Corp of Engineers proposed several flood control plans. In the 1930s, the Works Projects Administration constructed drainage ditches and straightened and deepened the channel of Black Brook; however, the overall wetland character of the swamp remained. Failure to effectively drain and manage flooding of the swamp eventually caused farming to be unprofitable and too difficult to maintain; therefore, many farmers moved away. By the 1940s and 1950s, many of the remaining farmhouses became occupied by non-farming families, commuters, and local business owners, and abandoned farm fields began to succeed to forest.

After being established as a national wildlife refuge in the 1960s, Great Swamp NWR staff began plugging the previously constructed drainage ditches and creating short dikes with small water control structures in attempt to restore more than 1,000 acres of wetlands. Five major impoundments, encompassing a total of approximately 500 acres, were constructed in the 1970s and early 1980s in order to provide wildlife habitat and influence plant composition and abundance. Beginning in 1994, water levels were drawn down annually in an attempt to manage the five impoundments as moist soil units; however, this management technique was not successful as it resulted in a significant invasion of non-native purple loosestrife (*Lythrum salicaria*) and mild water pepper (*Polygonum hydropiperoides*) and was therefore terminated in 2001. The refuge currently manages for marsh habitat to maintain native wetland plant communities (USFWS 2003b).

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Invasive Species, Pests, and Disease

An "invasive species" is defined as a species that is (1) non-native (or alien) to the ecosystem under consideration and (2) whose introduction causes or is likely to cause economic or environmental harm or harm to human health (Executive Order 13112, February 1999). Invasive species have tremendous impacts on ecosystems, and the recreational, agricultural and commercial portions of the economies dependent on these ecosystems (USFWS 2010e).

Invasive species tend to be species that occur in high numbers and are therefore more likely to have multiple introductions of many individuals; are adaptable to a wide set of conditions (generalist); and may have greater genetic diversity and therefore more success in ecosystem establishment (Clavel et al., 2011).

Humans have deliberately and inadvertently introduced many species, some of which have had significant effects on native ecosystems (i.e., woolly adelgid, zebra mussel, European starling, and common carp). Some intentional introductions, such as ring-necked pheasant, may have negligible effects on native ecosystems. Other introductions, such as Norway rat, house sparrow, mute swan, and European starling, have adapted well to human habitation after their arrival in the United States.

Approximately 40 percent of the plants and animals federally listed as endangered species have been negatively impacted by invasive species (Pimentel et al*.,* 2005; NJISC 2009). In addition to the ecological costs created by invasive species introductions and establishment, there are tremendous costs to various sectors of the economy including agriculture, recreation and tourism. It is estimated that invasive species cost approximately $120 billion every year in the United States (Pimentel et al*.,* 2005). New Jersey is impacted by a wide variety of invasive plants, animals, insects, fungi, and pathogens. For example, it is estimated that about 1,000 species or 30 percent of the State's vascular flora are non-native and generally believed to cover hundreds of thousands of acres within New Jersey (NJISC 2009). The annual economic impact to New Jersey alone has been estimated at $290 million or 33 percent of the State agricultural cash receipts (NJISC 2009). New Jersey's high number of invasive species is attributable to its long history of colonization and its position as an international commercial and transportation hub (Snyder and Kaufman 2004).

The introduction of exotic disease has significantly altered the character of vegetation communities in New Jersey. One prominent example, the chestnut blight (*Cryphonectria parasitica*), is a parasitic fungus that was accidentally introduced to the United States in 1904 from eastern Asia. This fungus causes disease in the bark of chestnut trees, eventually killing the tree. Within 50 years, the fungus spread over the chestnut's entire range and decimated all mature trees in the northeastern United States. As a result, no fully grown chestnut tree remains in the forests of New Jersey. Although sprouts may develop from diseased tree trunks, they rarely grow more than 15 to 20 feet in height before being killed by the fungus. The massive die-off of the chestnut tree resulted in vast holes in New Jersey's forests, which are now filled by other tree species, such as hickory and oak (including pignut hickory and red oak) as well as other species such as red and sugar maple (McCormick and Platt 1980; Collins and Anderson 1994).

Other destructive fungi include Dutch elm disease, which is spread from tree to tree by the elm bark beetle, and dogwood anthracnose, which is resulting in major declines in native flowering dogwood species. Environmental stresses, such as acid rain and other atmospheric pollution, severe winter weather and drought, may have initially weakened the dogwood, causing it to become more susceptible to a fungus that eventually causes death to the tree (Collins and Anderson 1994).

Bacterial Leaf Scorch (BLS), caused by *Xylella fastidiosa*, is another disease that colonizes and obstructs the xylem of tree species. The disease was initially observed primarily in urban landscape trees; however, in 2001, the disease was sighted in a New Jersey woodland area and then documented in Parvin State Forest in 2003. BLS is now considered widespread in New Jersey and infects various tree species, including oaks, sycamores, maples, dogwoods, American elm, and some agricultural plants. Many other plants, such as numerous shrub species and grasses, become infected with BLS, but do not show symptoms and do not die (US Forest Service 2011).

Invasive wildlife diseases may also have potential impacts at Great Swamp NWR. A potentially disastrous type of chytrid fungus, *Batrachochytrium dendrobatidis* or *Bd,* has been severely impacting amphibian populations worldwide as animals become infected with a disease known as chytridomycosis (USFWS

2010c; Borrell 2009; AARK 2011). The disease attacks the skin of the amphibian and makes trans-dermal respiration difficult and also attacks neurological systems and impacts behavior. As Great Swamp NWR is home to diverse group of New Jersey amphibians, this fungal infection has the potential to have serious implications to the ecology of the refuge. *Bd* has been identified in New Jersey (NJDEP 2011b) and the New Jersey Endangered and Non-Game Species Program (ENSP) is currently testing amphibians throughout New Jersey, including Great Swamp NWR, for disease presence. ENSP is working to determine if it is impacting or has impacted frog and salamander populations within the State.

A variety of exotic animal species, particularly insects, have impacted forests of the northeastern United States. The gypsy moth is one example of a leaf-eating insect that has impacted the forests of Great Swamp NWR. Gypsy moths were imported into Massachusetts from Europe in 1869 by a French scientist attempting to cross gypsy moths with silkworm moths to develop a strong race of silk producing insects; however, a windstorm accidentally blew the gypsy moth eggs out of the laboratory into the surrounding area. The caterpillars that hatched from these eggs had no natural predators and eventually spread into other eastern states. Although gypsy months were first discovered in New Jersey as early as 1919, defoliation in woodlands was not notably reported until after 1966. Since then, an average of 187,000 acres is defoliated annually; however, the highest amount of defoliation occurred in 1981, which resulted in more than 800,000 acres. The gypsy moths typically defoliate oak and pine species, as well as other tree species include beech, birch, willow, poplar, and red maple. Defoliation often weakens trees and impairs natural growth; however, repeated defoliation over subsequent years often kills the tree. Certain oak species, such as red, black, and scarlet, are slightly resistant to gypsy moth defoliation, while pine species are more susceptible and often die after a single severe defoliation (Collins and Anderson 1994).

USFWS

The Asian longhorned beetle (ALB) was imported from China into Brooklyn, New York in 1996. The beetle infestation spread to Long Island, Queens, and Manhattan. In 1998, a separate introduction of the beetle was discovered on trees in the suburbs of Chicago, Illinois. Beetles were also detected in Jersey City (2002), and Middlesex and Union Counties (2004) in New Jersey. ALBs were also discovered on Staten Island and Prall's Island, New York in 2007 and most recently, in Worcester, Massachusetts in August 2008. In April 2008, both the Jersey City and Chicago infestations were declared eradicated. The USDA Animal and Plant Health Inspection Service's (APHIS) Plant Protection and Quarantine is implementing quarantine and control strategies to eradicate this species in New York, New Jersey, and Massachusetts. The ALB is a wood boring beetle that typically prefers several species of maples, box elder, horsechestnut, ash, poplar, buckeye, elm, London plane, birch, and willow as host trees. After mating, the female ALB chews depressions into the bark of various hardwood trees in which they lay their eggs. Once the eggs hatch, the larvae bore through the bark of the tree to feed on the sensitive vascular layer beneath, forming tunnels in the trunk and branches. This weakens the integrity of the tree and will eventually kill the tree if the infestation is severe enough. Over the course of a year, a larva matures and then pupates under the surface of the bark. An adult beetle emerges by chewing its way out of the tree, leaving a characteristic round hole. Beetles typically emerge from June through October (USDA

2010). Current management practices in New Jersey consist of removing infested trees, chipping in place, and burning the chips. The stumps of infested trees are ground to below the ground surface and all potential host trees within one-eighth to one-quarter mile radius of infested trees are removed to stop the spread of ALB (NJDEP 2011).

The Emerald ash borer (EAB; *Agrilus planipennis*) is an exotic beetle that likely arrived in the United States on solid wood packing material carried in cargo ships or airplanes originating from Asia. EAB was discovered in southeastern Michigan near Detroit in 2002 and has since established in Quebec and Ontario; Ohio (2003); Indiana (2004); Illinois and Maryland (2006); Pennsylvania and West Virginia (2007); Wisconsin, Missouri, and Virginia (2008); Minnesota, New York, Kentucky (2009); Iowa and Tennessee (2010); and Connecticut, Kansas, and Massachusetts (2012). EAB was confirmed in Bucks County, Pennsylvania in March 2012. Since its discovery, the EAB has killed tens of millions of ash trees in southeastern Michigan alone with tens of millions more lost in the other affected states. In attempt to slow the spread of EAB, regulatory agencies and the USDA have enforced quarantines and fines in many states to prevent potentially infested ash trees, logs, or hardwood firewood from being moved out of affected areas (USDA et. al 2012). Although not yet documented in New Jersey, the EAB is a serious threat to the State's forests and potentially to Great Swamp NWR due to the common presence of ash species within many refuge forests.

The EAB is a metallic green, wood-boring beetle that only feeds on native ash trees (*Fraxinus* spp.), including white (*F. americana*), green (*F. pennsylvanica),* blue (*F. quadrangulata*), and black (*F. nigra*). Adult EAB beetles leave a "D"-shaped exit hole in the bark when they emerge in the spring. The larva spends its life inside the tree, feeding on the spongy layer of the tree just beneath the bark. The feeding destroys the tissue and prevents the tree from moving water and nutrients back and forth from the roots to the rest of the tree, which eventually causes death in the tree (Wisconsin DATCP 2012). EAB can kill an ash tree in just a few years or a little longer, depending on the size of the tree.

Great Swamp NWR actively manages for a number of invasive plant species impacting the habitats of the refuge. Common shrub invasives of successional areas include multiflora rose, Russian olive, and autumn olive. Within the historically disturbed and successional forested areas, species such as garlic mustard*,* wineberry*,* Japanese honeysuckle, multiflora rose*,* tree-of-heaven, Japanese stiltgrass and long-bristled smartweed may be observed. Common reed, reed canary grass, and purple loosestrife have all developed as monotypic cultures within Great Swamp NWR, primarily along heavily manipulated wetland areas and along utility rights-of-way.

Additional information regarding common invasive plant species of Great Swamp NWR and current management strategies are included in the section 2.5.4.

2.1.6 Current Climatic Conditions

General Description

The dominant feature of the atmospheric circulation over North America, including New Jersey, is a broad, undulating flow from west to east across the middle latitudes of the continent. These "prevailing westerlies" shift from north to south and vary in intensity during the course of the year, exerting a major influence on the weather throughout New Jersey. Geology, distance from the Atlantic Ocean, and prevailing atmospheric flow patterns create distinct variations in the daily weather of New Jersey (OSCNJ 2009).

These variations may influence local ecology and anthropogenic activity. Annual precipitation can range from approximately 43 to 47 inches, but may reach up to 51 inches in the north-central portion of the State. Measureable precipitation typically falls on approximately 120 days per year, although fall months are typically the driest with an average of 8 days of measurable precipitation per month (Rutgers University). July and August typically receive the most precipitation and February receives the least.

New Jersey is located between the 39th and 41st parallels, or about halfway between the equator and the North Pole. Its geographic location results in highly variable daily weather, which is influenced by wet, dry, hot and cold air masses. This type of climate, known as continental climate, is characterized by a significant variation between summer and winter temperatures and by relatively large fluctuations in daily temperature. During the winter, the prevailing winds originate from the northwest, which carry cold air masses from the sub-polar areas of Canada. From May through September, New Jersey is blanketed with moist tropical air originating from the Gulf of Mexico. Average temperatures in northern New Jersey range from 27.9 degrees Fahrenheit in January to 73.2 degrees Fahrenheit in July (Collins and Anderson 1994).

New Jersey is divided into five climate zones, designated as the Northern, Central, Pine Barrens, Southwest and Coastal Zones. Great Swamp NWR is situated between the Northern and Central Climate Zones. Due to Great Swamp NWR's position between the Northern and Central Climate Zones and based upon observations by refuge staff, the growing season at the refuge is estimated to be approximately 195 days (i.e., average between Northern and Central Climate Zones). The growing season is a period in which the daily temperature averages 43 degrees Fahrenheit or more.

The Northern Climate Zone consists primarily of elevated highlands and valleys. This zone generally exhibits colder temperatures than the other zones of the State and has minimal influence from the Atlantic Ocean. Clouds and precipitation are often enhanced by orthographic, or mountain, effects. Thunderstorms are typically responsible for producing most of the precipitation during summer months. The Northern Climate Zone generally has the shortest growing season of about 155 days (OSCNJ 2009).

The Central Climate Zone extends from New York Harbor and the Lower Hudson River to the Delaware River in the vicinity of Trenton. This zone consists of many urban settings with elevated pollutants produced from automobile traffic and industrial processes. Evening temperatures within the urban areas are typically higher than those of surrounding suburban and rural areas since paved and concrete surfaces retain heat, known as "heat islands." The northern perimeter of this zone often defines the boundary between the freezing and non-freezing precipitation during winter months. Approximately 15 to 20 days above 90 degrees Fahrenheit are often observed in central New Jersey. Included in table 2-6 below is a summary of mean precipitation and temperature collected at the Boonton, New Jersey Weather Station (located approximately 12 miles north of Great Swamp NWR) between 1971 and 2000.

TABLE 2-6: MONTHLY AVERAGES FOR TEMPERATURE AND PRECIPITATION AT BOONTON WEATHER STATION (1971-2000)													
Parameter	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sept	Oct	Nov	Dec	Annual Average
Mean Temperature (°F)	27.4	29.8	38.9	49.6	60.0	68.7	73.6	71.8	64.0	52.1	42.9	32.8	51.0
Mean Precipitation (inches)	4.17	3.05	4.24	4.37	4.83	4.55	4.67	4.05	5.08	3.96	4.19	3.78	50.94

2.1.7 Global Climate Change

Introduction

Increases in ambient temperatures of the earth's surface is expected to cause land-ice to melt and sea levels to rise. The increase of greenhouse gas concentrations emitted due to human activity is believed by science to amplify the earth's natural greenhouse effect and cause global climate change (NCDC 2011). Examples of greenhouse gases include carbon dioxide, methane, nitrous oxide, halocarbon, ozone, and water vapor (Global Climate Change Impacts in the United States 2009). Concentrations of carbon dioxide, a major greenhouse gas, have risen from 280 parts per million (ppm) prior to the industrial revolution to concentrations of approximately 370 ppm today (NCDC 2011). This change represents an atmospheric carbon dioxide increase of over 30 percent during this period. In New Jersey, long-term data documents an increase in average temperature and a rise in sea level that is consistent with observed and predicted global trends (NJDEP 2008d). An anthropogenic radiative forcing (increase of energy) of the atmosphere is estimated at an increase of 1.6 watts per meter (Wm^{-2}) at 2005 levels relative to 1750 preindustrial values (Bates et al 2008). This forcing correlates to a global warming trend of positive 0.74 degrees Celsius between 1906 and 2005. A more rapid acceleration of warming has occurred in the latter fifty years (Bates et al, 2008). These rates of warming have been identified in the lower and mid-troposphere layers of the atmosphere as well as at the earth's surface (Bates et al 2008).

Data indicates that the Northeast has become warmer and wetter over the last century and particularly since 1970, at a rate of 0.45 degrees Fahrenheit per decade. Although is difficult to document the changes in the number of frost-free days in the Northeast, the growing season has increased since 1980 by approximately one week nationally with greater increases in the western U.S. than in the eastern U.S. Average annual precipitation has increased by 0.4 inches over the last century with increases in very heavy daily precipitation and decreases in the percent of precipitation falling as snow (Perschel et al. 2007).

Carbon dioxide emissions due to human activity are projected to further increase global temperatures by 2.5 degrees Fahrenheit to 10.4 degrees Fahrenheit over the period of 1990 to 2100. Global MSL is likely to rise an additional 4 to 35 inches over the same period (NJDEP 2008d). Rising ambient temperatures are expected to have direct and indirect impacts to human health, natural ecosystems, agriculture, and water supply in New Jersey.

The IPCC is a scientific organization developed by the World Meteorological Organization and the United Nations Environmental Program and comprised of hundreds of scientists worldwide. The IPCC evaluates

and reports on most current climate change science. IPCC reports in their "Summary for Policymakers of the Synthesis Report of the IPCC Fourth Assessment Report" that "warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level" (IPCC 2007). The FWS has endorsed IPCC and released a summary of findings from the IPCC fourth assessment report (USFWS 2010a).

In response to accelerating climate change, the FWS prepared a plan entitled "Rising to the Urgent Challenges of a Changing Climate: A Strategic Plan for Responding to Accelerating Climate Change in the 21st Century", which was finalized in September 2010 (USFWS 2010a). The goals and objectives of the Strategic Plan fall under three major strategies:

- *Adaptation – the use of management techniques and strategies, including reactive and anticipatory, to reduce impacts to fish, wildlife and habitats as a result of climate change.*

- *Mitigation – involves reducing the FWS "carbon footprint" by using less energy, consuming fewer materials, and altering land management practices with the ultimate intent to become carbon neutral by the year 2020.*

- Engagement - *reaching out to FWS employees; our local, national, and international partners in the public and private sectors; our key constituencies and stakeholders; and citizens to join forces with them in seeking solutions to the challenges and threats to fish and wildlife conservation posed by climate change* (USFWS 2010a).

The primary purposes of the plan are to present a vision for accomplishing the FWS mission in the face of accelerating climate change and to provide direction for our organization and its employees, defining our role within the context of the Department and the larger conservation community (USFWS 2010a).

In 2009, Congress urged the Council on Environmental Quality (CEQ) and the Department to develop a national, government-wide climate adaptation strategy to assist fish, wildlife, plants, and related ecological processes in becoming more resilient, adapting to, and surviving the impacts of climate change (USFWS et al 2012). In cooperation with the NOAA, the New York Division of Fish, Wildlife & Marine Resources, and with support by the AFWA, the FWS prepared a draft plan entitled "National Fish, Wildlife, and Plants Climate Adaptation Strategy," which was released for public review and comment in January 2012. The purpose and overarching goal of the plan is to provide a nationwide, unified approach, reflecting shared principles and science-based practices, to protect the nation's biodiversity, ecosystem functions, and sustainable human uses of fish, wildlife, and plants in a changing climate (USFWS et al 2012). The plan provides a basis for sensible actions that can be taken now, in spite of uncertainty that exists about the specific impacts of climate change, and presents guidance about what actions are most likely to promote natural resource adaptation. The plan is expected to be finalized in June 2012.

Potential Local and Regional Impacts of Global Climate Change

The information below represents a selection of some significant and scientifically supported climate-based ecological impacts that may occur within the Northeastern United States, including Great Swamp NWR. While it is certain that the climate in the future will be altered throughout the world, precise predictions are difficult due to variation in emission volumes, climate and ecosystem response, and other compensation

mechanisms or compounding factors (NABCI 2010). This great potential for variation is reflected in the discussions within this section.

The difficulty of predicting climate induced impact is certainly true at the refuge specific level. Addressing and curtailing potential climate associated problems at the refuge will require extensive monitoring of potentially climate sensitive species, early detection of ecological and species impacts, and innovative and adaptive management strategies. These strategies are further discussed in the later chapters of the CCP.

Water Resources

The earth's hydrological cycles are directly connected to climatic radiation and temperature levels (Bates et al. 2008). As a result it could be expected that changes in global temperature may influence rainfall patterns and subsequent flow and cycling of water within ecological systems. Weather instability (including an increase in short-term droughts and floods) resulting from global climate change may impact water recharge or input timing, reduce storage capacity, and increase drought or flooding (NABCI 2010).

Some studies that compare trends in global climate change to rates of precipitation, runoff and river flow have shown a statistically significant correlation (Bates et al. 2008). Other studies have not identified trends or were not able to separate out the impacts from localized variables such as anthropogenic catchment (Bates et al, 2008). This inconsistency illustrates the influence of localized environmental characteristics on the specific effects of global climate change within a community or ecosystem. On a global scale however, there is fairly consistent pattern of significant runoff increases in the United States and higher elevations, and decreases in other global regions including West Africa and Southern Europe (Bates et al. 2008). Within the Northeast, winter flooding, precipitation and high flow periods are expected to increase by as much as 20 to 30 percent with increased rainfall impacts under varying levels of emissions (Frumhoff et al., 2007).

Some studies have projected two to five fold increases of extremely hot summer days and increases in short-term (one to three month) warm season droughts in the Northeast. Subsequent low flow (least amount of water volume within a stream) periods during summer seasons may be prolonged for northeastern streams. Water demands within ecosystems may also seasonally increase within the region due to increases in plant productivity and subsequent evapotranspiration (Frumhoff et al. 2007).

Forest Community Impacts

Barbara Frankenfield

Climate is a major factor on the range, rate of growth and reproduction of trees. In addition, climate impacts the forest ecological processes involving water and nutrient cycling. A 350 to 500 mile northward shift of forest complexes is expected by the end of the century as a result of global climate change (Iverson et al, 2008). Although these forest shifts are expected, the effect of global climate change on any community is complicated by many variables, including invasive species changes, stress and disease, habitat loss, species competition, deer grazing, seed dispersal and other wildlife influences (Frumhoff et al. 2007).

As with all types of flora and fauna, certain tree species are more likely to adapt to climate shifts while other species will not be as successful. Tree species extinctions not occurring in the last 120,000 years of gradual climate change may rapidly occur as some species may not be able to adapt to this abrupt change. Cool climate coniferous forests of the Northeast are considered particularly vulnerable. Other deciduous hardwood species, such as sugar maple (*Acer saccharum*), American beech (*Fagus grandiflora*), birches (*Betula* spp.), quaking aspen (*Populus tremuloides*), white ash (*Fraxinus americana*), and black cherry (*Prunus serotina*), may be lost in portions of their range (Stout et al., 2008; Frumhoff et al., 2007). Oak–hickory and oak-pine forests may expand northward in the United States (NABCI 2010). Particular species, such as white oak (*Quercus alba*), black oak (*Quercus nigra*), and black gum (*Nyssa sylvatica*), may expand their range northward under various warming scenarios within the Northeast (Stout et al. 2008).

Impacts to red maple (*Acer rubrum*), one of the most dominant forest tree species of Great Swamp NWR, may vary greatly under different warming scenarios. Although this species is projected to be impacted under certain high emissions conditions, red maple is highly adaptable and has expanded its range in the past 100 years (Frumhoff et al 2007; Fei and Steiner 2007). Studies have shown significant growth increases (130 percent) among juvenile red maples corresponding with increases in soil temperature of up to 9 degrees Fahrenheit (Frumhoff et al. 2007). Due to the significant proportions of red maple-dominant communities at Great Swamp NWR, these varying scenarios could have significant implications for the refuge with regard to rates of succession and management responses.

Increased CO_2 driven photosynthesis within some forests may result in increased growth and productivity rates. This increased growth may result in increased water efficiency, demand for soil nutrients, and accelerated decomposition rates and could potentially offset some CO_2 production by providing increases in carbon storage. However, such benefits could be neutralized by forest loss due to land use changes (Frumhoff et al. 2007).

Birds

It has been determined that approximately 36 percent of the 165 wetland breeding birds in the United States show medium or high vulnerability to climate change (NABCI 2010). Wetland birds that occur at Great Swamp NWR projected to decline due to climate driven drought and flood cycles include common loon (*Gavia immer*), sora (*Porzana carolina*), and American bittern (*Botaurus lentiginosus*) (Frumhoff et al. 2007). Waterfowl and wading bird habitat may be affected as climate change results in changes in rainfall and temperature. Potential impacts to the prairie pothole wetlands could have an impact on breeding waterfowl throughout the continent due to their importance as breeding habitat for 50 to 80 percent of North American ducks (NABCI 2010).

Due to their ability to adapt to varying conditions, common generalist resident bird species such as blue jay (*Cyanocitta cristata*), American robin (*Turdus migratorius*), Northern cardinal (*Cardinalis cardinalis*), tufted titmouse (*Baeolophus bicolor*) and red-tailed hawks (*Buteo jamaicensis*) may be less affected or increase under various emissions scenarios. Other common Great Swamp NWR passerines, such as white-throated sparrows (*Zonotrichia albicollis*) and the American goldfinch (*Carduelis tristis*), may be impacted by global climate change as their current ranges continually shift northward (Matthews et al*.,* 2008).

Habitat specific and migratory species, especially northern forest birds, have been determined to be particularly vulnerable to global climate change (NABCI 2010). Approximately one third of the 312 forest breeding birds in the United States have been found to have medium or high susceptibility to global

warming (NABCI 2010). A number of less common Great Swamp NWR forest passerines and neotropical migrants, such as wood warblers (*Dendroica* spp.), yellow-bellied flycatcher (*Empidonax flaviventris*), veery (*Catharus fuscenscens*) and hermit thrush (*Catharus gIuttatus*) have all been predicted to decline as a result of rising global temperatures (NABCI 2010; Frumhoff et. al 2007). Changes in migratory timing, including the seasonal availability of food resources, would be a major contributing factor to these declines (NABCI, 2010). The FWS suggests monitoring populations of insect eating birds, such as nightjars (Family *Caprimulgidae*) and swifts (Family *Apodidae*), as an early indicator of potential impacts to forest habitats (NABCI 2010). High elevation species, such as the Bicknell's thrush (*Catharus bicknelli*), that rely on a spruce fur habitat, are expected to be more heavily impacted under various emissions scenarios.

Northern grassland areas are expected to become drier with increased evapotranspiration caused by global climate change impacts. It is also suspected that increased atmospheric carbon dioxide may contribute to faster succession of woody species in grassland habitats (NABCI 2010). Approximately 50 percent of grassland bird species of the United States, including the State-listed bobolink (*Dolichonyx oryzivorus*), are expected to be impacted by global climate change (NABCI 2010). Christmas bird count data indicates that grassland birds were the only general group of birds unable to shift north in response to global climate change over the last 40 years. This inflexible response has been attributed to the poor quality of northern grassland habitats (NABCI 2010).

Insects, Pathogens and Invasive Species

As trees become stressed from climate change, introduced Northeastern pests may become more successful at infiltrating populations of trees. Since insects are poikilothermic (cold-blooded) animals and sensitive to temperature fluctuation, climate change may also result in redistributions of pest insects and subsequent forest impacts (Logan et al., 2003). As growing and reproductive seasons are prolonged, some insects, including pest insects, will likely produce more generations per season (Ibanez et al. 2011). Insects that may benefit from warming scenarios may include the wooly adelgid, emerald ash borer, and gypsy moth. Certain parasitic fungi and other diseases, including Dutch elm disease, white pine blister rust and beech bark disease, are also expected to benefit from climate change (Frumhoff et al. 2007).

In addition to pathogens, fungi and insects, certain invasive plants including kudzu, Canada thistle and weedy vines, such as Japanese honeysuckle, appear to respond positively to rising CO_2 and would be expected to expand their range in Northeastern forests (Frumhoff et al. 2007).

Some wildlife diseases' ability to spread and infect hosts may also be connected to climate change. The amphibian-infecting chytrid fungus, *Bd* (see section 2.1), has been potentially linked to climactic changes including variations in temperature and rainfall (Pounds et al. 2006; Rohr et al. 2011); however, the full nature and extent of this connection has not yet been fully determined (Borrell 2009). Efforts have been made to model the effect of climate and anthropogenic activity on *Bd* and predict future infections on a global scale (Rohr et al. 2011).

In addition to changes in parasitic relationships, there is a high potential for global climate change to impact other crucial ecological interactions, such as trophic (feeding) and mutualistic relationships. Climate induced interruptions between angiosperm plant flowering and pollinator flight activity periods (phenology) have the potential to severely impact ecosystems worldwide (Memmott et al. 2007). There is evidence that the first flowering date of some plants has been advanced by an average of four days per degree centigrade over the past 100 years in temperate zones (Memmott et al. 2007). According to some climate

change models, phenological shifts resulted in a reduction of floral resources available to 17 to 50 percent of all pollinator species due to a reduced overlap between the pollinators activity period and plant food availability (Memmott et al. 2007). Specialized species with a limited range of food hosts may be especially vulnerable to these climate induced disruptions. As with other ecological predictions related to global climate change, we could expect great variation in responses among different species or the same species in various locations and conditions (Ibanez et al. 2010).

A large body of scientific evidence indicates that global climate change will result in worldwide ecological consequences in the future. While numerous ecological and anthropogenic variables make the most precise and site specific determinations difficult, certain shifts or impacts have a higher potential of occurring. Some of those changes that could impact the refuge include the following:

- More instability in hydric regimes with increased periods of drought and flood.
- Reductions in water quality or more seasonal changes in water quantities.
- Changes in seasonal temperatures, including increases in extremely hot summer days.
- Potential increases in forest productivity and related ecological processes such as succession.
- Northward shifts of forest communities, including expansions or losses of certain community types.
- Potential increase in opportunities for pests and disease within some forest communities.
- Disruptions to key ecological interactions, such as pollination and timing of migrations.
- Increases of various insect populations.
- Losses of some northern forest breeding, wetland and grassland bird species.
- General stability or increases among generalist species and losses of specialist species.

2.1.8 Air Quality

Regional Air Quality – Criteria Pollutants

The 2007 Air Quality Index Report, published by the NJDEP Bureau of Air Monitoring, provides the most recent report data available. In New Jersey, there are monitoring stations that continually monitor six specific criteria air pollutants, which are used as indicators of air quality and for which National Ambient Air Quality Standards (NAAQS) have been established by the EPA. These pollutants are listed as carbon monoxide (CO), nitrogen oxide (NO_2), ozone (O_3), sulfur dioxide (SO_2), particulate matter (PM) and lead (Pb). Because ambient levels have dropped far below the standard throughout the State, lead is only monitored through the Bureau of Air Quality Monitoring Network at the New Brunswick Station. Ambient air quality data is used as the baseline for evaluating the effect of the construction of new emission sources or of modifications to existing sources. New stationary sources of air contamination require permits from the NJDEP Bureau of Air Quality.

TABLE 2-7: CRITERIA POLLUTANTS MONITORED WITHIN THE SUBURBAN REPORTING REGION (INCLUDING GREAT SWAMP NWR)						
Station	County	CO	SO_2	PM	O_3	NO_2
Chester	Morris	----	X	----	X	X
Morristown	Morris	X	----	X	----	----
New Brunswick	Middlesex	----	----	X	----	----
Perth Amboy	Middlesex	X	X	X	----	----
Rutgers University	Middlesex	----	----	----	X	X

Notes:
X = Tested at Station
---- = Not Tested at Station

The air monitoring data is also used to characterize the general air quality within nine distinct Air Quality Index Reporting Regions covering New Jersey. Great Swamp NWR is contained entirely within Reporting Region 3 – Suburban Region. Reporting Region 3 includes five stations for measuring criteria pollutants in Morris, Somerset and Middlesex Counties, including stations in Chester (Route 513) and Morristown in Morris County.

Descriptor ratings, ranging from “Good” to “Very Unhealthy,” have been established to provide a general system of rating the regional air quality. The NAAQS is given a numerical Air Quality Index (AQI) rating. The primary health-based standard AQI rating for each pollutant is generally a value of 100; any pollutant values above 100 are considered unhealthy. The values for each pollutant are as follows: 0 to 50 is considered “good”; 51 to 100 is considered “moderate”; 101 to 150 “is unhealthy for sensitive groups”; 151 to 200 is “unhealthy”; and 200 to 300 is “very unhealthy” air quality.

According to the 2009 AQI Report, the Suburban Region had 327 days of “good” air quality, 37 days of “moderate” air quality and 1 day of air quality considered “unhealthy for sensitive groups.” Based on the NJDEP 2009 Air Quality Monitoring Report, there were no days marked as “unhealthy” or “very unhealthy” overall within the region. Regions with closer proximity to the urban centers of Philadelphia and New York City tended to have less “good” air quality days and more “moderate” air quality days than the Suburban region. These urban areas also tended to have a number of particulate matter exceedances during the course of the year (NJDEP 2009c).

Data for the Suburban Region indicates that excessive ozone is the most common cause of air quality exceedances in the region and most often occur in the summer. Daily AQI Exceedances (above 100) for Region 3 in which ozone levels rise above NAAQS may occur several times annually during warmer months in the vicinity of Great Swamp NWR.

Regional Air Quality - Air Toxics

Air toxics are a large group of pollutants that are likely to be emitted into the atmosphere in large enough quantities to result in adverse health effects, including lung and respiratory conditions, birth defects and cancer. Although there is no Federal air quality standard for these toxicants, Congress in 1990 directed the EPA to begin addressing 200 of these substances by developing technology control standards (NJDEP Department of Air Monitoring).

Some of these toxicants are tested for in Air Quality Monitoring Stations through a manual monitoring network. The data obtained through samples collected are then analyzed in a laboratory. The data collected through manual sampling cannot be monitored in real time as the criteria pollutants are. Seventy volatile organic compounds (VOCs) are air toxics monitored under the manual monitoring network. VOCs are typically emitted from industrial sources, including chemical plants, factories and motor vehicles. In addition to being linked to adverse health effects, VOCs contribute to the development of ground level ozone. Ozone is a gas that forms when nitrogen oxides and VOCs react in the presence of sunlight and heat. Ozone is the most common criteria pollutant exceeding standards in the State. Ozone season is during the summer and ozone formation occurs mainly during daytime. Repeated exposure to ozone results in damage to the lungs and aggravates many respiratory ailments. Children and asthmatics are especially prone to adverse health effects due to exposure to ozone.

VOCs are measured at four monitoring stations in New Jersey. For the purposes of the Great Swamp NWR CCP, data collected at the geographically closest station to the refuge (the Chester Station-Approximately 12.5 miles northwest of Great Swamp) from the most recently available NJDEP Bureau of Air Monitoring Report (2007) are shown in table 2-8. Ten VOCs were found at the Chester Station in mean concentrations above the accepted long-term health benchmark established by NJDEP. These compounds include the following in micrograms per cubic meter (ug/m3). Table 2-8 also includes a risk ratio (RR), which evaluates the potential harm of a chemical by evaluating its concentration in the sample against the established benchmark. If the risk ratio is greater than one, its level of concentration may be of concern (NJDEP 2007).

TABLE 2-8: AIR TOXICANTS EXCEEDING LONG-TERM HEALTH BENCHMARKS CHESTER LABORATORY MONITORING STATIONS (2007)

Pollutant	NJDEP Long-Term Health Benchmark (ug/m^3)	Chester Annual Mean	
		ug/m^3	Risk Ratio (RR)
Acetaldehyde	0.45	1.28	3
Acrolein	0.02	0.67	34
Benzene	0.13	0.45	3
1,3 –Butadieine	0.033	0.10	3
Chloroform	0.043	0.08	2
Carbon tetrachloride	0.067	0.54	8
Chloromethane	0.56	1.16	2
Formaldehyde	0.077	2.32	30
p-Dichlorobenzene	0.19	0.091	2
Tetrachloroethylene	0.17	0.29	1.7

The results indicate that Acrolein and formaldehyde have, by many magnitudes, the highest risk ratio of the chemicals exceeding benchmarks at both stations. These two chemicals have been summarized below.

Acrolein is an industrial VOC typically associated with the production of acrylic acid and is commonly produced in the atmosphere. It vaporizes easily and is released into the atmosphere through the combustion of many different substances including fossil fuels, tobacco smoke, cooking oils and grease, and during residential commercial or industrial fires. It may also be used as an agent to control aquatic weeds, bacteria, algae and mollusks (ASTDR 2011). Exposures to acrolein typically come from breathing in tobacco smoke, automobile exhaust, vapors from cooking grease, or exposure to facilities where acrolein

is manufactured or used (ASTDR 2011). Acrolein is found throughout the environment, including soils, water, and air. The chemical dissipates rapidly from soil and water, and breaks down rapidly in the air (50 percent within one day of release) due to interaction with chemicals and sunlight (ASTDR 2011). Little is known about the health effects of acrolein; however, breathing large quantities could cause lung damage or death. Exposure to lesser amounts can cause eye and throat irritation (ASTDR 2011). The EPA has not determined this chemical to be carcinogenic based on the lack of data.

Formaldehyde is a colorless gas with a pungent smell commonly used for a variety of applications. It is used in the production of textiles, resins and other chemicals. It is also used as embalming fluid, disinfectant, fungicide, fertilizer and food preservative. It is also found some cosmetics and medicines. Formaldehyde naturally occurs in low levels in plants and animals, including humans (ASTDR 2011). Releases of formaldehyde into the air may be the result of its industrial production, or release from wood products such as particle board, paints and varnishes, automobile exhaust, cigarette smoke, carpets and some fabrics. Indoor air levels of formaldehyde are generally greater than outdoor air levels. In general formaldehyde breaks down quickly in the air (typically within hours) and dissipates quickly in water. It evaporates rapidly from soils and does not accumulate in plant or animal tissue (ASTDR 2011). The most common exposure to formaldehyde is direct inhalation. Formaldehyde is classified as a carcinogen and a mutagen based on inhalation studies (ASTDR 2011). It is corrosive in nature and can cause eye, ear nose mouth, throat or skin irritation and neurological damage (NJDHSS 2010; ASTDR 2011)

2.2 Regional Demographic and Socioeconomic Setting

2.2.1 Population

As with many undeveloped areas in New Jersey, the refuge is surrounded by suburban and urban landscape. The refuge lies approximately 11 miles south of Morristown, the Morris County seat (see map 2-1). Downtown New York City is less than 30 miles away, and the top five cities or townships in New Jersey with the highest population estimates (i.e., Newark, Jersey City, Paterson City, Elizabeth City, and Edison Township) are less than 25 miles away (US Census Bureau 2010). Many local residents commute to these nearby metropolitan areas for work.

USFWS

New Jersey is the most densely populated state in the country with an estimated 1,185 people per square mile (table 2-9). Of the 21 counties in New Jersey, Morris County and Somerset County are the 11th and 12th most densely populated, respectively (US Census Bureau 2011). As with the nation as a whole, the population of New Jersey and both counties has increased over the last 10 to 18 years (table 2-9). However, Somerset County's population has grown more quickly than the Nation's, the State's, or Morris County's growth rates. Between 1990 and 2000, Somerset County's population grew (about 24 percent) more than twice as much as New Jersey's (9 percent) or Morris County's (11.6 percent). Between 2000 and 2010,

estimated population in the United States was at 9.7 percent. New Jersey's population growth during this period was 4.5 percent.

Overall, median age in the United States has increased approximately 3 percent between 2000 and 2007 (U.S. Census Bureau 2009b). During this same time span, median age was higher in the State of New Jersey (37.4), Morris County (42.4), and Somerset County (39.0) compared to the United States (38.5).

TABLE 2-9: NATIONAL, REGIONAL, AND LOCAL COMMUNITY FOR AREAS NEAR GREAT SWAMP NWR

Community	Population in 2010				Population Change	
	2010 Population	Land Area (square miles)	Persons per square mile	2000 Population	1990 to 2000	2000 to 2010
United States*	308,745,538	3,537,438.44	87.3	281,424,602	13.15%	9.71%
New Jersey	8,791,894	7,417.34	1185.3	8,414,360	8.85%	4.49%
Morris County	492,276	468.99	1,049.7	470,212	11.60%	4.69%
Chatham Township	10,452	9.36	1,164.2	10,086	7.74%	3.63%
Harding Township	3,838	20.44	192.7	3,180	-12.64%	20.69%
Long Hill Township	8,702	12.14	734.3	8,777	12.15%	-0.85%
Morristown	18,411	3.03	6,284.9	18,544	14.55%	-0.71%
Chatham Borough	8,962	2.41	3,776.1	8,460	5.66%	5.93%
Somerset County	323,444	304.69	1,061.6	297,490	23.81%	8.72%
Bernards Township	26,652	23.93	1,113.6	24,600	--	8.34
Bernardsville Borough	7,707	12.91	597.2	7,345	11.34%	5.51%

Notes:
-- indicates data were not available
* Census 2010 data used for U.S. population
Source: U.S. Census Bureau Population Estimates Program and American Fact Finder. Retrieved September 2011. (http://factfinder.census.gov/home/saff/main.html?_lang=en)

According to the U.S. Census Bureau 2000 Census Data (U.S. Census Bureau 2010), New Jersey's population consisted of 68.6 percent white persons not of Hispanic or Latino origin, slightly lower than the percentage reported for the nation's population as a whole (72.4 percent). Morris County (82 percent) reported higher percentages, while Somerset County (70.1 percent) compared to New Jersey and the United States. The percentages of residents identifying themselves as Black or African American were lower in Morris (3.1 percent) and Somerset (8.9 percent) Counties when compared to New Jersey (13.7 percent) and the U.S. (12 percent) (U.S. Census Bureau 2010). This trend is consistent for residents of

other ethnicities, with one exception. Both Morris (9 percent) and Somerset Counties (14.1 percent) had higher percentages of residents identifying themselves as Asian compared to New Jersey (8.3 percent) and the U.S (4.8 percent). (U.S. Census Bureau 2010).

2.2.2 Employment and Income

Data analyses by Headwaters Economics (2009a) show that, based on data from 2006, employment (total jobs) in the State of New Jersey has been dominated almost equally by retail trade (10.8 percent), healthcare and social assistance (10.7 percent), and State and local government positions (11.2 percent). Manufacturing accounted for 6.6 percent of all jobs in the State in 2006, a decrease of about 2 percent compared to 2001. Employment patterns in Morris and Somerset Counties differed slightly from the State's in that professional and technical services (e.g., lawyers, accountants, scientific researchers) comprised the largest number of jobs (about 12 percent of total jobs in both Counties), followed by retail trade and health care and social assistance (Headwaters Economics 2009b, 2009c). Farm employment accounts for less than 0.5 percent of the total employment for Morris County, Somerset County, and New Jersey.

These patterns are similar to national employment by industry figures in 2006. For the United States as a whole, retail trade, state and local government, and health care and social assistance accounted for between 10 and 11 percent of the total jobs each (Headwaters Economics 2009d). The biggest difference between the county and the national employment information was within the professional and technical services category. Nationally, this category only accounted for about 7 percent of the total jobs, compared to about 12 percent for each county, and 8 percent for the State.

Currently, the United States is recovering from its largest recession since the 1930's (e.g., Bull and Felsenthal, 2009). The average national unemployment rate for 2009 was estimated at 9.3 percent, and equaled or exceeded 10 percent in October, November, and December of 2009 (BLS 2010a). National unemployment rates consistently remained near 10 percent throughout 2010 (BLS 2011) and have slowly dropped to the current (April 2012) level at 8.1 percent (BLS 2012). Historically, New Jersey has fared marginally better than the nation as a whole in regards to unemployment, usually experiencing lower unemployment rates (table 2-10). New Jersey was; however, above the national unemployment average for 2011. Over the last ten years or so, Morris and Somerset Counties have had unemployment rates about 1.5 percent lower than the national figures (BLS 2010a, BLS 2010b, and BLS 2011). New Jersey had similar unemployment numbers to the United States as a whole, while unemployment estimates for Morris and Somerset Counties were between 1 and 2 percent lower (BLS 2010b; 2011; 2012). Between 2009 and 2010 the average unemployment rate in New Jersey rose slightly by 0.4 percent and dropped by 0.7 percent in 2011(BLS 2011; 2012).

TABLE 2-10: ANNUAL AVERAGES OF UNEMPLOYMENT RATES FOR THE UNITED STATES, NEW JERSEY, MORRIS COUNTY AND SOMERSET COUNTY BETWEEN 2000 AND 2010				
	Average Annual Unemployment Rate[1]			
Year	U.S.	New Jersey	Morris Co.	Somerset Co.
2001	4.7	4.3	3.3	3.3
2002	5.8	5.8	4.6	4.8
2003	6.0	5.9	4.6	4.6
2004	5.5	4.9	3.7	3.7
2005	5.1	4.5	3.3	3.4
2006	4.6	4.6	3.3	3.4
2007	4.6	4.3	3.0	3.1
2008	5.8	5.5	4.0	4.1
2009	9.3	9.2	7.2	7.4
2010	9.6	9.5	7.3	7.4
2011	8.9	9.3	7.0	7.1
Ten Year Average 2001-2010	6.3	6.2	4.6	4.8

[1] U.S. data from Bureau of Labor Statistics (BLS). Labor Force Statistics from the Current Population Survey. Retrieved 3 May 2010. (http://www.bls.gov/cps/). All other data from Bureau of Labor Statistics (BLS). 2010b. Local Area Unemployment Statistics. [Online] Retrieved 3 May 2010 (http://www.bls.gov/lau/data.htm). 2010 Data retrieved from U.S. Census Data and Bureau of Labor September 2011; 2011 data retrieved May 2012.

In general, New Jersey, Morris County, and Somerset County are affluent compared to the rest of the country (see table 2-11; U.S. Census Bureau 2011). Median family income per year in New Jersey exceeds the national figure by over $21,000 while this value for Morris and Somerset Counties exceeds the national figure by over $50,000. However, median family income and per capita family income, when adjusted for inflation, have decreased in the United States, New Jersey, Morris County, and Somerset County between 1999 and 2005-2009.

TABLE 2-11: CALCULATED ANNUAL MEDIAN FAMILY INCOME AND PER CAPITA INCOME FOR THE UNITED STATES, NEW JERSEY, MORRIS COUNTY AND SOMERSET COUNTY					
Location	Annual Estimate	Census 2000 (1999 dollars)	2000 Adjusted (2009 dollars)	2005-2009 (2009 dollars)	Percentage Change
United States	Median Family Income	50,046	64,466	62,363	-3.26
	Per Capita Income	21,587	27,798	27,041	-2.72
New Jersey	Median Family Income	65,370	84,179	83,957	-0.26
	Per Capita Income	27,006	34,777	34,566	-0.61
Morris County	Median Family Income	89,773	115,604	114,019	-1.37
	Per Capita Income	36,964	47,599	46,764	-1.75
Somerset County	Median Family Income	90,605	116,675	113,873	-2.40
	Per Capita Income	37,970	48,895	46,835	-4.21

[1] Data adjusted for inflation using the Bureau of Labor Statistics inflation calculator (http://www.bls.gov/data/inflation_calculator.htm).
Source: U.S. Census Bureau. 2011. American Fact Finder Page. [Online] Retrieved September 2011. (http://factfinder.census.gov/home/saff/main.html?_lang=en).

2.2.3 Recreation and Tourism

Tourism is an important part of New Jersey's economy. A recent study completed by IHS Global Insight (2009) found that tourism spending in 2008 contributed $27.9 billion to New Jersey's gross State product, accounting for 5.8 percent of the State's total gross state product. The same study found that tourism Sexpenditures were responsible for over 443,000 jobs, about 10.9 percent of the State's total employment. Tourism also generated an estimated $7.7 billion in Federal, State, and local government taxes for 2008 (IHS Global Insight 2009). Activities generating the most tourism dollars included dining, entertainment, gambling, shopping, sightseeing, and similar (DKSA 2009). While tourism is important to the State's economy, it plays a smaller role in the region around Great Swamp NWR. A 2008 regional analysis of tourism in New Jersey shows the northwestern New Jersey Skylands region, including Great Swamp NWR, comprised the smallest share of total statewide tourism spending at 8.5 percent (IHS Global Insight 2009). Morris County itself; however, was listed as ninth out of the 21 New Jersey counties for overall tourism expenditure in 2008 at a total of $1,323,000,000.

Great Swamp NWR has the potential to increase visitation, and associated economic benefits to the area, because of its proximity to highly populated areas. Great Swamp NWR currently attracts an estimated

150,000 to 160,000 visitors per a year to the region from throughout the United States and various countries.

Based on a recent report completed by the FWS, over 34 million people visited refuges for recreation in the lower 48 States (Carver and Caudill 2007). These visits generated almost $1.7 billion in sales in regional economies, supporting 27,000 jobs and nearly $543 million in employment income. Refuge recreation spending generated an additional $185.3 million in tax revenue at the local, county, State, and Federal levels.

2.2.4 Contribution of the Refuge to the Local Economy

Refuges provide many benefits to local economies in addition to tourism dollars. Property values and associated property taxes often increase near open spaces, benefitting local communities (Gies 2009). In addition, land in public ownership requires little in the way of services from municipalities yet it provides valuable recreation opportunities and quality of life benefits for local residents.

National wildlife refuges also contribute to local economies through shared revenue payments. Under the provisions of the *Refuge Revenue Sharing Act* (the Act of June 15, 1935; 16 U.S.C. 715s), the FWS pays an annual refuge revenue sharing payment to counties that contain lands the FWS administers. 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. Recent FWS revenue sharing payments for Great Swamp NWR are presented in table 2-12.

TABLE 2-12: RECENT GREAT SWAMP NWR REVENUE SHARING PAYMENTS (1986 THROUGH 2012)

Year	Municipality		
	Chatham	Harding	Long Hill
1986	$22,749	$60,364	$37,015
1987	$22,473	$59,821	$37,841
1988	$ 27,096	$ 72,127	$ 46,670
1989	$ 29,676	$ 78,996	$ 51,640
1990	$ 35,656	$ 94,915	$ 64,019
1991	$ 24,182	$ 66,500	$ 49,005
1992	$ 22,160	$ 69,538	$ 45,029
1993	$ 21,135	$ 69,385	$ 45,777
1994	$ 21,011	$ 68,708	$ 48,066
1995	$ 17,905	$ 58,552	$ 43,263
1996	$ 21,195	$107,062	$ 56,520
1997	$ 19,349	$ 97,740	$ 52,398
1998	$ 18,210	$ 91,983	$ 49,311
1999	$ 16,954	$ 85,638	$ 49,258
2000	$ 14,872	$ 75,124	$ 46,212
2001	$ 19,238	$306,479	$107,428
2002	$ 17,972	$286,306	$102,015
2003	$ 17,273	$281,394	$101,726

TABLE 2-12: RECENT GREAT SWAMP NWR REVENUE SHARING PAYMENTS (1986 THROUGH 2012)			
Year	Municipality		
	Chatham	Harding	Long Hill
2004	$ 15,278	$248,959	$ 90,904
2005	$ 17,255	$281,164	$102,663
2006	$ 15,970	$263,458	$ 95,018
2007	$ 16,993	$254,754	$ 92,894
2008	$16,993	$197,652	$72,072
2009	$16,993	$188,461	$67,850
2010	$28,136	$60,436	$118,333
2011	$30,150	$126,803	$64,762
2012	$28,331	$119,154	$60,856

2.3 Refuge Administration

2.3.1 Refuge Establishment and Land Acquisition

In 1959, the Port Authority of New York & New Jersey announced plans to consider Great Swamp as a potential site for a commercial jet airport. As a result of major opposition, local citizens formed the Great Swamp Committee of the North American Wildlife Foundation, and through a national campaign, raised one million dollars to acquire nearly 3,000 acres. The Foundation began acquiring these lands in 1960 with the intention to donate this area to the United States. Great Swamp NWR was established in 1960 in accordance with provisions of the Migratory Bird Conservation Act of 1929, and formally dedicated by the Secretary of the Interior in 1964.

Great Swamp NWR, presently 7,773 acres, comprises the largest land ownership (53 percent) of the GSW area. Remaining lands are predominantly held in private ownership with the exception of the Somerset County Lord Stirling Park and Environmental Education Center (1,027 acres) and the Morris County Outdoor Education Center (40 acres). Additional information regarding establishment and acquisition history is included in section 1.5 of chapter 1.

Helen C. Fenske

Helen C. Fenske was a Green Village resident, who in the early 1960s, led a grassroots effort to prevent the Great Swamp from becoming a commercial jetport, as planned by the Port Authority of New York and New Jersey. Through her skillful community organizing, fundraising and political advocacy, Ms. Fenske worked to raise more than $1 million to purchase and donate nearly 3,000 acres of land to the Department for the establishment of Great Swamp NWR.

After the establishment of Great Swamp NWR, Ms. Fenske's efforts to improve and protect the refuge continued. Ms. Fenske was instrumental in developing Great Swamp NWR's Wilderness Area in 1964, the first NWR wilderness area in the United States.

Ms. Fenske continued conservation efforts throughout her life, including fostering the development environmental commissions, protecting open space and wetlands, and promoting the creation of Wallkill and Cape May NWRs. Ms. Fenske also served as the Assistant Commissioner of NJDEP. The Department

of Interior's Conservation Service Award was among the many awards she received during her lifetime. Helen C. Fenske died on January 19, 2007 at the age of 84.

2.3.2 Great Swamp NWR Staffing and Budgets

Great Swamp NWR currently consists of nine permanent staff: a Refuge Manager; Deputy Refuge Manager; Refuge Wildlife Biologist; Refuge Contaminants Biologist; Visitor Services Manager; Visitor Services Specialist; Engineering Equipment Operator; Maintenance Worker; and Refuge Law Enforcement Officer. The refuge also includes two temporary staff: a Biological Technician and Administrative Assistant.

Table 2-13 below summarizes general budget, visitation and volunteer hour data.

TABLE 2-13: GREAT SWAMP NWR STAFFING, BUDGET, VOLUNTEER HOURS AND VISITATION DATA					
Category	2010	2009	2008	2007	2006
Refuge Acreage	7,773	7,745	7,735	7,725	7,657
Budget					
Salaries/ops[A] (FTE's)	$1,340,423 (9.5)	$1,394219 (10.5)	$1,333,178 (10.5)	$1,274,293 (9.9)	$965,500 (9.8)
One-time Project Funds[B]	$43,800[C]	$84,220	$289,211	$2,218,119	$396,742
Fees	$3,684	$3,883	$3,490	$4,090	$4,567
Volunteer Hours	15,143	14,584	10,240	12,000	8,148
Visitation	156,500	155,500	151,000	155,000	240,000[D]

Notes:
[A] Includes annual maintenance, utilities, contracts, and other similar salaries.
[B] Includes deferred maintenance, construction, equipment, and biological projects.
[C] In addition, the refuge received $579,000 from the American Recovery and Reinvestment Act
***Apparent drop in visitation between 2006 and 2007 is the result of changes in how visitation was calculated and does not reflect an actual substantial drop in refuge visitation

2.3.3 Refuge Facilities and Maintenance Summary

The following is a summary of current refuge facilities, including wildlife management facilities, maintenance facilities, roads, parking lots and other visitor facilities, and other structures not occupied or in use. Facilities include the following:

- *Refuge Headquarters* is an administrative building that contains offices of staff members, a meeting room, bathrooms, a refuge receptionist desk, and informational displays and materials.

- The *Wildlife Observation Center* (WOC) is an area located off of Long Hill Road ideal for observing wildlife in forested, emergent and scrub-shrub wetland and open water habitats. The WOC consists of 1.5 miles of trails, including interpretive handicapped accessible boardwalk trails, three observation blinds for viewing wildlife, an informational kiosk, a large parking area, a visitor contact station, and all-season restrooms.

- The *Helen C. Fenske Visitor Center* was opened in 2009 and is housed in a century–old farmhouse located on Pleasant Plains Road. The facility provides visitor services and contains exhibits, meeting space, and offices. The Friends of Great Swamp NWR offer public programs and have their nature gift shop, library, and Discovery Den in the Visitor Center. The Visitor Center has an adjacent pavilion that is used for outdoor educational programs, a 0.5 mile loop trail, children's nature trail, outdoor restrooms, and ample parking.

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- Five *Impoundment Areas* are located within the management area of the refuge. Each impoundment includes water control structures.

- An *overlook observation area* located along Pleasant Plains Road, which includes two fixed viewing scopes, a kiosk, benches, and parking for about 10 cars.

- Four major *parking lots.*

- 8.5 miles of primitive, blazed *foot trails* within the Wilderness Area. An information kiosk is located at each Wilderness Area trailhead.

- Numerous interpretive, informational, directional, and administrative *signs*.

- *Maintenance storage facilities* house equipment and tools. Maintenance storage facilities include the pole barn, shop, oil shed, and Cement Plant.

- 11 *houses*, five of which are occupied by staff. Three are scheduled for demolition.

- Three *bridges*, located at Middle Brook, Great Brook, and Amil Gates.

- Gravel and paved *roads*, including 2.3 miles of Pleasant Plains Road. 1.3 miles consists of gravel and 1.0 mile is paved.

- *Additional Structures:* the Bluebird lot (formerly referred to as Q99) includes an outdoor restroom. A kiosk, benches and parking for about 20 cars are planned for the future.

2.3.4 Step-Down Plans, Findings of Appropriateness, and Compatibility Determinations

Step Down Plans

As previously discussed in chapter 1, there are more than 25 step-down management plans that are generally required on refuges. Please refer to section 1.7 for a summary on the requirements for step-down plans, a list of plans that are complete and up-to-date, and a list of plans required upon completion of this CCP.

Findings of Appropriateness and Compatibility Determinations

The *Policy on the Appropriateness of Refuge Uses* (603 FW 1) provides a national framework for determining appropriate refuge uses to prevent or eliminate those that should not occur in the Refuge System (USFWS 2006b). It describes the initial decision process the refuge manager follows when first considering whether to allow a proposed use on a refuge. *Policy on Compatibility* (603 FW 2) complements the *Policy on Appropriateness of Refuge Uses* (603 FW 1). If a refuge manager finds a use appropriate, the use is further evaluated through a CD. The policy provides guidelines for determining the compatibility of uses and procedures for documentation and periodic review of existing uses (USFWS 2000d). Chapter 1 describes parameters used in making Compatibility Determinations and Findings of Appropriateness.

The list below outlines the current CDs and uses that have been approved for the refuge. The list includes original, updated and new determinations completed and reviewed as part of the CCP process. The detailed findings are included in appendix B of this report.

Compatibility Determinations:

- Wildlife Observation, Photography, Environmental Education, and Interpretation
- Public Hunting
- Alternative Forms of Transportation to Access Refuge Lands
- Leashed Dog Walking During Daylight Hours on Pleasant Plains Road
- Research
- Commercial Filming, Motion Picture Production, and Advertisements
- Police and Fire Training
- Maintenance of National Weather Service Automatic Rain Gauge
- World Series of Birding
- Maintenance of Utility Rights of Way

2.3.5 Partnerships

NJDEP Division of Fish and Wildlife

The NJDFW works closely with Great Swamp NWR by assisting in the management of its hunting program and by providing assistance and direction in the management of sensitive wildlife species through ENSP, which has assisted the refuge in management of its endangered species, such as the bog turtle and Indiana bat. The NJWAP, which sets direction for the protection of wildlife within New Jersey, has been utilized by Great Swamp NWR as a planning tool to assist in the prioritization of species for management. ENSP has also assisted with onsite species surveys and inventories of the refuge, including the 2009 Bioblitz.

The *Great Swamp Watershed Association*

The GSWA was established in 1981 by a small group of concerned citizens. GSWA conducts water quality monitoring on streams within the watershed, promotes intelligent land use, provides environmental education, and protects habitat and open space (GSWA 2009).

Ten Towns Committee

The Ten Towns Committee was established in 1995 through an *Intermunicipal Agreement* among the ten GSW townships in Morris and Somerset Counties to manage and improve local water quality (Ten Towns Committee 2009). The Ten Towns Committee also established a macroinvertebrate water quality monitoring program in 2000, which was to be conducted on an annual basis. Since 1998, GSWA, in conjunction with the Ten Towns Committee, had been monitoring the water quality and quantity of the five main streams in the GSW. The Ten Towns Committee was dissolved on June 30, 2010 as many of the organization's initial policy goals had been completed and are still in place.

For more information on the GSWA and Ten towns Committee, see Watershed Advocacy and Protection in section 2.1.4 of this chapter.

Friends of Great Swamp NWR

Friends of Great Swamp NWR is an independent, non-profit organization that was established in 1999 by local citizens in partnership with the FWS. The *Friends* mission is to promote stewardship of the natural resources of the refuge; inspire appreciation of nature through education and outreach; and engage in partnership activities that support and enhance Great Swamp NWR and the Refuge System. The *Friends* program has provided important input on issues related to refuge public use and management during the course of the CCP. Additional information on the *Friends* program is included in the Volunteer section of the CCP (see chapter 2, section 2.4.6).

Somerset County Environmental Center

The Somerset County Environmental Center is located within Lord Sterling Park in Basking Ridge. The park is comprised of 425 acres of the western portion of the GSW Basin and adjacent to Great Swamp NWR. The park provides access from its environmental center to wetland, open water, forest and meadow habitats. The Environmental Center offers a variety of exhibits and educational programming, including a traveling program. The center also offers canoeing and kayaking through portions of the park's open waters (Somerset County Park Commission 2011).

Morris County Park Commission Great Swamp Outdoor Education Center

The Morris County Outdoor Education Center is located along the eastern side of Great Swamp NWR in Chatham Township. The park offers a variety of recreational and educational opportunities for visitors. Facilities include an exhibit based visitor center, including wildlife observation along a boardwalk system, guided hikes, public education, teacher certification, and scout programs (Morris County Park Commission 2011).

The Raptor Trust

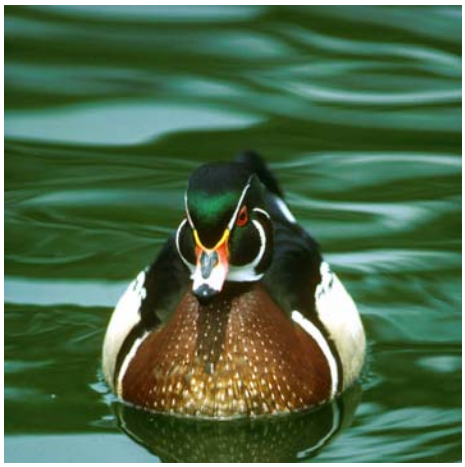
The Raptor Trust is a highly respected and nationally-recognized wild bird rehabilitation center located within the southwestern portion of Great Swamp NWR on White Bridge Road. The Raptor Trust includes a hospital with state-of-the-art medical facilities, adequate housing for hundreds birds, and an education building. The Raptor Trust provides the public with access to view many rehabilitated birds, and offers a variety of raptor-subject programs to the public, schools and scouts (Raptor Trust 2006).

The National Park Service

Morristown National Historical Park is comprised of four geographically separate units located north of Great Swamp NWR. The historical park is associated with the 1777 and 1779 to 1780 winter encampments of the Continental Army and General George Washington's headquarters in Morristown. The park contains 27 miles of hiking trails that wind through mature forests. The park offers curriculum-based programs for 4th and 5th grades on the significance of the parks resources and region during the American Revolution (National Park Service 2011).

New Jersey Audubon Society

The New Jersey Audubon Society was founded in 1897 and is one of the oldest independent Audubon societies. The New Jersey Audubon Society is a privately supported, not-for-profit, statewide membership organization unaffiliated with the National Audubon Society. The New Jersey Audubon Society promotes the conservation of natural lands and protects New Jersey's wildlife and endangered species. The New Jersey Audubon Society manages natural lands within the State, including the 276 acre Scherman-Hoffman Wildlife Sanctuary, which is located approximately 2.5 miles northwest of Great Swamp NWR in Bernardsville, New Jersey (New Jersey Audubon Society 2011).



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Ducks Unlimited, Inc.

Ducks Unlimited conserves, restores, and manages wetlands and associated habitats for North America's waterfowl. The New Jersey Chapter includes more than 5,700 members. Chapters work through partnerships with individuals, landowners, agencies, scientific communities and others to accomplish its conservation work (Ducks Unlimited Inc. 2011).

The Trust for Public Land

The Trust for Public Land is a national nonprofit organization that conserves land for use as parks, gardens, historic sites, rural lands, and other natural places. The trust acquires properties to improve natural areas and quality of life for inner cities. The trust helps to plan solutions, raise funds and complete conservation transactions. Within New Jersey, the Trust has protected nearly 25,000 acres and helped to pass several million dollars in new State spending on conservation. Local Trust lands include the McVickers Brook Preserve in Mendham Borough, which connects into the Patriots Path, and Morristown National Historical Park (Trust for Public Land 2011).

The Land Conservancy of New Jersey

The Land Conservancy of New Jersey is an important organization in State land preservation .The Conservancy has preserved over 17,000 acres and assisted in securing over $206 million in county, State, and Federal grants for their land conservation projects. Land preserved near the refuge includes the 26-acre Passaic River County Park Addition in Long Hill Township, 35-acre Great Swamp NWR Addition in

Long Hill Township, and the 10-acre Loantaka Brook Greenway in Chatham Township (Land Conservancy of New Jersey 2011).

2.4.6 Volunteer Program

In Fiscal Year (FY) 2012, volunteers contributed 13,809 hours to Great Swamp NWR. Volunteers assist with biological projects; maintain of refuge facilities and trails; develop and conduct environmental education programs; assist with special events; create educational exhibits; and staff exhibits during on- and off-site special events. Volunteer orientations are held biannually and a recognition dinner is held annually.

Friends of Great Swamp NWR

The *Friends* provide major coordination of the volunteer program at Great Swamp NWR. The *Friends* currently have a group of volunteers who conduct environmental education and interpretation activities on the refuge. Since the fall of 2008, approximately 5,200 students in Kindergarten through Grade 12 have attended these programs. During bird migration season each year, the *Friends* spend over 500 hours greeting visitors at the Wildlife Observation Center.

Friends of Great Swamp NWR are involved in the following:

Visitor Services
The *Friends* greet visitors and provide general refuge information at the Helen C. Fenske Visitor Center and Wildlife Observation Center.

Work Projects and Refuge Cleanup Activities
The *Friends* assist with maintenance projects, including homestead cleanups and biannual roadside cleanups.

Education & Outreach
The *Friends* conduct or assist with scheduled school, club, scout, or group tours, answer questions, show video programs, and provide orientation to the refuge.

Surveys and Refuge-Specific Projects
The *Friends* work closely with refuge staff on an as–needed basis on various biological and management projects. These projects include wildlife and bird surveys and banding, deer hunt assistance, vernal pool and stream bank restoration projects, or invasive species control.

TABLE 2-14: VOLUNTEER HOURS BY FRIENDS OF GREAT SWAMP NWR							
Category	FY 2006	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012
Wildlife and Habitat	2,676	2,359	4,200	3,557	4,958	4,245	6,279
Refuge Maintenance	968	655	500	549	669	498	963
Wildlife-Dependent Recreation	2,990	3,905	3,900	6,025	8,152	6,113	6,010
Environmental Education	419	310	100	642	280	271	241
"Other" Activities	958	753	1,000	1,278	1,084	222	316
TOTAL	8,011	7,982	9,700	12,051	14,816	11,349	13,809

2.4.7 Outreach

Public outreach is two-way communication between the FWS and the public to establish mutual understanding, promote involvement, and influence attitudes and actions with the goal of improving joint stewardship of our natural resources (USFWS 2001c). Recognition of the refuge, the Refuge System, and the FWS among neighbors, local leaders, conservation organizations, and elected officials are among the refuge's major purposes for public outreach efforts. These efforts generate support for conservation in the region. Forms of outreach include off-site exhibits and displays; news media relations; internet, intranet, and listservers; partnerships; environmental education; memberships in professional and community organizations; and Congressional relations.

Refuge staff often host or participate in local events which facilitates direct communication with the public and raises the visibility of the refuge. Volunteers also frequently represent the refuge at local events. For example, each fall the refuge participates in a cooperative outreach program with the Morris County Park Commission. Various other municipal, county, state and Federal land management agencies also participate in the event, all of which share a common theme or conservation message. The refuge staff or volunteers distribute information about the refuge, children's nature games, and display material. The mission of the Refuge System and the refuge's purpose are conveyed to the public to raise awareness and recognition. This public event is typically attended by about 500 people.

2.4.8 Research

From its inception, environmental and wildlife education have been an integral component of Great Swamp NWR (see chapter 1). Great Swamp NWR and its academic and organizational partners conduct numerous multi-year wildlife inventories for terrestrial vertebrate groups. This section provides a general list of the types of studies conducted on the refuge. Details on specific studies are included in section 2.6.1 and chapter 3.

Wildlife and Plant Inventories

While most species inventories focus on birds, other species groups, including other vertebrate and some invertebrate groups, have been inventoried on the refuge. Various plant and fungal inventories have also been conducted on the refuge. Examples of Great Swamp NWR species inventories include the following:

- Fungal inventories
- Herbaceous plant inventories
- Breeding grassland and early successional bird surveys
- Inventories of breeding waterfowl populations
- Marsh bird inventories
- Christmas Bird Counts
- World Series of Birding inventories.
- Frog call surveys
- Bog turtle and wood turtle mark-recapture study
- American kestrel nest box breeding data
- Productivity monitoring of great blue heron rookeries
- Woodcock singing ground surveys (refuge and State run)
- Wood duck box breeding data
- Deer population surveys
- Small mammal trapping surveys
- Moth surveys
- Butterfly surveys
- Stream aquatic invertebrate inventory
- Bioblitz (2009 and 2011) – General species diversity inventory)
- Vernal pool surveys
- Mal-formed frog survey

Threatened and Endangered Species Studies

Studies focusing on specific State or federally listed threatened or endangered species are regularly conducted at Great Swamp NWR. The habitat utilization and demography of Indiana bat, bog turtle, wood turtle, and blue-spotted salamander have all been studied on the refuge. Information from these studies is incorporated into management strategies on the refuge. Specific threatened and endangered species studies include the following:

- Roost selection by reproductively active female Indiana bats
- Roost tree selection by male Indiana bats
- Radio telemetry and habitat use by bog turtles and wood turtles
- Wood turtle artificial nesting mound productivity
- Blue-spotted salamander egg mass counts and breeding pool study

Other Ecological Studies

Ecological studies on the effect of wildlife populations, such as white-tailed deer on plant communities, have been conducted at the refuge. Data on deer population structure and trends are maintained by the

refuge, which assists with future management decisions and techniques. Hydrologic studies, including water quality monitoring studies, have also been conducted at the refuge.

Plant Communities and Wildlife Habitats

- General plant community evaluation
- Early successional shrub data
- Hedgerow study (avian use)
- Shorebird use of impounded wetlands (part of a larger USFWS Region 5 study)
- Invasive species management data
- Vernal pool studies

Wildlife Control and Health

- Frog abnormality study
- White-tailed deer harvest data
- White-tailed deer and forest understory health monitoring
- Mute swan control data
- Avian Influenza monitoring

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Abiotic Conditions

- Soil surveys
- Pool and stream elevation data
- Water quality studies

Please refer to the Great Swamp NWR HMP for a spreadsheet of all major studies that are occurring or have occurred at Great Swamp NWR. Specific details on key studies are further discussed within the alternatives analysis and text of chapter 3 of this CCP.

2.4.9 Special Use Permits, Including Research

Special Use Permits (SUPs) are issued to individuals, organizations, institutions, companies, and agencies that request the use of refuge facilities or resources beyond what is available to the public. Permits may or may not be research or education oriented in nature. SUPs commonly issued at Great Swamp NWR include access in restricted areas, entrance after hours, collection or sampling of resources for research or monitoring, and special events or other activities. SUPs are needed to engage in the following activities on a national wildlife refuge (USFWS 2011a):

- Agriculture, such as haying, grazing, crop planting, logging, beekeeping, and other agricultural activities.

- Commercial Activities, including commercial fishing, trapping, and other activities.

- Research and Monitoring by students, universities, or other non-FWS organizations.
- Commercial Filming, including audio, video, and photographic products with a monetary value.
- Commercial Visitor Services, such as outfitters or guides for hunting, fishing, canoeing, kayaking, and other visitor services.
- Special Events, including guided birding trips, amateur photography workshops, and special events (for example, BioBlitz).
- Other – any activity not mentioned above.

For Great Swamp NWR, these activities typically include public access at night or into the Management (restricted) Area for an approved event or project, access for right-of-way maintenance, and police and fire training in government structures

Approved Evaluations of Appropriateness and Compatibility Determinations (see section 2.4.4) are required before SUPs can be issued under current FWS policy. Special conditions and restrictions are identified for each permit awarded to ensure safety, prevent conflicts with other uses, and minimize disturbance to wildlife and habitats. Specified SUP periods typically range from one day to one year, depending on the nature of the request.

More than 130 permits have been issued at Great Swamp NWR since 2001 and the number of SUPs has generally increased each year. Approximately 11 permits were issued in 2006; 23 in 2007; 24 in 2008; 26 in 2009; and 30 in 2010.

2.5 Soils, Vegetation, and Habitat Types

2.5.1 Soils

Great Swamp NWR lies at the bottom of former glacial Lake Passaic. Terraces of sand and silt were deposited by Great Brook, Loantaka Brook and the Passaic River. The wetland complexes of Great Swamp NWR typically include several feet of peat, alluvial sand and silt, which are underlain by tens to hundreds of feet of accumulated glacial clay and silt. In some places, the clay and silt is underlain by sand and gravel, which was deposited during both the Illinoisan and late Wisconsin glaciations (Stanford 2007). According to the Soil Survey Geographic (SSURGO) Database for Morris County, Great Swamp NWR is comprised of 28 soil units of 16 soil series (refer to table 2-15, Soil Types of Great Swamp NWR and figure 2-3).

TABLE 2-15: SOIL TYPES OF GREAT SWAMP NWR[1]

Soil Symbol	Soil Name	Description	Acreage[2]
AdrAt	Adrian muck (0-3% slopes, frequently flooded)	Nearly level, very poorly drained organic soils underlain by sandy deposits at a depth of 16-50 inches, which has a permanent high water table and is ponded or flooded in winter and spring.	220.79

TABLE 2-15: SOIL TYPES OF GREAT SWAMP NWR[1]			
Soil Symbol	Soil Name	Description	Acreage[2]
BhdAt	Biddeford silt loam (0-2% slopes, frequently flooded)	Nearly level, deep, very poorly drained soils in depressions, along streams, and in old meander scars on the flat, nearly level bottom of the former glacial Lake Passaic basin. Soils formed in stratified, glacial lacustrine deposits and have a thin mantle of silty and mucky sediment washed from surrounding soil. Very frequently ponded, susceptible to flooding, and slow permeability.	998.55
BohC	Boonton moderately well drained gravelly loam (8-15% slopes)	Gently to strongly sloping, well drained and moderately well drained soils on hills and within the margins of the former glacial Lake Passaic basin. Heavy fine sandy loam and gravelly loam with coarse fragments of stone, cobble and gravel. Soils formed in stony glacial till that overlies fractured basalt or red shale and sandstone bedrock.	6.71
CarAt	Carlisle muck (0-2% slopes, frequently flooded)	Deep, nearly level, very poorly drained organic soils in depressions that were formerly or are now partly occupied by lakes or ponds. Upper 18 inches contains black, highly decomposed muck underlain by about 60 inches of very dark grayish-brown, decomposed muck that contains many fibers and pieces of wood.	2,071.82
EkhhB	Ellington loamy substratum variant fine sandy loam (3-8% slopes)	Gently sloping to steep, moderately well drained and somewhat poorly drained soils formed in somewhat gravelly material that was derived from shale, siltstone, and sandstone, and smaller amount of other material such as granitic gneiss. Fine sandy loam soils underlain by finer textured residual material weathered from trap and or shale bedrock. Soils on sides of Watchung ridges within basins formerly occupied by glacial Lake Passaic.	125.43
EkhhC	Ellington loamy substratum variant fine sandy loam (8-15% slopes)		61.44
EkhhD	Ellington loamy substratum variant fine sandy loam (15-25% slopes)		12.01
MknA	Minoa silt loam (0-3% slopes)	Deep, nearly level to gently sloping, somewhat poorly drained silt and fine sandy soils on slightly elevated areas within and at the margins of former glacial Lake Passaic. Areas are recessional beaches or terraces formed by wave action or currents working on older lake sediment, formed in lacustrine sediment.	24.19
MknB	Minoa silt loam (3-8% slopes)		108.27
NekB	Neshaminy gravelly silt loam (3-8% slopes)	Deep, gently sloping to steep, well-drained gravelly and stony soils on hills south of the terminal moraine of the Wisconsin glaciation. Soils formed in material weathered from the underlying basalt bedrock.	68.14
NekC	Neshaminy gravelly silt loam (8-15% slopes)		12.66

TABLE 2-15: SOIL TYPES OF GREAT SWAMP NWR[1]			
Soil Symbol	Soil Name	Description	Acreage[2]
		Coarse fragments generally increase with depth, and in places, generally contain few cobbles, stones and boulders.	
PHG	Pits, sand and gravel	Open excavations and adjoining areas of fill material removed during mining of sand, gravel, and burrow material, generally 6-20 feet deep with steep to vertical sides. Common in glacial outwash and glacial till areas.	5.08
PafAt	Palms muck (0-2% slopes, frequently flooded)	Very deep, very poorly drained soils formed in herbaceous organic material underlain by loamy deposits on closed depressions on moraines, lake plains, till plains, outwash plains and hillside seep areas, and on backswamps of flood plains.	207.29
PbpAt	Parsippany silt loam (0-3% slopes, frequently flooded)	Deep, nearly level, poorly drained soils that have a moderately fine textured subsoil. The water table is at or near the surface during much of winter, early in spring and after heavy rains. These soils typically occur on the nearly level bottom of the formerly glacial Lake Passaic basin and formed in stratified sediment of lacustrine origin, derived mostly from red and brown shale, basalt, and granitic rock. Coarse fragments are very rare or absent. In PbphAt, a thin substratum of fine sandy loam is present within 40 inches of the surface and is dominantly fine sandy loam or silt loam below a depth of 40 inches.	707.59
PbphAt	Parsippany silt loam, sandy loam substratum (0-3% slopes, frequently flooded)		2,283.94
PbtAt*	Parsippany very poorly drained variant silt loam (0-2% slopes, frequently flooded)	Deep, very poorly drained silt loam and silty clay loam soils on low-lying flats and in depressions in the former glacial Lake Passaic that formed in glacial lake sediment derived mainly from red shale, granite gneiss, and basalt. These areas are subject to frequent flooding and often contain scattered areas of black organic matter on the surface and small areas where water is ponded most of the year.	1.54
PeoB	Penn channery silt loam (3-8% slopes)	Moderately deep, gently sloping to steep, well-drained shaly silt loam soils on hillsides within the Passaic basin. Soils are subject to erosion and have poor stability and compaction characteristics due to high content of silt.	35.02
PeoC	Penn channery silt loam (8-15% slopes)		21.89
PohB	Pompton sandy loam (3-8% slopes)	Deep, nearly level to gently sloping, somewhat poorly drained sandy loam soils in wide, nearly level swales on terraces and on broad, low outwash plains that formed in sandy and gravelly glacial outwash derived mainly from granitic material and in places from red	636.55

TABLE 2-15: SOIL TYPES OF GREAT SWAMP NWR[1]			
Soil Symbol	Soil Name	Description	Acreage[2]
		and brown shale and traprock, and a small amount of other kinds of material, such as quartzite, sandstone, and conglomerate. These soils are underlain by stratified, water-sorted sand and gravel.	
PrkAt	Preakness sandy loam (0-3% slopes, frequently flooded)	Deep, nearly level, poorly drained sandy loam soils on broad outwash plains in the former glacial Lake Passaic basin, subject to annual floods in spring and low-frequency floods in summer. Soils are generally granitic material, with smaller amounts of quartzite, sandstone and shale. The water table is at or near the surface late fall, winter and spring, with many ponded areas in winter.	457.44
PrsdAt	Preakness dark surface variant sandy loam (0-3% slopes, frequently flooded)	Deep, nearly level, very poorly drained, moderately coarse textured soils generally located in small isolated kettles or other undrained depressions on terraces and pitted outwash plains. They occur in sandy and swampy areas in the Great Swamp region, with the water table at or near the surface most of the year, and are formed in stratified and sorted glacial outwash. These soils are underlain by stratified sandy and gravelly material.	158.66
RerB	Reaville deep variant channery silt loam (0-6% slopes)	Deep, nearly level to gently sloping, moderately well drained and somewhat poorly drained shaly soils in waterways, on gently sloping hillsides, and in seep spots at the base of steeper slopes. These soils formed in material weathered from the underlying shale bedrock or in local alluvium of similar material that washed from the surrounding slopes. Shale fragments occur throughout the profile and increase in size and number with increasing depth.	118.75
RksB	Riverhead gravelly sandy loam (3-8% slopes)	Well drained, nearly level to strongly sloping gravelly sandy loam soils on undulating outwash terraces and plains, as well as small isolated moraines. These soils formed in sandy and gravelly outwash derived mainly from granitic material that contains small amount of shale, sandstone, quartzite, and conglomerate.	106.50
RksC	Riverhead gravelly sandy loam (8-15% slopes)		35.68
UdrB	Udorthents, refuse substratum (0-8% slopes)	Deep, somewhat poorly drained, moderately well drained, and well drained loamy soils on flood plains that formed in sediment derived mainly from glacial till, granite gneiss, and limestone, which washed from nearby uplands.	2.19
UR	Urban land	This unit is characterized by areas that have been cut or filled as a result of development and covered	4.92

TABLE 2-15: SOIL TYPES OF GREAT SWAMP NWR[1]			
Soil Symbol	Soil Name	Description	Acreage[2]
		with an impervious surface, such as buildings or pavement. The original soil profile is not distinguishable.	
USRHVB	Urban land-Riverhead complex (3-8% slopes)	This complex consists of well-drained, nearly level to strongly sloping sandy and gravelly soils on undulating outwash terraces and plains in valleys that are underlain by loose, unweathered, stratified and sorted sand and gravel outwash, mostly of granitic material that contains some shale, sandstone, quartzite, and conglomerate. Approximately 55 percent of this complex has been disturbed by man to the extent that the original profiles no longer remains and 35 percent Riverhead soils.	188.25
WATER	Water	Areas mapped as water.	23.27
WhpA	Whippany silt loam (0-3% slopes)	Deep, nearly level to gently sloping, somewhat poorly drained silt loam soils on broad flats and slight rises in former glacial Lake Passaic that formed in glacial lake sediment derived mainly from red shale, granitic gneiss, and basalt. In WhphA and WhphB, a thin stratum of sandy loam is present within 40 inches of the surface and is dominantly sandy loam or silt loam Below a depth of 40 inches.	156.00
WhpB	Whippany silt loam (3-8% slopes)		69.05
WhphA	Whippany silt loam, sandy loam substratum (0-3% slopes)		221.56
WhphB	Whippany silt loam, sandy loam substratum (3-8% slopes)		144.78
WkkAt	Willette muck (0-2% slopes, frequently flooded)	Nearly level to gently sloping, very deep, very poorly drained soils organic soils formed in organic material 16 to 51 inches deep overlying clayey deposits on lake plains, ground moraines, and end moraines.	133.22
		TOTAL	9,429.18

Notes:
[1] –SSURGO Database for Morris County, USDA, Natural Resource Conservation Service, Fort Worth, Texas, December 2004.
[2] - Acreages include all lands within the approved acquisition refuge boundary.

2.5.2 Vegetation and Habitat Types

The Refuge System adopted the National Vegetation Classification System (NVCS) developed by The Nature Conservancy and the Natural Heritage Network as its standard system for classifying vegetation communities.

In September of 2008, NatureServ produced the *Vegetation Classification and Mapping of Great Swamp National Wildlife Refuge.* Vegetation mapping of the refuge was undertaken in conjunction with a vegetation mapping project at the Morristown National Historical Park. NatureServ utilized vegetation mapping protocols and standards originally established by the USGS – National Park Service Vegetation

Mapping Program. NatureServ worked with refuge staff to develop an initial vegetation classification for the refuge based on the NVCS and the New Jersey Natural Heritage Program's state types (Breden 1989). In the summers of 2002 and 2003, 55 vegetation plots were sampled to cover the observed range of variation in the vegetation (Sneddon 2008). Based on the 2008 study, 25 Associations were identified at Great Swamp NWR; these Associations are listed along with key species in table 2-16. These combined habitat types are used in the development of habitat objectives in chapter 3.

To facilitate management strategies developed under the CCP, the diverse vegetation categories developed in the 2008 study were incorporated into the 13 broader habitat management/land use-land cover categories listed below. These categories take into account both vegetation types and land use management practices, and were used to develop the alternatives mapping. Table 2-16 represents a crosswalk illustrating how the vegetation types were grouped for the purpose of developing the CCP. In some cases, vegetation communities may fall under more than one of the management category. For example, areas defined as "cattail marsh" fall under the categories "non-forested wetland" and "impoundments" in the CCP mapping.

The General land cover types at Great Swamp NWR include the following types.

Habitat Types

Bottomland Forest

Great Swamp NWR contains approximately 5,028 acres of forested bottomlands that includes floodplains and riparian habitats, including approximately 35 acres of woodland vernal pool habitat. This vegetation cover type is the most dominant on the refuge. Dominant tree types of most of these forests include green ash, red maple, pin oak, and some swamp white oak. This forest type also contains inclusions of mesic forest dominated by white oak, red oak and American beech.

These habitats contain a variety of high priority bird species in BCR 28 and 29, presence of federally listed species (i.e., Indiana bat), and several State-listed species (i.e., barred owl, blue-spotted salamander, and red-shouldered hawk). Bottomland forests are of particular importance to fall migrating songbirds and raptors. Impacts include invasive species, especially Japanese stiltgrass (*Microstegium vimineum*); increased flow and sedimentation from upstream development; altered hydrology due to historic trenching, ditching, and channelization; impaired water quality (i.e., non-point pollution); forest succession and browsing pressure or overgrazing by white-tailed deer (impediment to regeneration); and parasites, disease, and infestation (i.e., gypsy moth, chestnut blight, Dutch elm disease).

Upland Forest

Great Swamp NWR contains approximately 288 acres of upland forest. Upland forest areas are primarily mapped as small inclusions within the bottomland forests of the Wilderness Area in the easternmost portion of the refuge. The NaturServ study primarily identifies these forests as Coastal Plain beech-chestnut oak forest. A number of high priority bird species in BCR 28 and 29, such as wood thrush, several migrating wood warbler species and various neotropical migrants utilize the refuge's upland forests. Refuge upland forests are important for fall migrating raptors, as well as the barred owl. The refuge upland forests require less management and/or limited management capability due to legal constraints within the Wilderness Area. Invasive species are among the greatest threat; particularly Japanese barberry (*Berberis thunbergii*),

garlic mustard (*Alliaria petiolata*), tree-of-heaven (*Ailanthus altissima*), multiflora rose (*Rosa multiflora*), Russian olive, Japanese wisteria, and Japanese honeysuckle (*Lonicera japonica*). These species thrive along forest edges and are spread from surrounding residential encroachment. Forest succession and browsing pressure or overgrazing by white-tailed deer (impediment to regeneration) are also threats to this habitat type. Other threats include parasites, disease, and infestations (i.e., gypsy moth, chestnut blight, Dutch elm disease).

Non-Forested Wetlands

Great Swamp NWR contains approximately 692 acres of non-forested emergent wetland habitat. Much of this habitat is identified under the NVCS classification as eastern cattail marsh (see table 2-16). Other marsh areas are dominated by forbs, such as pickerelweed and broadleaf arrowhead, while other areas are dominated by tussock sedge and other *Carex* sedges. Portions of the communities within this general habitat type contain federally listed species (i.e., bog turtle) and support several State-listed species (i.e., wood turtle, American bittern, and Northern harrier). Some of these habits are managed or planned to be managed as habitat restoration for bog turtle. Open marshes and adjacent waters are of high importance to fall migrating waterfowl (average peak fall population = 10,000 waterfowl individuals), including highest priority species in BCR 28 and 29. Threats to these communities include invasive species, particularly purple loosestrife and common reed; increased flow and sedimentation from upstream development; impaired water quality (i.e., non-point pollution); altered hydrology due to historic ditching and channeling; and forest succession. This category contains Floodplain Pool (see table 2-16), identified by NatureServ as a Globally Rare (G2) community (Sneddon 2008). The CCP mapping identifies approximately 0.17 acres of *open water* within a non-forested wetland of the wilderness area (see alternative A, Map 3-1).

Impoundments

Great Swamp NWR contains five artificial impoundments that comprise approximately 479 acres of open water, emergent forb and cattail marsh, and scrub-shrub wetland components. Through the mid-1900s, the hydrology of Great Swamp NWR was historically disturbed by repeated attempts of draining and ditching for farming activities and stream alterations for flood and mosquito control purposes. In the 1960s, refuge staff began plugging the previously constructed drainage ditches and creating short dikes with small water control structures in attempt to restore more than 1,000 acres of previously drained wetlands. Five major impoundments were constructed in the 1970s and early 1980s in order to provide wildlife habitat and influence plant composition and abundance. This resulted in an increase in use by many wetland-dependent wildlife species (USFWS 1987a). Chapter 3, objective 1.2 provides additional information on refuge impoundments and their current management.

Pool 1 consists of approximately 116 acres and receives water from Great Brook, Middle Brook, and direct precipitation. This pool contains primarily herbaceous species with some open water and buttonbush stands. The dominant vegetation in Pool 1 is cattail (*Typha* spp.), burreed (*Sparganium* spp.), mild water pepper (*Polygonum hydropiperoides*), wool grass (*Scirpus cyperinus*), buttonbush (*Cephalanthus occidentalis*), bulrush (*Scirpus* spp.), and willow (*Salix* spp.). The purpose of Pool 1 is to provide waterfowl roosting, brooding, feeding, resting, and loafing habitat during migration (USFWS 1987; USFWS 2003b).

Pool 2 consists of approximately 295 acres and receives water from Primrose Brook, Great Brook, and precipitation (USFWS 2003b). This pool contains persistent herbaceous vegetation, as well as a high diversity of red maple swamp and flooded timber (USFWS 1987). The dominant plants are cattail, swamp

rose mallow (*Hibiscus palustris*), burreed, wool grass, smartweeds (*Polygonum* spp.), pickerelweed, common reed grass, willows, and some live and standing dead timber in the northwest section of the impoundment (USFWS 2003b). The purpose of Pool 2 is to provide habitat for wildlife, particularly passerines and waterbirds, as well as roosting and feeding habitat for waterfowl during migration (USFWS 1987; USFWS 2003b).

Pools 3A and 3B encompasses approximately 55 and 88 acres, respectively, and are naturally occurring marshes with a mixture of herbaceous vegetation. Pool 3A is dominated by burreed, cattail, wool grass, buttonbush, and various other shrubs. Pool 3A receives water from Pool 2 via a feeder ditch Water Control Structure (WCS) #23, Pool 3B via WCS #34, and precipitation (USFWS 2003b). The pool was managed as a green timber impoundment favoring mast production of oaks (USFWS 1987). Pool 3B receives water from Pool 3A through WCS #34, Middle Brook via WCS #35, and precipitation. The pool is characterized by stands of cattail, buttonbush, and various other shrubs, ash, willow, red maple, pin oak (*Quercus palustris),* bulrush, swamp rose mallow, burreed, tussock sedge (*Carex* spp.), arrow arum, purple loosestrife, and common reed grass. The purpose of Pools 3A and 3B is to provide feeding and roosting habitat for waterfowl during migration (USFWS 2003b). The pools are frequently used by migratory waterfowl, herons, bitterns, rails and marsh wrens (USFWS 1987).

USFWS

Middle Brook Pool is approximately 17 acres in size and receives water from Pool 1 through WCS #5, and a 100-foot emergency spillway between Pool 1 and Middle Brook, and some small ponds, during times of flooding (USFWS 2003b). The upper reaches of the pool are dominated by tussock sedge. During a draw down, the lower portions of the pool are dominated by smartweeds, millets, sedges, burreed, wool grass, cattail, and swamp rose mallow (USFWS 2003b). Middle Brook Pool is used by nesting waterfowl and as a loafing area for Canada geese (USFWS 1987). The purpose of this pool is to provide feeding and roosting habitat for migratory waterfowl (USFWS 2003b).

In addition to the five major impoundments, a small 4-acre impoundment was constructed near the refuge headquarters to serve as an observation pond for visitors. This pond is particularly popular with visitors in the season following a mechanical set back of plant succession and is often considered a “must stop” for birders (Byland 2001). Early in the season the water is held at a depth of 4 to 6 inches to attract early waterfowl migrants. Every few years, the impoundment is drawn down completely after the shorebirds have left and the soils are disked to set back perennial plants. Water is pumped back into the impoundment a few weeks later to create a moist soil condition. The most common plants observed in the impoundment include sedges, pondweeds (*Potamogeton* spp.), blunt spikerush (*Eleocharis obtusa*), common water plantain (*Altisma plantago-aquatica*), and seedbox (*Ludwigia alternifolia*) (USFWS 2003b). Although much smaller than the impoundments, this pool attracts a variety of shorebirds in numbers that compare to or occasionally exceed the larger impoundments (Byland 2001).

Grassland/Grassland Management

Great Swamp NWR contains approximately 793 acres of maintained open habitats dominated by herbaceous species. Most of these grassland habitats are identified as "successional wet meadow" in the 2008 NaturServ Report. These areas are periodically mowed to suppress woody vegetation growth. Some of the grassland areas are fragmented by narrow hedgerows of trees and woody vegetation. Larger patches of grasslands are utilized by low densities of regionally prioritized bird species, such as bobolink, Northern harrier, and Eastern meadowlark. Larger grassland habitats are also used for interpretive programs, including bluebird box programs run by the Friends of Great Swamp. Chapter 3, objective 2.1 describes the current management practices of grasslands.

In addition, approximately 20 acres of grasslands are designated as administrative grassland have management constraints due to the presence of historic landfills or dump sites and must be maintained as open fields. All of these historic landfills or dump sites have been remediated, are considered "stable" due to depth of contamination, or are in some stage of remedial action or investigation. These sites will continue to be maintained and monitored in the future in accordance with O&M Plans.

Brushland Management

Great Swamp NWR contains approximately 314.5 acres of successional field habitat containing a mix of woody and herbaceous species. The 2008 NaturServ study identified these areas primarily as "Successional Wet Meadow" (see table 2-16). These brushland management areas may contain nesting woodcock, State-listed species such as wood turtle, and support regionally prioritized shrub –nesting species such as blue-winged warbler. Threats to the refuge's successional habitats include invasive species, particularly multiflora rose (*Rosa multiflora*); forest succession; altered hydrology due to historic trenching, ditching and channelization.

Scrub-Shrub Wetlands

These areas include 58.0 acres of naturally occurring shrub swamps dominated by species such as buttonbush, shadbush, swamp rose and dogwoods (see table 2-16). These habitats are scattered throughout the Wilderness Area and to a lesser extent, portions of the Management Area east of Pleasant Plains Road. These habitats may contain standing water. These habitats support priority bird species in BCR 28 and 29, such as American woodcock, blue-winged warbler and willow flycatcher.

Other Land cover types

Administrative

This land cover type includes the two primary administrative facilities comprising approximately 7.8 acres at the refuge: the Headquarters Building and the Visitor Center. The mapping cover includes the buildings, associated lots and surrounding manicured areas that may include components of cool season grasses, hedgerows and shrubs.

Transportation/Utilities

This land cover designation refers to approximately 73 acres of management roads which are currently restricted from public access and utility rights-of-way for power and gas lines. Utility rights of way are generally kept open for maintenance purposes but may contain a variety of sensitive habitats including scrub-shrub and non-forested wetland habitats that support regionally prioritized or threatened and endangered species.

Residences

There are multiple residences on the refuge that are utilized by single families and refuge staff. These areas comprise approximately 27.5 acres of land cover on the refuge. This land cover type includes the structure itself and associated lawns and manicured areas.

Refuge management is most often focused on restoring, managing, or maintaining habitats or certain habitat conditions to benefit a suite of focal species or a suite of plants and animals associated with a particular habitat. The high and moderate priority habitats of Great Swamp NWR were identified based on information compiled (e.g., site capability, historic condition, current vegetation, conservation needs of wildlife associates). As part of this process, any limiting factors that affect the refuge's ability to maintain these habitats were also identified. Since all management activities cannot feasibly be undertaken at the same time, habitats were prioritized based on the following ranking factors:

- Where management actions would provide the greatest conservation benefit to identified priority species;
- Current habitat conditions and the urgency of needs for active management, and
- Landscape level rankings for particular habitats.

Although a habitat may be ranked as a "moderate" priority, this should not be interpreted as meaning that the habitat type does not provide valuable habitat to a variety of species or contribute to the overall biological diversity, integrity, and environmental health of the refuge. In some cases, habitats may not require active management by the refuge, or may represent an area where little management capability is available.

TABLE 2-16: CCP HABITAT TYPES AND NVCS VEGETATION COMMUNITIES

Habitat	NVCS Community identified in NaturServ Report (Sneddon 2008)	Dominant Vegetation
Non-Forested Wetlands	Floodplain Pool	*Peltandra virginica, Dulichium arundinaceum, and Polygonum spp.*
	River Bulrush Marsh*	*Schoenoplectus fluviatilis, Peltandra virginica, Hibiscus spp.*
	Eastern Cattail Marsh	*Typha angustifolia, Typha latifolia, Boehmeria cylindrica, Mikania scandens, Peltandra virginica*

TABLE 2-16: CCP HABITAT TYPES AND NVCS VEGETATION COMMUNITIES		
Habitat	NVCS Community identified in NaturServ Report (Sneddon 2008)	Dominant Vegetation
	Leafy Forb Marsh	*Pontederia cordata, Sagittaria latifolia, Peltandra virginica, Polygonum robustius*
	Eastern Reed Canary Marsh	*Phalaris arundinacea*
	Eastern Tussock Sedge Meadow	*Carex stricta, Boehmeria cylindrica*
	Waterlily Aquatic Wetland	*Nuphar lutea*
Grassland, Grassland Management, Administrative Grasslands	Successional Wet Meadow	*Carex stricta, Euthamia graminifolia, Phalaris arundinacea, Rubus allegheniensis, Spiraea tomentosa, Vernonia noveboracensis*
Brushland Management	Successional Wet Meadow	*Carex stricta, Euthamia graminifolia, Phalaris arundinacea, Rubus allegheniensis, Spiraea tomentosa, Vernonia noveboracensis*
Scrub-Shrub Wetlands	Buttonbush Shrub Swamp	*Cephalanthus occidentalis, Bidens discoidea, Carex comosa, Carex stricta,*
	Blueberry Wetland Thicket*	*Vaccinium corymbosum Clethra alnifolia, Rhododendron viscosum, Carex stricta, Impatiens capensis, Osmunda cinnamomea*
	Successional Shrub Swamp	*Rosa palustris, Cornus amomum, Carex stricta, Typha latifolia, Cornus sericea*
Upland Forest	Coastal Plain Beech–Chestnut Oak Forest	*Prunus serotina, Liriodendron tulipifera, Acer rubrum, Fraxinus americana, Fagus grandifolia, Kalmia latifolia, Quercus prinus*
Impoundments	Isolated Basins NVCS Components of Non-Forested Wetlands and Scrub-Shrub Wetlands	*Spiraea tomentosa, Vaccinium corymbosum, Carex stricta, Phalaris arundinacea, Nuphar lutea* ssp., *Spiraea tomentosa, Vaccinium corymbosum, Carex stricta, Phalaris arundinacea,*

TABLE 2-16: CCP HABITAT TYPES AND NVCS VEGETATION COMMUNITIES		
Habitat	NVCS Community identified in NaturServ Report (Sneddon 2008)	Dominant Vegetation
		Nuphar lutea ssp. *Advena Spiraea tomentosa, Vaccinium corymbosum, Carex stricta, Phalaris arundinacea, Nuphar lutea* ssp.
Bottomland Forest	Beech-Red Maple Subhydric Forest	*Acer rubrum, Fagus grandifolia, Liquidambar styraciflua, Vaccinium corymbosum*
	Red maple –Lizard's Tail Forest	*Acer rubrum, Fraxinus pennsylvanica, Saururus cernuus*
	Red Maple-Black Gum Swamp	*Acer rubrum, Clethra alnifolia, Nyssa sylvatica, Viburnum dentatum*
	Beech-Red Maple Subhydric Forest	*Acer rubrum, Fagus grandifolia, Liquidambar styraciflua, Vaccinium corymbosum*
	Northeastern Modified Successional Forest	*Prunus serotina, Liriodendron tulipifera, Acer rubrum, Fraxinus americana*
	Pin Oak-Swamp White Oak Forest	*Quercus palustris, Quercus bicolor, Liquidambar styraciflua, Viburnum dentatum*
	Pin Oak Small River Floodplain	*Fraxinus pennsylvanica, Quercus palustris, Polygonum virginianum, Lindera benzoin*
	Red Maple Swamp Wooded Marsh, Red Maple Tussock Sedge Wooded Marsh	*Acer rubrum, Carex stricta, Clethra alnifolia, Saururus cernuus, Vaccinium corymbosum Fraxinus pennsylvanica,*
Bottomland Forest	Ash-Red Maple Impoundment	*Fraxinus americana, Acer rubrum, Vaccinium corymbosum*
	Woodland Vernal Pool	*Acer rubrum, Quercus alba (overhanging),Clethra alnifolia, Vaccinium corymbosum*
	Northeastern Modified Successional Forest	*Fagus grandifolia, Betula lenta, Carpinus caroliniana*

Altered Habitats

Prior to FWS ownership and management, the long history of ditching, draining and clearing of the western portion of the refuge has resulted in a variety of altered habitats with plant communities and land formations reflecting past disturbances. Subsequently, the FWS implemented various restoration efforts throughout the refuge, such as plugging ditches and creating approximately 500 acres of impoundments. The linear nature of many vegetation and topographical boundaries in the western portion of the refuge is indicative of historic land manipulation (Sneddon 2008). Aerial photographs of the eastern portion of the refuge (Wilderness Area) show less disturbed vegetation, hydrological and topographic conditions, and the gradients between these habitats and vegetation communities tend to be more subtle and non-linear.

Other altered habitats include areas that are kept in varying stages of vegetation succession by periodic mowing to increase the refuge's overall habitat and wildlife diversity. Fields that were managed for haying when in private ownership are now managed as early-successional wet meadows with shrub cover ranging from 6 to 60 percent, depending on mowing frequency (Sneddon 2008). Areas such as modified successional forest, successional wet meadow and successional shrub swamp are additional altered communities that have historically experienced vegetation clearing.

2.5.3 Rare Plants and Exemplary Natural Communities

A review of the NJDEP's Natural Heritage Program (NHP) database did not indicate the presence of any State or globally rare plant communities on the refuge; however, the 2008 NatureServ study revealed the presence of one rare vegetation association, known as Floodplain Pool (Sneddon 2008). The Floodplain Pool Association is described as an herbaceous community that may form a continuous bed along the side of slowly flowing water in larger streams, or be characteristic of smaller channels within the floodplain of the larger streams. This association is identified as globally imperiled. According to the NatureServ report, the rank of the Floodplain Pool also indicates there are likely to be fewer than 20 viable examples globally. The global rank of this community is still not fully confirmed as additional data is needed to rank the association with greater confidence. Sneddon (2008) identified this habitat in 13 polygons comprising approximately 31 acres on the refuge. The Floodplain Pool Association is mapped along portions of the Passaic River, Black Brook and Great Brook.

Many other refuge associations have not yet been globally ranked due to an overall lack of data on the particular association. Other habitats, including vernal pools and spring fed emergent wetlands, are not known to support rare plants or plant communities at the refuge, but are still important due to their ability to support State or federally listed threatened and endangered wildlife species.

The NHP database revealed three historic records of rare wetland plants on or immediately adjacent to the refuge. These species include the featherfoil (*Hottonia inflate;* G4/S1; recorded 1947 & 2009), water-plantain spearwort (*Ranunculus ambigens;* G4/S2; recorded 1936) and black-girdle woolgrass (*Scirpus atrocinctus;* G5/S1*;* recorded 1951). No other rare plants were recorded on or adjacent to the refuge in the database.

Two field vegetation surveys were conducted by Bowman's Hill Wildflower Preserve in 2008, which revealed the presence of water horehound (*Lycopus americanus* var. *longii*), a State-ranked imperiled or vulnerable plant (S2/S3). The first survey area was located adjacent to the Great Swamp NWR Visitor's

Center on Pleasant Plains Road and situated along the Passaic River. This survey area included riparian woodlands and a vernal pool. Eighty-six plants, 87 percent of which are native to New Jersey, were identified during the survey (Bowman's Hill Wildflower Preserve 2008a). The second survey area was located adjacent to Great Swamp NWR Visitor's Center and situated between Pleasant Plains Road and the Passaic River. This survey area consisted of "damp sedgy field… that has been used for grazing sheep and, more recently horses" (Bowman's Hill Wildflower Preserve 2008b). Collectively, 131 plants, 58 percent of which are native to New Jersey, were identified during the survey (Bowman's Hill Wildflower Preserve 2008b).

2.5.4 Invasive Plant Species

Executive Order 13112 (see section 2.1.5, Invasive Species, Pests and Diseases) requires the National Invasive Species Council (Council) to produce a National Invasive Species Management Plan (Plan) every two years. In January 2001, the Council released the first Plan, which serves as a blueprint for all Federal action on invasive species. Collaboration between the Council and the *Fulfilling the Promise* team, also known as the National Invasive Species Management Strategy Team, furthered the Plan to focus on invasive species control and management efforts in the Refuge System. This National Strategy, developed in 2003, provides precise guidance to regional and field offices, and identifies four primary goals, including 1) increase awareness; 2) reduce impacts to refuge habitats; 3) reduce impacts to neighboring lands; and 4) utilize and develop new integrated pest management approaches (USFWS 2003a). The Plan focuses on those non-native species that cause or may cause significant negative impacts and that do not provide an equivalent benefit to society. A major component of vegetation management within all Great Swamp NWR habitats involves the control of invasive plant species.

TABLE 2-17: COMMON INVASIVE PLANT SPECIES AT GREAT SWAMP NWR AND PAST CONTROL EFFORTS

Common Name	Scientific Name	Control Efforts By the Refuge
Autumn Olive	*Elaeagnus umbellata*	Cut stem application of herbicide application in select areas.
Russian Olive	*Elaeagnus angustifolia*	Cut stem application of herbicide application in select areas.
Japanese Barberry	*Berberis thunbergii*	Started treating herbicide in 2001, killed more than 70,000 plants.
Japanese Knotweed	*Polygonum cuspidatum*	Foliar treatment as well as "snip and drip" application of herbicide
Garlic Mustard	*Alliaria petiolata*	Will be receiving biological control from Cornell.
Multiflora Rose	*Rosa multiflora*	Cutting and herbicide spot treatment in select areas.
Common Reedgrass	*Phragmites australis*	Treatment with herbicide on more than 40 monoculture tracts over three years.

TABLE 2-17: COMMON INVASIVE PLANT SPECIES AT GREAT SWAMP NWR AND PAST CONTROL EFFORTS		
Common Name	Scientific Name	Control Efforts By the Refuge
Purple Loosestrife	*Lythrum salicaria*	Treatment with herbicide from 1985-1995. Beginning in 1995, ½-million Galerucella beetles released, resulting in significant reduction in *L. salicaria* by 2005.
Reed Canary Grass	*Phalaris arundinacea*	Herbicide spot treatment in select areas.
Japanese stiltgrass	*Microstegium vimineum*	Hand pulling by volunteers and some herbicide treatment in select areas.
Bradford pear	*Pyrus calleryana*	Removal of 3,000 trees. Deer killed off 50% of the root systems.
Asiatic Bittersweet	*Celastrus orbiculata*	Cutting and base application of herbicide in select areas.
Wineberry	*Rubus phoenicolasius*	No management to date.
Tree-of-Heaven	*Ailanthus altissima*	Some cutting.
Japanese wisteria	*Wisteria floribunda*	Cut stem
Chinese Lespedeza	*Lespedeza cuneata*	All areas found have been treated with herbicide and monitored regularly.
Long-bristled smartweed	*Polygonum caespitosum*	No management to date.
Mile-a-minute vine	*Polygonum perfoliatum*	Hand-pulling by staff and volunteers and release of weevils for biological control.
Japanese honeysuckle	*Lonicera japonica*	Cut stem application of herbicide in select areas.

The 2008 NatureServ report indicates differences in distribution, abundance and composition of invasive species between the western and eastern portions of the refuge. Pre-refuge land manipulation (i.e., ditching, draining, agriculture, and logging) and some refuge management activities within the western portion of the refuge have resulted in the establishment of several invasive species. The eastern portion of the refuge (Wilderness Area) has undergone less intensive land use manipulations and therefore contains fewer invasive species.

Some invasive species were historically planted as wildlife food plots on the refuge, including multiflora rose, crown vetch, Russian olive, and autumn olive. In addition, birdsfoot trefoil and crown vetch were planted in dikes and fields for soil erosion control and fertility (USFWS 1987).

Within the historically disturbed and successional forested areas, species such as garlic mustard, wineberry, Japanese honeysuckle, multiflora rose, tree-of-heaven, Japanese stiltgrass and long-bristled smartweed may be observed. Certain species, such as reed canary grass, purple loosestrife and common reed, are highly capable of creating monotypic cultures and are most common in heavily manipulated wetland areas and along utility rights-of-way.

The following list briefly describes the common invasive plants of Great Swamp NWR (table 2-17):

Autumn Olive (Europe and Asia) - Autumn olive is a dense shrub or small tree found in old fields, roadsides, pastures and open woodlands. The species may shade out native species and is a nitrogen fixer that may alter soil nitrogen cycling and consequently impact natural plant succession (Swearingen et al. 2002).

Japanese Barberry (Asia) - This thorny shrub is found in alluvial woods and open forest understory. Barberry can grow densely in the understory, reducing habitat quality for birds and other wildlife and displacing native forest understory species (Swearingen et al., 2002). It may also raise the pH of soils and reduce litter layers in forests (DCNR 2002).

Japanese Knotweed (eastern Asia) -This species is a large herbaceous perennial that reaches heights of over 12 feet. It is a highly adaptable species tolerant of extreme conditions, such as high heat or shade (Swearingen et al., 2002). It is found in disturbed areas, roadsides, floodplain forests, and often along streams and other waterbodies. The species forms monoculture stands that impact riparian habitat by reducing plant and wildlife diversity (Swearingen et al., 2002; Snyder and Kaufman 2004). It may also alter water flow along streams and contribute to flooding.

Garlic Mustard (Europe) - Garlic mustard occurs in moist woodlands, floodplains, along trails and forest edges. The species reduces native herbaceous diversity and lowers habitat quality. As with many other invasive plants, it can suppress growth of native seedlings through allopathic chemicals (Snyder and Kaufman, 2004). The species displaces many native spring wildflower species of woodland habitats. It is also avoided by white-tailed deer (Swearingen et al., 2002).

Multiflora Rose (Asia) - Multiflora rose is found in a variety of habitats, including forest edges and gaps, floodplains, utility rights-of-way, roadside edges and other disturbed areas, grasslands and open wetlands. This thorny shrub produces dense monocultures that are impenetrable to humans and wildlife. This species outcompetes native species and reduces overall native species diversity (Snyder and Kaufman, 2004).

Common Reed or Phragmites (Europe) – The range of Common reed is pan-global (USDA : however, European strains have replaced much of the native common reed in the United States (Swearingen et al., 2002). Phragmites inhabits a variety of brackish and freshwater marsh habitats, as well as riverbanks, ditches, and dredge spoil areas. Large marsh areas, such as areas around the Newark Basin (including the Meadowlands, Great Meadows, Troy Meadows, and Great Swamp) are subject to *Phragmites* monocultures that reduce native plant species diversity and wildlife use.

Purple Loosestrife (Eurasia) - Purple loosestrife is a perennial herb with woody stems that produces a large purplish showy spike. It occupies open habitats, including sedge meadows, cattail marshes, streamside areas, floodplains, bogs, ditches and other disturbed wetlands. It is an aggressive reproducer that grows in monotypic stands that can alter wetland hydrology, reduce native plant diversity, impact sensitive wildlife, and decline overall production of the wetland (Snyder and Kaufman 2004).

Reed Canary Grass is a large fast growing wetland grass that occurs throughout the temperate northern hemisphere. It is found in a variety of moist environments, including wet meadows, marshes, pastures and riparian habitats (DCNR 2002). Possibly native strains may have crossed with European and other exotic strains to produce a more robust genetically diverse and invasive strain. Reed canary grass creates a

dense monoculture that outcompetes and smothers native species and drastically drops wetland diversity (DCNR 2002).

Japanese Stiltgrass (Asia) – Japanese stiltgrass grows in a wide variety of habitats, including wetland floodplains, forested uplands, forested and open wetlands, roadside ditches and other disturbed areas. This species grows rapidly and often in large dense patches. As with many other invasive plants, it forms a monoculture that reduces overall diversity and plant production (Snyder and Kaufman 2004).

Bradford Pear (Asia) – Bradford pear, a 30 to 50 foot tree, is planted as an ornamental and is popular for its showy white spring flowers. Bradford pear has become invasive as new strains have naturalized in the northeast (Swearingen et al., 2002). The species displaces native vegetation in open areas and interrupts succession processes (Swearingen et al., 2002).

Asiatic Bittersweet (eastern Asia) – Asiatic bittersweet is aggressive vine inhabits forest edges, open woodlands, fields, hedgerows and other disturbed lands. Asiatic bittersweet grows over native vegetation and kills trees by shading, girdling and uprooting them (Swearingen et al., 2002).

Wineberry (Asia) - Wineberry is a shrubby vine that grows along forest habitats that include wooded ravines and floodplains, shale bluffs and successional fields. The species can grow in impenetrable thickets that threaten certain rare plant communities (Snyder and Kaufman 2004).

Tree-of-Heaven (central China) - Tree-of-heaven may be found in a variety of disturbed sites with rocky or poor soils, including vacant lots, forest edges, roadsides, and other disturbed areas. It also sometimes establishes itself in old growth forest gaps created by fallen trees. It may also occur on trap rock or basalt cliff faces, such as those found along the Northern Watchungs or Palisades. The species breeds rapidly and can through chemical means, suppress the growth of native species and interfere with natural forest succession (Snyder and Kaufman 2004).

Japanese Wisteria (Japan) - Japanese wisteria is a woody vine introduced to North America in the early 19th century as an ornamental. It primarily spreads by vegetative growth and is capable of growing to a height of 35 feet. Japanese wisteria impacts native forest by girdling and killing trees as it grows. This can ultimately change the structure of a forest by altering sunlight penetration to the forest floor (CISEH 2010).

Chinese Lespedeza or Chinese Bush-Clover (eastern Asia) - Bush-clover is an erect perennial legume that grows in dense stands. Chinese bush-clover tolerates varying soil conditions, including very nutrient poor soils. Habitats vary widely, including forest edges, fields, open woodlands and wetland edges (Snyder and Kaufman 2004).

Long-bristled Smartweed (Oriental Lady's Thumb) (Asia) - This smartweed is a small herbaceous plant reaching 30 inches (CISEH 2010). It grows in disturbed habitats, such as pastures, yards, meadows, rights-of-way, and roadsides. It is also found in forests and shaded areas. Its ability to tolerate extreme shaded areas and a range of pH make it potential problem in moist shaded habitats, such as damp forests (Mehrhoff et al., 2003).

Japanese Honeysuckle (Eurasia) – Japanese honeysuckle is an aggressive vine that grows in a variety of disturbed habitats, including forest understories, old fields, roadsides, thickets, fence rows and rocky bluffs.

The vines can grow dense mats that smother and collapse native plants and result in a loss of plant regeneration (Snyder and Kaufman 2004).

Mile-a-Minute Weed (Asia) - Mile-a-minute weed is spreading northward throughout New Jersey from the south. This vine invades open and disturbed areas including roadsides, forest edges, wetlands, and stream edges. It is a sprawling plant that grows rapidly overtop of native plants, shading from light exposure (Snyder and Kaufman 2004).

2.6 Wildlife Resources

2.6.1 Federally Listed Threatened and Endangered Species

There are currently two federally listed species that have established populations at Great Swamp NWR, the federally listed threatened bog turtle and the federally listed endangered Indiana bat. Both of these species utilize specific habitats at Great Swamp NWR. The bog turtle is a year-round resident that utilizes certain open wetlands at the refuge. Reproductively active female and juvenile Indiana bats were first identified on the refuge in 2005. The Indiana bat uses refuge swamp forests and riparian corridors for maternal roosts and as foraging habitat during warmer months. Both of these species have been studied extensively on the refuge and are given primary consideration in the CCP and in wildlife management decisions. Summaries of the FWS recovery plans for these species are included in chapter 1 of the CCP.

Bog Turtle

The Northern population of the bog turtle is a federally listed threatened species and listed as Endangered in the State of New Jersey. The New Jersey NHP's ranking system identifies the bog turtle as G3 (globally, either very rare and local throughout its range or found locally in restricted range or because of other factors making it vulnerable to extinction throughout its range) and S1 (critically imperiled in New Jersey because of extreme rarity; Natural Heritage Program 2008).

The NJWAP lists the species as a high priority with a goal to increase and stabilize the population in the Piedmont Region of New Jersey. Protection of this species' habitat would benefit other key refuge resources of concern, such as spotted turtle (*Clemmys guttata*), American woodcock (*Scolopax minor*), and various passerines, including but not limited to, common yellowthroat (*Geothlypis trichas*), golden-winged warbler (*Vermivora chrysoptera*), song sparrow (*Melospiza melodia*), swamp sparrow (*Melospiza georgiana*), and blue-winged warbler (*Vermivora pinus*).

Among the contributing factors to the decline of bog turtles is habitat destruction due to development; illegal collection; wetland ditching, flooding and filling; water quality degradation; and forest succession or invasive species encroachment (Beans and Niles 2003). Bog turtles require open wetlands, generally with a scrub-shrub component, with perennial groundwater seepage and typically several inches of mucky substrate (generally greater than 4"). Bog turtle populations inhabit areas on the refuge, which are locally uncommon and unique.

The bog turtle utilizes calcareous (limestone) fens, sphagnum bogs, and wet, grassy pastures and occasionally linear drainage ditches characterized by soft, muddy substrates and perennial groundwater seepage (Conant 1975; Behler and King 1979; Ernst et al., 1994). Habitats regularly utilized typically

contain water depths no greater than 4 inches (10 cm) above the substrates with some deeper portions. The bog turtle favors open areas for basking and nesting. Vegetation can include cattails (*Typha latifolia, T. angustifolia*), tussock sedge (*Carex stricta)*, other sedge species *(Carex* spp., *Cyperus* spp., *Dulichium* spp.), rushes (*Juncus* spp.), bulrushes (*Scirpus* spp.), spikerushes (*Eleocharis* spp.), spotted jewelweed (*Impatiens capensis*), red maple (*Acer rubrum*), alders (*Alnus* spp.), skunk cabbage (*Symplocarpus foetidus*), arrow-leaved tearthumb (*Polygonum sagittatum*), rice cut-grass (*Leersia oryzoides*), and other open canopy wetland species (Cromartie, et al. 1982). In addition to soft mucky substrates for burrowing and hibernation sites may have an interspersion of wet and dry areas, often with the presence of muskrat and meadow vole runways for travel corridors and cryptic basking sites (USFWS 1997d).

The diet of the bog turtle generally consists of insect larvae, crayfish, mollusks, worms, snails, slugs, seeds, berries, and shoots, as well as amphibians and carrion. Eggs are deposited on raised hummocks in open areas from mid-June to early July; incubation occurs for 48 to 58 days. Eggs and young bog turtles are highly susceptible to predation by a number of animals, including raccoons, opossums, foxes, mink, skunks, muskrats, shrews, large birds (i.e., egrets, herons, crows, birds of prey), bull frogs, snapping turtles, and water snakes (USFWS 2012i). Summer home ranges average about 3.2 acres (1.3 ha). Hibernation occurs within subterranean burrows (2 to 22 inches deep), where springs ensure that water flows through winter (Beans and Niles 2003).

In the early 1960s, Rutgers University researchers were the first to raise awareness about bog turtles being located in the newly established refuge. The refuge is one of three NWRs in the Northeast in which populations of the bog turtle are known to occur. Several sites on the refuge have either had recent or historic bog turtle activity (USFWS 2012j). In May 2004, active monitoring of the refuge's bog turtle populations began using methods such as radio-telemetry, mark recapture, and nest protection (Schmuck 2012). These studies provide important information on bog turtle habitat use, home-range size, and population density, as well as identifying new subpopulations on the refuge (USFWS 2012j).

Bog turtles were initially captured by visual surveys, which consisted of locating suitable habitat and looking for tracks, feeling along the base of mature tussock sedges, and probing muck sections with a walking stick or snake stick and listening for the distinctive tap that occurs when a turtle shell is struck. If a gravid female was located, she would be kept in a nest tub until she laid her eggs. A nest tub is an enclosed area, such as a buried Rubbermaid container, that mimics their habitat. Nests in a tub are protected from predators and the elements, such as excessive shade from thick vegetation growth or flooding. The hatchlings were then marked and released on site (Schmuck 2012).

When a turtle is captured, its location is recorded using a global positioning system (GPS) along with a description of the microhabitat, its age, gender, and whether or not a female was gravid. Measurements of the carapace and plastron, weight, maximum width, and maximum height are also recorded. If a turtle is fitted with a transmitter, an additional weight is taken of the turtle with the transmitter affixed. On average, the weight on the transmitter and adhesive is approximately six grams. All turtles that are captured are marked with notches on their marginal scutes, creating a unique permanent identifying code. The code for each individual turtle is recorded and a drawing of the marked carapace is recorded on the data sheet. Any distinguishing physical characteristics and behavior when captured are also recorded (Schmuck 2012).

Since May 2004, a total of 31 bog turtles have been captured at three sites on the refuge. Of these, 17 were captured during visual surveys, three in live catch box traps, two captured while copulating with a radio-tracked turtle, four captured in nest tubs as hatchlings, and five captured as hatchlings in nest cages after the nest was located by thread spooling, a technique used to locate a bog turtle nest of known gravid females. Of the bog turtles captured, two male and eight females were classified as breeding age, which is over the age of eight (Schmuck 2012).

Beginning in 2009, the refuge began monitoring nest sites to measure clutch size and nesting success at the refuge. In 2009, the refuge monitored two nests containing three eggs each, which had 33 percent and 100 percent nest success rates. Of the eggs that did not hatch, one egg was determined to be infertile and the second contained a developing embryo, which appeared to have drowned due the egg being located at the bottom of the nest. No nests were monitored in 2010. In 2011, the refuge monitored one nest containing five eggs; however, the nest failed due to flooding associated with Hurricane Irene. In 2012, the refuge monitored two nests, which contained three and five eggs each. The nest success rate was determined to be 100 percent and 40 percent, respectively, resulting in a total of five new hatchlings. The unhatched eggs were found to be infertile. All hatchlings were marked, measured, and released on site for future monitoring (Schmuck 2012).

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In addition to active monitoring, habitat management and restoration efforts also began in 2004. Informal habitat assessments indicated a considerable portion of historic bog turtle habitat has degraded in quality due to encroachment of invasive plants and natural succession of tussock sedge-dominated wetlands to red maple swamps. Limited habitat restoration activities were conducted in select areas to open the canopy by girdling trees, cutting pole-sized trees and applying glyphosate to the stump to prevent re-growth, or injecting imazapyr into trunks of larger diameter trees. Habitat management activities also included the control of invasive plant species, such as Japanese stilt grass and common reed grass (USFWS 2012j).

The refuge will continue to conduct habitat restoration activities while also documenting the effects of habitat restoration practices, including herbicide application, on the refuge's bog turtle population and its habitat (USFWS 2012j).

Indiana Bat

The Indiana bat, a State and federally listed endangered species, utilizes riparian corridors at Great Swamp NWR for foraging and warm season roosting.

In 1967, the FWS listed the Indiana bat as federally endangered due to significant population declines documented at their seven major hibernacula in the Midwest (Beans and Niles 2003). At the time of their listing, the Indiana bat population was approximately 883,300 (USFWS 2007). Surveys conducted in 2007

estimated the range wide population at approximately 468,184. Winter surveys conducted in 2007 at known Priority 1 and 2 hibernacula sites in New Jersey estimated the population at 659 (USFWS 2008i). As of October 2006, the FWS had records of existing winter populations at approximately 281 hibernacula in 19 states and 269 maternity colonies in 16 states (USFWS 2007). In 1992, Indiana bats were found hibernating in three areas near Hibernia, New Jersey. Great Swamp NWR recently confirmed the occurrence of maternity colonies in 2005 and is the only known national wildlife refuge with Indiana bat maternity colonies.

Similar to the original recovery plan, the 2007 Revised Draft Indiana Bat Recovery Plan continues to emphasize protection of hibernacula, but also increases the focus on summer habitat and proposes use of four Recovery Units: Ozark-Central, Midwest, Appalachian Mountains, and Northeast. Great Swamp NWR is located within the Northeast Recovery Unit and within the Eastern Broadleaf Forest Ecoregion Division (USFWS 2007).

The primary goal of the recovery plan is to reclassify the Indiana bat to federally listed threatened, with an ultimate goal of removing the species from the Federal List of Threatened and Endangered Wildlife. The reclassification of the Indiana bat will be attained through the achievement of the following objectives: (1) permanent protection of 80 percent of Priority 1 hibernacula; (2) a minimum overall population number equal to the 2005 estimate (457,000); and (3) documentation of a positive population growth rate over five sequential survey periods. Similarly, delisting of the Indiana bat will be attained by addressing the following: (1) permanent protection of 50 percent of Priority 2 hibernacula, (2) a minimum overall population number equal to the 2005 estimate; and (3) continued documentation of a positive population growth rate over an additional five sequential survey periods (USFWS 2007).

A goal for increasing this population was also set for the Piedmont Region under the NJWAP. Great Swamp NWR is documented as having one or more maternal roost colonies for Indiana bat in New Jersey (Kitchell 2008). Maternal roosts are typically established in agricultural areas with fragmented forests. Roosting by Indiana bat occurs within the Management and Wilderness Areas of the refuge, where an interspersion of forests, shrubland, open water, and wet meadow exists (Kitchell 2008). Roost trees are found within a variety of forested habitats, including wetlands and riparian areas, and primarily include snags or nearly dead trees with peeling or exfoliating bark. Primary roost trees are of large diameter [greater than 22 inches diameter at breast height (dbh)] in open areas with high exposure to sunlight, while alternate roosts are generally smaller in diameter and located within the forest interior (Kitchell 2008). Foraging occurs primarily in and around forested habitats that include pole-stage mixed-oak forest, floodplain forest, upland forest, and forested wetlands (Butchkoski and Hassinger 2002; Gardner et al., 1991; Humphrey et al., 1977; Murray and Kurta 2004; Romme et al., 2002, Sparks et al., 2005). Pregnant or lactating bats forage primarily within wooded or riparian corridors, streams, associated floodplain forests and impounded bodies of water; however, they will sometimes use hedgerows, upland forest, early successional fields and along croplands (Kitchell 2008).

White-Nose Syndrome

As discussed in chapter 1, the first documented case of WNS was reported near Albany, New York in the winter of 2006 to 2007. WNS is characterized by the colonization of a psychrophilic, or “cold-loving,” fungus on the muzzle, ears, and flight membranes of hibernating bats (Blehert, et al., 2008); however, the presence of the fungus is typically only observable on approximately half of bats affected. The fungus has been identified as *Geomyces destructans.* Affected bats may exhibit low body weights and abnormal

behaviors, including early emergence from hibernation and movement to colder areas of caves. WNS quickly spread to hibernacula of several other New England states the following winter. In 2008-2009, the syndrome spread as far south as Virginia and included the states of New Jersey and Pennsylvania. Since it was first documented, WNS has been confirmed in 20 states and 4 Canadian providences (USFWS 2012d). WNS has been confirmed in states as far west as Oklahoma. More than 5.5 million hibernating bats have died since WNS was documented in 2006-2007 (USFWS 2012d). In some hibernacula (caves or mines where bats hibernate in winter), approximately 90 to 100 percent of bats are dying (USFWS 2010c). The majority of bats dying in the Northeast have been little brown bats; however, WNS has also affected tri-colored, Northern long-eared, big brown, Eastern small footed, and Indiana bats (USFWS 2010c).

In 2009, WNS was confirmed in five hibernacula in New Jersey, including Hibernia mine, both Mount Hope mines, and Upper and Lower Copper mines (NJDEP 2009a). Data suggests that at least some of the refuge's Indiana bats winter in Hibernia and Mount Hope mines (Kitchell 2011). A majority of the bats hibernating in Hibernia mine are little brown bats, with lesser amounts of Indiana bats and Northern long-eared bats (Valent 2011). Visual signs of the fungus and behavioral changes were observed in Hibernia mine in January 2009 and mortality was evident in March to April 2009 (Valent 2011). In February 2010, NJDFW estimated 93 percent mortality in Hibernia mine (Valent 2011). The presence of WNS in New Jersey has resulted in at least a 50 percent decline in *Myotis* species (Valent 2011). Data indicate substantial changes in the bat population and the proportion of maternal females (see chapter 1, section 1.4.14).

Pre- and Post-WNS Research: Population Trends

The refuge has accumulated six summers of intensive bat population and roosting ecology data. Mist-netting and banding of captured bats occurred from May 15 through August 15 from 2006 to 2010 and from June to August 2012. While previous years' netting targeted flight corridors expected to yield Indiana bats, netting in 2012 aimed to comprise foraging habitat of all native, cave-dwelling bats on the refuge and assess the impacts of WNS on species populations. These combined datasets may represent the richest pre- and post-WNS population monitoring database of any refuge in the Region (USFWS 2012g).

Prior to the discovery of WNS in New Jersey, research was conducted at the refuge during the summers of 2006 and 2007 to determine roost selection and landscape movements of Indiana bats (USFWS 2012g; M. Kitchell 2008). The primary goal of the study was to identify and characterize roosts selected by reproductively active female Indiana bats, although all bats captured during mist netting efforts were identified to species, examined to assess general health, and fitted with numbered aluminum bands. Research was continued for another three field seasons (from 2008 to 2010), collecting similar information, except that both sexes of Indiana bats were studied (USFWS 2012g; L. White, In Prep.). Thus, 3 years of data were collected on bats at the refuge prior to detection of WNS in the State.

During the first two years of the study (2006 to 2007), a total of 520 bats representing six species were captured, including Indiana bat, little brown bat, big brown bat, Northern long-eared bat, red bat, and tri-colored bat (USFWS 2012f). Twenty four female Indiana bats were radio-tracked to 74 roost sites, representing three colonies, and peak emergence counts of Indiana bats at four primary trees were 252, 164, 52, and 55 bats (M. Kitchell 2008). During the following three summers (2008 to 2010), a total of 680 bats representing seven species were captured, including the aforementioned species as well as hoary bat (*Lasiurus cinereus*) (USFWS 2012f; L. White, In Prep). However, the number of bats captured among the three years differed ($P < 0.05$). For example, in 2008, 276 bats (representing 40.6 percent of all captures from 2008 to 2010) were captured; in 2009, the number was 231 (34.0 percent of all captures); and in 2010, 173 bats (25.4 percent of all captures) were captured. Decreasing numbers of captures over the three-year period were attributed to the emergence of WNS in New Jersey (USFWS 2012f; L. White, In Prep.).

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No research was conducted in 2011. However, the 2012 bat inventory and monitoring effort at the refuge comprised mist netting at a level of effort comparable to previous years (2006 to 2010), radio-telemetry, and both mobile and stationary acoustic surveys. Nine mist net sites were sampled across the refuge, seven of which were netted historically. Demographic and morphometric data were gathered for all captured bats. A combination of swab sample collection and wing score indexing was used to detect evidence of WNS, and individuals were fitted with numbered aluminum bands. Select bats were radio-tagged and tracked to roosts daily for the lifespan of the transmitters.

During the summer 2012, a total of 215 bats representing five species were captured. Proportions of little brown, Indiana, and big brown bats continued the trend from 2008-2010, with little brown bat captures dropping by an additional 3.8 percent and Indiana bat captures by 5.9 percent from 2010 to 2012, while big brown bat captures increased from 68.2 percent in 2010 to 82.8 percent in 2012. Relative proportions of Northern long-eared bats and tri-colored bats also declined, with Northern long-eared bat captures decreasing by 4.5 percent and tri-colored bat captures by 5.2 percent. Additionally, the proportion of Eastern red bats captured in mist-nets increased by 5.5 percent (USFWS 2012g). The results of swab sample collection and Wing Score Indexing from 2012 have yet to be analyzed (USFWS 2012g).

The complete data from 2006 to 2012 demonstrate total declines of 39.9 percent in little brown bat captures, 16.6 percent in Indiana bat captures, 6.6 percent in Northern long-eared bat captures, 3.4 percent tri-colored bat captures, and total increases of 57.7 percent in big brown bat captures and 9.2 percent in Eastern red bat captures since 2006 (USFWS 2012g). These trends suggest that WNS has caused a marked reduction in the number of *Myotis* species on the refuge, particularly little brown bat. Recent increases in the proportion of big brown bat and Eastern red bat captures suggest that these species are

resistant or resilient to the fungus and may be experiencing population increases or range expansions, potentially resulting from recent niche vacancies or reduced roosting and foraging competition by *Myotis.*

Table 2-18: Number of Each Bat Species Captured at Great Swamp NWR (2006-2010 and 2012)						
Species	Pre-WNS			Post-WNS		
	2006	2007	2008	2009	2010	2012
Little brown bat	98	133	114	3	9	3
Big brown bat	60	74	82	151	118	174
Indiana bat	40	46	35	26	11	1
Northern long-eared bat	20	28	24	33	11	4
Tri-colored batF	8	5	8	8	9	0
Eastern red bat (*Lasiurus borealis*)	9	9	13	8	13	32
Hoary bat (*Lasiurus cinereus*)	0	0	0	2	2	0

Source: Kitchell, M.E. and L.A. White. "Community Ecology of Bats on the Maternity Range: A Comparison Pre- and Post-White-Nose Syndrome." 2010.

Further research will be useful in documenting the extent that WNS is impacting both sexes of all cave-dwelling bat species that use the refuge. Data will be compared to that collected pre-WNS to aid in understanding the severity of bat population declines.

Roost Selection

Evaluation of bat roosting ecology was performed from 2006 to 2010, which involved locating roosts (typically through radio-telemetry), and then measuring the characteristics of those roosts and surrounding areas. Roost tree and surrounding habitat characteristics (e.g., roost species, dbh, height, decay stage, canopy cover, habitat type, dominant vegetation, etc.) were analyzed and compared to other roost locations in order to depict habitat requirements or preferences within a given area. Roost fidelity and longevity were also assessed through the potential recapture of previously banded individuals or the use of previously marked roosts by newly radio-tagged individuals (USFWS 2012g; L. White, In Prep).

During 2006 and 2007, reproductively active female Indiana bats were fitted with radio-transmitters and tracked daily to identify roosts and foraging areas. Once roost trees were identified, standardized measurements were taken for each identified roost tree as well as randomly selected trees and their surrounding habitats (0.1 hectare). Emergence counts were conducted during 2007 at all trees containing radio-tagged bats. All known locations for radio-tagged bats (capture site, roosts, and estimated foraging points) were combined to produce home range estimates (USFWS 2012g; Kitchell 2008).

During 2006 and 2007, 24 female Indiana bats were tracked to 74 roosts, representing three colonies. Only two roosts were used by more than one transmitted bat. Four primary roost trees yielded peak emergence counts of 252, 164, 52 and 55 bats. Selected roosts were comparable to those documented in the literature in terms of recorded characteristics (species, decay stage, dbh, height, canopy closure); however, certain roost tree parameters varied significantly between 2006 and 2007 (dbh, height, and canopy closure). Reproductive female Indiana bats selected shagbark hickory (*Carya ovata*) and American elm (*Ulmus americana*) as roosts more often than would be expected based on comparisons with randomly

selected trees. Moreover, roost plots were characterized by fewer, larger trees and a greater proportion of suitable roost trees than random plots.

The variation in roost characteristics observed between years emphasizes that Indiana bats may be flexible in their roost requirements, and the large home ranges identified suggest that bats may range widely across the habitats available to them, even if roosting and foraging habitat is not limiting. Furthermore, the number of colonies found, the number of roosts identified, and the average distance moved between roosts during 2006 and 2007 suggest that the refuge represented ideal maternity habitat for Indiana bats (USFWS 2012g; Kitchell 2008).

From 2008 to 2010, male and female Indiana bats were fitted with radio-transmitters in order to identify and compare roosts and foraging areas of both sexes. Prior to this investigation, male Indiana bats were assumed to have less restrictive habitat requirements than females; however, roost selection and foraging habitat had not been thoroughly documented for males (L. White, Prep). The results of this three-year assessment are still being analyzed (USFWS 2012g).

During 2012, 14 bats were fitted with radio-transmitters. Preference was given to reproductively active female *Myotis*; however, due to the rarity of such captures, additional individuals (a male Indiana bat, juvenile female little brown bat, five adult female big brown bat, one juvenile female big brown bat, and one adult female Eastern red bat) were also radio-tagged. Bats were tracked to roosts daily for the lifespan of their transmitters (approximately 12 days), roost characteristics were recorded, and emergence counts were performed at each identified roost. A total of 39 roosts were identified during 2012. This included 19 trees of six species (pin oak, red maple, Northern red oak, swamp white oak, American beech, and black cherry), 19 buildings (barns and houses), and one bat box. None of the roosts identified in 2012 matched any previously documented Indiana bat roosts. Three primary roosts (two barns and one house) yielded peak emergence counts of 69, 67, and 35 (USFWS 2012g).

Acoustic Monitoring

The 2012 study used mobile and stationary acoustic surveys in combination to further document the extent to which different areas of the refuge are being used by foraging bats. Bat activity (sightings and recorded calls) were documented at each of the six mobile acoustic survey sites across the Management Area, as well as each of the nine stationary survey locations across the refuge. Although these acoustic data have yet to be thoroughly evaluated, preliminary analyses suggest that numbers of recorded *Eptesicus* calls versus *Myotis* calls are comparable to relative mist-net captures for each genus, further emphasizing the shift in species abundances since pre-WNS (USFWS 2012g). Acoustic data are expected to yield a higher proportion of Eastern red bat calls than those obtained from mist-netting. Hoary bats are not known to be affected by WNS and thus should not have experienced recent population declines on the refuge; however, the species tends to forage at heights exceeding those of mist-nets, which limits their chances of being captured in mist-nets (USFWS 2012g).

2.6.2 State-listed and Other Priority Species

In addition to the two Federally listed wildlife populations, approximately 67 State-listed species (see appendix A) have been identified on the refuge, including 26 State-endangered or threatened species. Terrestrial vertebrate and some insect populations have been heavily studied and well documented on the refuge.

There are many national, regional, State, and local plans and reports that have identified species for conservation concern in and around Great Swamp NWR. For development of the Draft HMP, the myriad of species provided in each plan and potentially occurring at the refuge was compiled into a Comprehensive List of Resources of Concern. The list cross references each species that has been identified, or may be expected to occur, on the refuge with the relevant plans where it has been prioritized. Nearly 160 species are identified in the comprehensive list, including 19 waterbird species; 14 shorebird species; 87 landbirds, including 17 owls and raptors; 18 waterfowl species; 6 mammals, including 5 bat species; 5 reptile species; 4 amphibian species; 4 fish species; and 1 butterfly, Harris' checkerspot (*Chlosyne harrisii*).

Sources utilized in the development of the Great Swamp NWR Comprehensive Resources of Concern list include the following: USFWS Endangered Species List; New Jersey Threatened, Endangered and Special Concern List; Appalachian Mountains Joint Venture; ACJV; Appalachian Mountains BCR 28; Piedmont Region BCR 29; Priority Bird Species in PIF Bird Conservation Plan Physiographic Area 9; Priority Bird Species in PIF Bird Conservation Plan Physiographic Area 10; NJWAP; Federal Trust Fish Species List; Waterbird Conservation for the Americas; North American Waterbird Conservation Plan; North American Shorebird Plan Atlantic Flyway Priorities; Northeast Partners in Amphibian & Reptile Conservation (NEPARC); and Amphibians and Reptiles of the Northeast.

2.6.3 Birds

More than 240 species of birds have been recorded during various times of the year at Great Swamp NWR. The refuge provides significant migratory, wintering and nesting habitat for numerous waterfowl, waterbirds, and landbird species, particularly within the regional context of the urbanized New York City Metropolitan Area. Approximately 109 bird species have been recorded nesting within or near the refuge.

Waterfowl

Waterfowl breeding and foraging habitat has traditionally been a major focus of management at Great Swamp NWR and protection of waterfowl is defined in the original refuge purpose. Land uses that predate the refuge resulted in extensive wetland draining and ditching in the Great Swamp. Since the late 1960s, the FWS plugged many ditches to restore these drained wetlands. Over time, nature has also blocked many ditches with tree roots, dropped branches and accumulated leaf and other vegetative matter. In addition, between the early 1970s and early 1980s, five impoundments with low level dikes and water control structures were constructed. The five impoundments, encompassing 485 acres, have integrated spillways to prevent undesirable high water levels during periods of heavy precipitation and runoff. A small four-acre impoundment was also constructed near refuge headquarters as a moist soil management area for wildlife observation. This shallow pond is particularly popular with visitors during the season following a mechanical set back of plant succession. Seasonally, the water is held at a depth of 4 to 6 inches to attract dabbling ducks. Subsequently, the water is drawn down in May and June and becomes highly attractive to shorebirds. The resultant emergent wetlands and open waters of Great Swamp NWR provide vital

wintering and breeding habitat for a variety of waterfowl. For additional information on impoundments and impoundment management, refer to section 2.5.2 above.

Waterfowl species that utilize the refuge for foraging or resting during migration include mallard (*Anas platyrhynchos*), American black duck (*Anas rupripes*), green-winged teal (*Anas carolinensis*), American wigeon (*Anas americana*), Northern pintail (*Anas acuta*), gadwall (*Anas strepera*), Northern shoveler (*Anas clypeata*), blue-winged teal (*Anas discors*), Canada goose (*Branta* Canadensis), Ring-necked ducks (scientific name), and bufflehead (*Bucephala albeola*). The most common waterfowl nesting on the refuge are wood duck (*Aix sponsa*), mallard, Canada goose (*Branta canadensis*), and an occasional hooded merganser (*Lophodytes cucullatus*), a State-listed Special Concern species.

Monitoring data was collected for waterfowl located in or around pools 1 and 2, pools 3a and 3b, and occasionally other locations between 1993 and 2006. The data is typically collected on a once a week basis between during the fall, winter and spring. Birds are identified as a fly over, within the waterbody or adjacent to the waterbody. The average number of waterfowl (number of observed waterfowl per single survey event) annually is presented for each species that occurs on the refuge in table 2-19 below.

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The averages presented in table 2-19 indicate that the most common spring and fall migrant waterfowl are mallards (37 percent of counted waterfowl) and wood duck (31 percent of counted waterfowl). American black duck, Canada goose and Northern shoveler all represent about 10 percent of the annual waterfowl counted. Northern pintail and American wigeon represent approximately 2 percent of the waterfowl counted. Other species noted in table 2-19 represent less than 2 percent of the waterfowl counted during annual surveys.

Average fall count of total waterfowl is approximately 1,061.1 per survey event as opposed to approximately 790.5 waterfowl per survey event in the spring. This difference is primarily driven by higher fall mallard and wood duck migratory counts which respectively average approximately 30 percent and 23 percent more birds in the fall than in the in the spring. Canada geese also have a similar percentage difference between fall and spring migratory counts.

TABLE 2-19: AVERAGE ANNUAL WATERFOWL COUNTS 1993-2006*															
Species	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**Total Avg.**
Mallard	635.6	143.6	361.3	334.1	679.9	436.3	262.9	N/D	170.8	145.2	72.9	477.1	535.7	99.0	**334.9**
Wood Duck	402.0	269.4	396.1	397.8	627.8	329.8	444.1	N/D	138.6	54.6	52.5	192.8	429.7	63.0	**292.2**
Canada Goose	109.5	59.3	123.2	112.6	252.0	71.0	90.5	N/D	46.8	92.5	43.2	40.8	150.3	38.0	**94.6**
American Black Duck	106.4	19.5	109.4	111.5	209.1	162.6	102.8	N/D	41.4	36.0	12.4	76.2	104.0	27.0	**86.0**
Green-winged Teal	160.0	5.2	102.3	69.1	112.2	46.5	53.3	N/D	8.5	3.9	7.6	52.8	50.5	464.0	**87.4**
Northern Pintail	48.4	1.2	13.4	33.3	45.8	8.9	5.7	N/D	3.5	4.8	1.6	25.8	10.7	38.0	**18.5**
American Wigeon	76.9	4.1	12.1	10.2	24.5	1.7	6.5	N/D	0.0	3.2	0.0	8.3	11.0	71.0	**17.7**
Blue-winged Teal	18.1	36.0	1.3	3.1	0.0	0.1	0.7	N/D	0.0	0.0	0.3	0.0	0.0	0.0	**4.6**
Gadwall	8.2	0.3	0.0	0.0	0.8	0.4	0.0	N/D	0.1	0.2	0.3	0.8	0.0	0.0	**0.9**
Hooded merganser	2.1	0.0	0.0	0.6	0.0	0.2	0.2	N/D	0.2	0.2	0.1	0.3	1.7	0.0	**0.4**
Northern Shoveler	0.9	0.0	0.9	0.0	0.0	0.0	0.0	N/D	0.1	0.1	0.2	0.0	0.3	0.0	**0.2**
Ring Necked Duck	0.0	0.0	0.0	0.3	0.4	0.0	0.0	N/D	0.1	0.1	0.5	0.7	0.0	0.0	**0.2**
Greater/Lesser Scaup	0.0	0.0	0.0	0.0	0.0	0.0	0.0	N/D	0.0	0.0	0.0	0.0	1.3	0.0	**0.1**
Mute Swan	0.0	0.0	0.0	0.0	0.0	0.0	0.0	N/D	0.0	0.3	0.3	0.0	0.0	0.0	**0.0**
Bufflehead	0.0	0.0	0.0	0.0	0.0	0.0	0.0	N/D	0.1	0.1	0.0	0.0	0.0	0.0	**0.0**
Common Merganser	0.0	0.0	0.0	0.0	0.0	0.0	0.0	N/D	0.0	0.1	0.0	0.0	0.0	0.0	**0.0**
Snow Goose	0.0	0.0	0.0	0.0	0.0	0.0	0.0	N/D	0.0	0.1	0.0	0.0	0.0	0.0	**0.0**
Canvasback	0.0	0.0	0.0	0.0	0.0	0.0	0.0	N/D	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**
Common Goldeneye	0.0	0.0	0.0	0.0	0.0	0.0	0.0	N/D	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**
Tundra Swan	0.0	0.0	0.0	0.0	0.0	0.0	0.0	N/D	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**
TOTAL	**1567.8**	**538.5**	**1120.0**	**1072.3**	**1952.6**	**1057.5**	**966.5**	**N/D**	**410.1**	**341.4**	**192.0**	**875.5**	**1295.2**	**800.0**	**937.6**

Notes:
N/D – no data available
* - Annual waterfowl counts are based on the number of observed waterfowl at a location during a single survey event (day)

Land Birds

Approximately 87 species of land birds with varying levels of regional priority have been identified on the refuge. Of these priority land birds, approximately 42 have been identified as nesting species in the various habitats of the refuge. These nesting birds include a large variety of passerines (perching birds), owls, raptors, woodpeckers, doves and cuckoos, swallows and swifts, and wild turkey. Neotropical migrant passerines are the most diverse group of priority birds nesting or migrating at the refuge. Neotropical migrant birds are those species which summer in North America and winter in Latin America or the Caribbean (USFWS 2011e).

The wood thrush (*Hylocichla mustelina*) is a high regional priority neotropical migrant passerine commonly nesting in the forests at Great Swamp NWR. Wood thrush is one of the refuge's and region's most important indicator species with respect to forest management. Although wood thrush is considered a common species, their overall range-wide population has been found to have declined by 43 percent since 1966 (Rosenberg et al 2003).

Wood thrushes prefer to nest in often moist deciduous or mixed forests with a dense tree canopy and a generally well-developed understory. The most common tree species in wood thrush habitat within the eastern region are oaks and maples and to a lesser extent American beech, pines and hickories (Rosenberg et al. 2003). Wood thrush will utilize a wide variety of fragmented habitats with relatively small patch sizes. The reproductive success of wood thrush; however, decreases rapidly in patch sizes less than 100 acres (Rosenberg et al. 2003). In general studies have shown that nest predation and cowbird brood parasitism of wood thrush occur at higher rates in fragmented habitat areas (Rosenberg 2003) and contribute to this correlation.

Other prioritized interior forest, forest edge and shrub nesting species at the refuge include veery (*Catharus fuscescens*), scarlet tanager (*Piranga olivacea*), rose-breasted grosbeak (*Pheucticus ludovicianus*), black-billed cuckoo (*Coccyzus erythropthalmus*), and yellow-billed cuckoo (*Coccyzus americanus*). Approximately 11 warbler species nest on or near Great Swamp NWR. Key nesting warblers include the prothonotary warbler (*Protonotaria citrea*), blue-winged warbler (*Vermivora pinus*), yellow-breasted chat (*Icteria virens*), and the Louisiana waterthrush (*Seiurus motacilla*). All three local mimic thrushes, including the prioritized brown thrasher (*Toxostoma rufum*), nest on the refuge. Eight species of flycatchers nest at Great Swamp NWR. High regional priority forest-nesting flycatchers include the Acadian flycatcher and the Eastern wood pewee. The willow flycatcher is a prioritized shrub-nesting species at the refuge. Six species of woodpecker, including the State-threatened red-headed woodpecker (*Melanerpes erythrocephalus*), also nest on the refuge.

Two sparrow species with regional priority, the field sparrow and the Eastern towhee, are very common and nest in the shrub and successional habitat on the refuge. Important grassland passerines that nest on the refuge include the State-threatened bobolink and the Eastern meadowlark (*Sturnella magna*).

Several State-listed forest-nesting raptors are documented to nest on or near the refuge. These include the State threatened [State endangered (breeding)] red-shouldered hawk (*Buteo lineatus*); State-listed Special Concern Cooper's hawk (*Accipiter cooperii*); the State endangered Northern goshawk (*Accipiter gentilis*); the State threatened barred owl (*Strix varia*); and the State listed Special Concern broad-winged hawk (*Buteo platypterus*). The American kestrel (*Falco sparverius, Statethreatened*), an open field cavity-nesting species, also nests on the refuge.

In addition to providing land bird nesting habitat, the forested, successional and wetland complexes of Great Swamp NWR provide vital migratory habitat for thousands of land birds in the spring and fall. Great Swamp is important as a migratory stopover, particularly in the context of its urban setting. Loss of migratory stopover habitats, such as those provided at Great Swamp NWR, has been identified as a potential contributing factor to population declines of neotropical migrant passerines (NJDEP 2010c).

The refuge's fields and shrub habitats host a large variety of spring neotropical migrant passerines during April and May (Boyle 1986). Common spring migrant passerines include 10 species of flycatcher, including the eight that nest at the refuge; three prioritized vireo species; all six eastern swallows; and approximately 30 species of warblers. Wooded swamps and other wetlands at the refuge provide important migratory habitat for the regional priority rusty blackbird (*Euphagus carolinus*) during the spring and fall.

The highest priority warbler species that occasionally utilize the refuge for migration include two species that have been given consideration for federal listing, the cerulean warbler (*Dendroica cerulea*) and the golden-winged warbler (*Vermivora chrysoptera*). Other high priority warblers that utilize the refuge for migration include Canada warbler (*Cardellina canadensis*), Kentucky warbler (*Geothlypis formosa*), prairie warbler (*Cardellina canadensis*), and worm-eating warbler (*Helmitheros vermivorum*). Other prioritized warbler species commonly observed at the refuge during spring and fall migration include black-throated blue warbler (*Dendroica caerulescens*), black-throated green warbler (*Dendroica virens*), Northern parula (*Setophaga americana*), and blackburnian warbler (*Dendroica fusca*).

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Three rare New Jersey grassland sparrows [the savannah (*Passerculus sandwichensis*), vesper (*Pooecetes gramineus*) and grasshopper (*Ammodramus savannarum*)] are spring and fall migrants on the refuge.

In addition to the nesting owls and raptors that migrate through Great Swamp NWR, the refuge also provides wintering and migratory habitat for other State-listed owl species, including the long-eared (*Asio otus*) and short-eared (*Asio flammeus*) owls. State endangered (nesting) Northern harriers (*Circus cyaneus*) are commonly observed foraging in open fields during summer, winter and migratory periods.

Waterbirds

A number of rare waterbirds utilize the refuge, including several key nesting species. Great blue heron (*Ardea herodias*) rookeries found within the refuge are regularly monitored for productivity. In recent years, as many as four separate rookeries existed at once, but at the current time only one remains active. Other nesting heron species include American bittern (*Botaurus lentiginosus*), least bittern (*Ixobrychus exilis*) and green heron (*Butorides virescens*). Other herons use the refuge for forage or during migration primarily in spring through the fall. Key foraging heron species include the black-crowned (*Nycticorax nycticorax*) and

yellow-crowned (*Nyctanassa violacea)* night heron, cattle egret (*Bubulcus ibis*), snowy egret (*Egretta thula*) and little blue heron (*Egretta caerulea*). Four rail species, including the king rail (*Rallus elegans*), Virginia rail (*Rallus limocola*), sora (*Porzana carolina*) and common moorhen (*Gallinula chloropus*), nest within the marsh habitats at Great Swamp NWR.

Shorebirds

The term shorebird refers to diverse groups of bird species under the order *Charadriiformes* that are represented by members of the sandpiper, plover, tern and gull families at Great Swamp NWR. Breeding shorebird species at Great Swamp NWR include the killdeer (*Charadrius vociferus*), spotted sandpiper (*Actitis macularia*), and common snipe (*Gallinago delicate*). In addition, a number of migratory sandpiper species utilize the refuge primarily during the spring and through the fall. Solitary (*Tringa solitaria*) and least (*Calidris minutilla*) sandpipers are common in the spring. Semipalmated sandpiper (*Calidris pusilla*), greater (*Tringa melanoleuca*) and lesser yellowlegs (*Tringa flavipes),* dunlin (*Calidris alpine*), and short-billed dowitcher (*Limnodromus griseus*) are primarily observed in the spring or summer. The State endangered upland sandpiper (*Bartramia longicauda*) is a rare spring visitor to the refuge.

American woodcock (*Scolopax minor*), a member of the sandpiper family, is a well-established breeding bird at Great Swamp and is the most important shorebird at the refuge from the management and regional priority perspective. Long-term regional declines (New Jersey and surrounding Northeastern states) of American woodcock observed by the USFWS between 1968 and 2012. According to the American Woodcock Conservation Plan, New Jersey's population of singing males has declined by 83 percent since the early 1970's (Palmer 2008). There has been no significant Northeastern regional decline, however, between 2000 and 2012 (Cooper and Rau 2012).

The woodcock benefits significantly from the management of fields and successional habitats at the refuge. The species utilizes the refuge's patchwork of grassland, scrub-shrub, forest, and wetland habitats for courtship, roosting, nesting, and foraging. Male woodcock may be regularly observed performing courtship displays throughout the open fields of the refuge between March and May. Courtship habitats for woodcock are preferably at least 2.9 acres (1.2 hectares) in size and consist of open fields, meadows, pastures or brushland and forest clearings (USFWS 2001c). American woodcock nesting cover is ideally located within 300 feet of the male's courtship habitat (USFWS 2001c). Nesting and brood rearing occur in young, open, second-growth deciduous forests with well-drained soils.

Since 1968, the State of New Jersey has collected data on breeding woodcock populations (peenting [singing] males) shortly after sunset during late April and early May at Great Swamp NWR. The State data has been collected once annually with the exception of 1991 and 1992 when no State data was collected due to a Division of Fish and Wildlife reporting error. In addition to the State data, Great Swamp NWR staff has collected peenting male woodcock data on the refuge since 1983. Both surveys have continued concurrently and are conducted by stopping at set point locations along established routes within the western portion (Management Area) of the refuge.

Table 2-20 below lists every year that the woodcock survey was conducted by either the New Jersey Division of Fish and Wildlife or the FWS along with the average number of peenting woodcocks per stop that each agency reported hearing. The last column quantifies the difference between the State and FWS data as a percentage for each given year. Numbers highlighted in red represent years when FWS average numbers of peenting woodcock were below State findings. Both agencies did not conduct surveys on all

years listed. Discrepancies between State and refuge derived data may be explained in part by differences in the frequency of survey sessions (USFWS 2012k). The NJDFW only conducts their survey once annually. The refuge's survey may include multiple survey sessions within a single season.

The routes of the two surveys differ from each other but cover much of the same general area in the western portions of the refuge. The survey routes currently utilized today by both FWS and NJDFW span much of the managed (mowed and hydroaxed) fields along Pleasant Plains Road, north of White Bridge Road, where the greatest concentrations of peenting woodcock occur. The State survey also includes five stops along White Bridge Road, east of Pleasant Plains Road, to the western end of the Wilderness Area. The refuge routes utilized by FWS between 1983 and 2004 were altered in 2005 to eliminate route portions that do not contain areas regularly utilized by peenting woodcock (USFWS 2012k).

Table 2-20: COMPARISON OF PEENTING WOODCOCK SURVEYS CONDUCTED AT GREAT SWAMP NWR BY USFWS AND NJDEP DIVISION OF FISH AND WILDLIFE

Year	# of Peenting Woodcocks / Total # of Stops		% Difference
	NJDFW	USFWS	
1968	0.10*	---	-10.00
1969	0.00*	---	0.00
1970	0.40*	---	-40.00
1971	0.80	---	-80.00
1972	1.10	---	-110.00
1973	1.50	---	-150.00
1974	1.70	---	-170.00
1975	1.10	---	-110.00
1976	0.70	---	-70.00
1977	0.30*	---	-30.00
1978	0.30*	---	-30.00
1979	0.40*	---	-40.00
1980	0.30*	---	-30.00
1981	0.40*	---	-40.00
1982	0.20*	---	-20.00
1983	0.10*	0.50*	40.00
1984	0.10*	1.67	156.67
1985	0.40*	1.25	85.00
1986	0.00*	0.75	75.00
1987	0.00*	1.42	141.67
1988	0.20*	2.21	200.83
1989	0.20*	1.79	159.17
1990	0.60	1.56	95.56
1991	---	1.67	166.67

Table 2-20: COMPARISON OF PEENTING WOODCOCK SURVEYS CONDUCTED AT GREAT SWAMP NWR BY USFWS AND NJDEP DIVISION OF FISH AND WILDLIFE			
Year	# of Peenting Woodcocks / Total # of Stops		% Difference
	NJDFW	USFWS	
1992	---	0.96	95.83
1993	0.20*	0.79*	59.17
1994	0.00*	1.11	111.11
1995	0.30*	2.03	172.78
1996	0.20*	1.00	80.00
1997	0.40*	1.42	101.67
1998	0.10*	0.83*	73.33
1999	0.20*	0.73*	53.33
2000	0.10*	0.82*	71.67
2001	0.20*	0.19*	-0.56
2002	0.20*	0.28*	7.78
2003	0.30*	0.17*	-13.33
2004	0.00*	0.67*	66.67
2005	0.30*	0.27*	-3.00
2006	0.60	0.67*	7.00
2007	0.50	0.87*	37.00
2008	0.40*	0.36*	-4.00
2009	0.80	0.36*	-44.00
2010	0.10*	0.33*	23.00
2011	0.80	0.76*	-4.00
2012	1.20	0.44*	-76.00

Notes:
* Indicates below respective means (0.41 for New Jersey Division of Fish and Wildlife and 0.93 for the U.S. Fish and Wildlife Service)
--- Indicates no survey conducted

The 43 years of annual State data at Great Swamp NWR contains an overall mean of 0.41 peenting woodcock per stop. The range of peenting woodcocks has ranged from 0 to 17 per year. During the period between 1971 and 1976, the State consistently recorded the highest frequency of peenting males per stop. A peak number of 17 (mean of 1.7 peenting woodcock per stop) was recorded in 1974. Until the 2012 season, a mean value greater than one peenting male per stop had not been recorded during State surveys at Great Swamp NWR since 1975 (USFWS 2012k).

U.S. Fish and Wildlife Service data contains a mean value of is 0.93 woodcocks heard per stop during the 30 years of surveying. Since 1983, the number peenting woodcocks has ranged from 0 to 35 during a single survey visit. During the period between 1984 and 1997, the FWS generally recorded the highest

frequency of peenting males per stop. With the exception of 1993, all years in this period were above the overall FWS mean of 0.93. The high of 35 peenting woodcocks (mean of 2.12 peenting woodcock per stop) was heard in 1988 (USFWS 2012k).

2.6.4 Mammals

Approximately 39 mammalian species have been identified at Great Swamp NWR. Common species include white-tailed deer (*Odocoileus virginianus*), raccoon (*Procyon lotor*), Virginia opossum (*Didelphis virginiana*), striped skunk (*Mephitis mephitis*), masked shrew (*Sorex cinereus*), smoky shrew (*Sorex fumeus*), and starnose mole (*Condylura christata*).

Common rodents and lagomorphs include the Eastern cottontail (*Sylvilagus floridanus*), Eastern chipmunk (*Tamias striatus*), woodchuck (*Marmota monax*), Eastern gray squirrel (*Sciurus carolinensis*), red squirrel (*Sciurus vulgaris*), Southern flying squirrel (*Glaucomys volans*), beaver (*Castor canadensis*), white-footed mouse (*Peromyscus leucopus*), meadow vole (*Microtus pennsylvanicus*), woodland vole (*Microtus pinetorum*), muskrat (*Ondatra zibethicus*), meadow jumping mouse (*Zapus hudsonius*), and woodland jumping mouse (*Napaeozapus insignis*).

Small and medium–sized predatory mustelids common at Great Swamp NWR include river otter (*Lutra canadensis*), mink (*Mustela vison*), and longtail weasel (*Mustela frenata*). Other *Carnivora* predators include coyote (*Canis latrans*), gray fox (*Urocyon cinereoargentueus*), and red fox (*Vulpes vulpes*). Transient black bears (*Ursus americanus*) have also been observed on the refuge.

White-tailed deer (*Odocoileus virginianus*) are common on the refuge and the numbers are managed with an annual hunting program. Harvest data for white-tailed deer has been recorded since the first refuge hunt in 1974. Raccoons (*Procyon lotor*) are also extremely common. Sightings of two locally rare predatory species, the fisher (*Martes pennanti*) and the State-endangered bobcat (*Lynx rufus*), have been reported on the refuge, but have not been confirmed.

Eight bat species, including the federally listed endangered Indiana bat, have been identified at the refuge. Other species of concern identified include Eastern red bat (*Lasiurus borealis*), Eastern small-footed bat, and hoary bat (*Lasiurus cinereus*). In addition to Indiana bat, certain bat species documented at the refuge including Northern long-eared bat, tri-colored bat and the little brown bat may be threatened by white-nose syndrome (see white-nose syndrome discussion in section 2.6.1).

2.6.5 Reptiles and Amphibians

The first herptile list for Great Swamp NWR was created in 1967 by J.D. Anderson. Since then, many reptile and amphibian populations have been well documented and studied on the refuge. This includes the inventory and/or study of seven State-listed Threatened, Endangered, or Special Concern species, including the federally listed turtle.

Frog call surveys are regularly conducted in the spring and summer on the refuge. Common species identified include Northern cricket frog (*Acris crepitans*), Northern gray treefrog (*Hyla versicolor*), Northern spring peeper (*Pseudacris crucifer*), green frog (*Lithobates clamitans melanotus*), bull frog (*Lithobates catesbeianus*), and Southern leopard frog (*Lithobates sphenocephalus utricularius*). Frog species less frequently encountered at the refuge include the State-listed Special Concern Fowler's toad (*Anaxyrus*

fowlerii), the American Toad (*Anaxyrus americanus*), New Jersey chorus frog (*Pseudacris triseriata kalmi*), upland chorus frog (*Pseudacris triseriata feriarum*), and pickerel frog (*Lithobates palustris*).

As with other similar habitat complexes in northern New Jersey, the redback salamander (*Plethodon cinereus*) is the most common salamander on the refuge. Other less common salamanders include Northern slimy salamander (*Plethodon glutinosus*), the four-toed salamander (*Hemidactylium scutatum*), red-spotted newt (*Notopthalmus viridescens viridescens*), and the Northern dusky salamander (*Desmognathus fuscus*). Although known to occur in the area, the Northern two-lined salamander (*Eurycea bislineata*) was not confirmed on the refuge until its discovery by refuge biologists in June 2009. The refuge also provides important vernal breeding habitat for two obligate vernal breeders: the wood frog (*Lithobates sylvatica*) and the State-endangered blue-spotted salamander. Populations of the blue-spotted salamander, though fairly common on the refuge, are extremely rare in New Jersey.

Great Swamp NWR hosts populations of two threatened and endangered turtle species: the bog turtle and wood turtle. Management efforts to monitor, sustain and expand refuge populations are ongoing for both of these species. Two State-listed Special Concern species, including the box turtle (*Terrapene carolina*) and spotted turtle, remain common at the refuge. Additional species include the snapping turtle (*Chelydra serpentina*), Eastern painted turtle (*Chrysemys picta*), musk turtle (*Sternotherus odoratus*), and Eastern mud turtle (*Kinosternon subrubrum*). Introduced species, such as the red-eared slider (*Trachemys scripta*), red-belly turtle (*Pseudemys rubriventris*), and Eastern river cooter (*Chrysemys concinna*), have also been reported at the refuge.

Great Swamp NWR is host to a variety of common snake species, including Northern water snake (*Nerodia sipedon*), brown snake (*Storeria dekayi*), common garter snake (*Thamnophis sirtalis*), Northern black racer (*Coluber constrictor*), and the Eastern milk snake (*Lampropeltis triangulum*). One State-listed Special Concern species, the ribbon snake (*Thamnophis sauritis*), is also common at the refuge. Species less common at the refuge include Eastern worm snake (*Carphophis amoenus*), black rat snake (*Scotophis alleghaniensis*), smooth green snake (*Opheodrys vernalis*), ringneck snake (*Diadophis punctatus*), and Eastern smooth earth snake (*Virginia valeriae*). One additional State-listed Special Concern species, the Eastern hognose snake (*Heterodon platyrhinos*), was identified during earlier surveys (Anderson 1967-76), but has not been observed on the refuge in recent years.

A comprehensive study of reptiles and amphibians was conducted at the refuge in 1993 to 1994 with a focus on endangered and threatened species (Record 1995). Ongoing studies have been conducted for endangered and threatened turtle habitat and populations, specifically for bog turtles, beginning in 2004 (see section 2.6.1), and wood turtles, beginning in 2006.

R Allen Simpson

The wood turtle study involves the mark and recapture, and radio tracking of individuals throughout the refuge to understand the movements and reproductive success of wood turtles on the refuge. Each year, mature adult, juvenile and hatchling wood turtles are identified along the open waters and a within a wide variety of

vegetated habitats throughout Great Swamp NWR. Specific habitats utilized at the refuge include stream banks and beds; vegetated riparian habitats; sphagnum bogs and other wetlands; floodplain forests; and successional fields dominated by reed canary grass, goldenrods and shrubs. They are also occasionally found in disturbed and non-habitat areas, such as along roads and around buildings.

The wood turtle population at the refuge is actively reproducing and multiple gravid females are tracked on the refuge each season. The refuge facilitates the development of eggs and has been successful in providing quality nesting mound habitat for the species, which produces multiple clutches of hatchlings annually.

2.6.6 Fish

Great Swamp NWR is located within the GSW, which is located within the southern portion of the Upper Passaic River watershed (refer to section 2.1 and figure 2.4). Although a comprehensive inventory of fish species inhabiting the refuge has not been conducted recently; studies of the Lower Passaic-Hackensack River watershed have been conducted. Approximately 39 species of freshwater fish have been reported in or immediately adjacent to Great Swamp NWR within the Passaic-Hackensack River watershed. No anadromous (Clupeids or striped bass) species have been reported within the refuge, as there are significant migratory impediments along major downstream waters (i.e., Great Falls). The refuge is primarily host to a warmwater fishery, with some cold water species existing near the refuge border (i.e., within Primrose Brook). Among the coldwater species identified are the non-native brown trout (*Salmo trutta*) and native brook trout (*Salvelinus fontinalis*).

Two common darter species, the tessellated darter (*Etherostoma olmstedi*) and the Johnny darter (*Etherostoma nigrum*), have been identified within the watershed. Fallfish (*Cyprinella spp. and Notropis spp.*) shiners and blacknose dace (*Rhinichthys atratulus*) are some of the stream fish identified at the refuge. Refuge waters also contain the American brook lamprey (*Lampetra appendix*), banded sunfish (*Enneacanthus obesus*) and bridle shiner (*Notropsis bifrenatus*), all of which will be considered for management in the NJWAP.

A number of larger warmwater predatory species exist within the refuge waters, including chain pickerel (*Esox niger*), largemouth bass (*Micropterus salmoides*), black crappie (*Pomoxis migromaculatus*), and yellow perch (*Perca flavescens).*

A total of seven fish surveys were conducted within the Passaic River (1990), Black Brook (1969), Loantaka Brook (2007) and Primrose Brook (1992/1999) by the New Jersey Division of Fish & Game, Bureau of Freshwater Fisheries. During these surveys, an overall total of 21 species of fish were identified, including longnose dace (*Rhinichthys cataractae*), rainbow trout (*Oncorhynchus mykiss*), and slimy sculpin (*Cottus cognatus*).

Fourteen species of fish were identified within Great Brook and Primrose Brook on the refuge during an electro-shock inventory as part of the *2009 BioBlitz*.

2.6.7 Invertebrates

A complete inventory of invertebrates has not been conducted at the refuge. Certain groups of species, including *Odonata* (dragonflies) and *Lepidoptera* (butterflies and moths), have been recorded more consistently at Great Swamp NWR.

Butterflies have been recorded at the refuge during single-day July counts from 1994 to 2005. Over 45 species of butterflies from 11 families have been identified at the refuge. Families include swallowtails, sulphurs, whites, skippers, hairstreaks, blues, brushfoots, satyrs, and wood nymphs. Common species identified during the surveys include common wood nymph (*Cercyonis pegala)*, little wood satyr (*Megisto cymela*), least skipper (*Ancyloxypha numitor*), silver-spotted skipper (*Epargyreus clarus*), little glassywing (*Pompeius verna*), great spangled fritillary (*Speyeria cybele*) and pearl crescent (*Phyciodes tharos*). Some introduced exotic butterflies, including cabbage white (*Pieris rapae*) and European skipper (*Thymelicus lineola*), are among the most common species identified. Rare moths of the genus *Papaipema* have also recently been identified on the refuge.

Aquatic invertebrate studies conducted in 2001 revealed the presence of 26 insect families, 2 amphipod families, mollusks including gastropods and bivalves, ostracods, isopods, acari and annelids. Gastropods (snails) represented the greatest biomass of invertebrates from more than 5,800 invertebrate individuals collected from two sites.

2.7 Refuge Visitor Services Program

The primary focus of the Refuge System is to protect wildlife and habitat; however, refuges also provide opportunities to “connect people with nature” by providing unique opportunities for people to learn about and enjoy the natural environment. This section highlights overall visitation data collected over recent years at the refuge. The USGS study completed in 2011 illustrated that visitors were generally satisfied with their experiences and the facilities available at Great Swamp NWR. Chapter 3, alternative A of the CCP identifies specific trends regarding visitor attitudes that were determined from the USGS study.

2.7.1 Visitation

Based on data collected from 2001 through 2010, refuge visitation ranges between approximately 140,000 and 162,000 visitors per year (T. McFadden, USFWS Great Swamp NWR, pers. com. 2009). The most recent visitation information from the refuge is for October 1, 2009 through September 30, 2010. During this time, the refuge reported an estimated 156,500 visitors. Onsite interpretation and nature observation account for the largest proportion of visitor days (65,684).

Visitor Hours

Great Swamp NWR is open every day from sunrise to sunset. The only current exception is during the 5-day deer hunt. During the deer hunt, the refuge is closed to any visitors who are not authorized to participate in the hunt. The refuge headquarters is open 8:00 a.m. to 4:30 p.m. Monday through Friday excluding Federal holidays. During seasonal bird migration in spring and fall, volunteers staff the WOC from Wednesday through Sunday. Staff and members of the Friends of Great Swamp NWR run the Visitor Center, which includes the “Friends Nature Shop.” It is currently open Thursday and Friday from noon to

4:00 p.m. and Saturday and Sunday from 10:00 a.m. to 4:00 p.m. Regular "Second Sunday" programs and occasional special events, such as the annual Fall Festival, are also scheduled.

2.7.2 Priority Public Uses

The Improvement Act identifies six wildlife dependent public uses for national wildlife refuges: hunting, fishing, wildlife observation, photography, environmental education, and interpretation. (Public Law 105-57 1997). The Act further directs that these public uses receive "enhanced consideration over other public uses in planning and management" within the Refuge System when they are determined to be compatible with the refuge purpose(s). In one way or another, five of the six priority public uses are authorized on Great Swamp NWR. The only priority public use not currently authorized on the refuge is fishing.

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Hunting

Currently, the only hunting authorized on Great Swamp NWR is the annual 5-day deer hunt, which occurs every fall. The annual white-tailed deer firearm hunt has been conducted on the refuge since 1974 to maintain the refuge deer population at or below a level that will not negatively impact wildlife habitat and the integrity of ecological communities, while providing a safe, high quality outdoor experience for hunters (USFWS 2012h). The annual hunt includes a 1-day youth hunt followed shortly thereafter by a 4-day general hunt. Hunting generally follows the New Jersey State guidelines, and detailed regulations and information are included in handouts sent to each of the hunters that purchase hunting permits on the refuge. Regulations are also published in the State's annual hunting digest.

The goals of the refuge's Deer Hunt Program are to: (1) Maintain a white-tailed deer population that allows a diverse and healthy forest understory and assures continuing production of tree seedlings to maintain forest cover in perpetuity; (2) Avoid a truncated buck age class structure and maintain a more natural buck age class distribution; and (3) Provide a safe and high quality outdoor experience for refuge deer hunters (USFWS 2012h). To achieve these goals, harvest strategies and regulations are implemented, evaluated annually, and adjusted when necessary to carry out the objectives of the Program. Program objectives are to: (1) maintain deer at a moderate density of 20 deer per square mile; (2) Maintain a male age class structure where at least 30 percent of the bucks are greater than or equal to 3 years old; and (3) Implement necessary safety precautions to prevent accidents (USFWS 2012h).

In 2011, 194 hunters, including 13 youth hunters, purchased refuge deer hunting permits. The hunter density was one hunter to 35 acres (USFWS 2012h). According to the Draft Deer Hunting Plan (USFWS 2009a), deer hunting is allowed on approximately 82 percent of the total refuge area with the remaining area designated as Safety Zones. There are 31 parking lots available throughout the refuge to distribute hunters and facilitate access for this public use.

Table 2-21 below illustrates relative trends of seasonal bag limits, number of hunters, number of deer harvested, and total hunt days from 1974 to 2011.

TABLE 2-21: COMPARISON OF HUNT STATISTICS FROM 1974-2010				
Year	Bag Limit	No. Hunters	Deer Harvested	Total Hunt Days
1974	1 Deer / Permit	371	127	6
1975	1 Deer / Permit	329	106	6
1976	1 Deer / Permit	354	128	6
1977	1 Deer / Permit	351	106	6
1978	1 Deer / Permit	350	100	6
1979	2 Deer / Permit	502	178	10
1980	2 Deer / Permit	523	148	10
1981	2 Deer / Permit	543	152	8
1982	2 Deer / Permit	491	126	7
1983	2 Deer / Permit	407	116	7
1984	1 Deer / Day / Permit; 2 Max. (a)	408	144	6
1985	1 Deer / Day / Permit; 2 Max. (a)	486	150	6
1986	1 Deer / Day / Permit; 2 Max. (a)	527	179	6
1987	1 Deer / Day / Permit; 3 Max.	439	149	5
1988	1 Deer / Day / Permit; 6 Max.	420	143	6
1989	1 Deer / Day / Permit; 6 Max.	382	153	6
1990	1 Deer / Day / Permit; 6 Max.	331	164	6
1991	2 Deer / Day / Permit	420	212	5
1992	2 Deer / Day / Permit	410	210	5
1993	2 Deer / Day / Permit	392	214	5
1994	2 Deer / Day / Permit	404	252	4
1995	2 Deer / Day / Permit	383	257	4
1996	2 Deer / Day / Permit	408	152	4
1997	2 Deer / Day / Permit	322	184	4
1998	2 Deer / Day / Permit	267	181	4
1999	2 Antlerless / Day, 1 Buck / Season (b)	283	198	4
2000	2 Antlerless / Day, 1 Buck / Season (c)	285	215	4
2001	2 Antlerless / Day, 1 Buck / Season (c)	274	190	4
2002	Unlimited Antlerless, 1 Buck (c)	264	271	4
2003	Unlimited Antlerless, 1 Buck (b)	274	178	4
2004	Unlimited Antlerless, 1 Buck (b)	275	187	5 (e)
2005	Unlimited Antlerless, 1 Buck (b)	275	150	5 (e)
2006	Unlimited Antlerless, 1 Buck (b)	222	102	5 (e)
2007	2 Antlerless or 1 Antlerless and 1 Buck (d)	186	85	5 (e)
2008	2 Antlerless or 1 Antlerless and 1 Buck (d)	161	79	5 (e)
2009	2 Antlerless or 1 Antlerless and 1 Buck (f)	183	113	5 (e)
2010	2 Antlerless or 1 Antlerless and 1 Buck (f)	230	121	5 (e)
2011	2 Antlerless or 1 Antlerless and 1 Buck (f)	194	42	5 (e)
2012	1 Either sex	98	18	3(e)

TABLE 2-21: COMPARISON OF HUNT STATISTICS FROM 1974-2010				
Year	Bag Limit	No. Hunters	Deer Harvested	Total Hunt Days
2013	1 Either sex	107	3	5(e)

Notes:
(a) – Indicates one bonus deer available if deer is harvested in the Wilderness Area.
(b) – Adult doe must be checked in before buck permit is issued.
(c) – First antlerless deer harvested must be an adult doe to obtain a buck permit.
(d) – First deer must be antlerless.
(e) – Youth hunt on first day.
(f) – First deer antlerless for shotgun and either sex for muzzleloader.

Despite a comparable number of deer hunters to hunts in the recent years (2007 to 2010), the 2011 hunt resulted in the fewest number of harvested deer and the lowest hunter success rate (22 percent) ever recorded on the refuge since the deer hunt began in 1974. The reduced number of deer harvested was attributed to population declines due to the EHD outbreak earlier in the season. As a result, the 2012 hunt program was reevaluated and adjusted to reduce the bag limit to one deer of either sex (USFWS 2012h).

Fishing

Fishing is currently not an authorized activity on Great Swamp NWR and no infrastructure specifically supports fishing access. However, refuge staff have found evidence (i.e., fishing line, lures, and bait) that unauthorized fishing is occurring at certain locations within the refuge. The refuge has sponsored offsite fishing derbies in the past and the Somerset County Park Commission provides fishing opportunities on waters adjacent to the refuge on the Passaic River.

Wildlife Observation and Photography

Wildlife observation and photography are popular public uses on the refuge and contributed to 174,132 visitor days in 2010. The refuge has established an informal 1.5 mile auto tour along Pleasant Plains Road. The auto tour includes the Bluebird parking area and the Overlook area. The Overlook focuses on an impoundment, and includes two mounted spotting scopes (one is wheelchair accessible), benches, a three-panel kiosk, and a small parking area with six designated parking spaces (including one designated handicap space). The Bluebird parking area has an outdoor restroom, kiosk, bench, and parking for 20 cars. In addition, the refuge Visitor Center provides opportunities to view wildlife associated with the butterfly garden, a nature trail and varied habitats adjacent to the center.

The refuge also has a WOC located off Long Hill Road. This facility includes all-season public restrooms, an eight-paneled kiosk, a seasonally-staffed visitor contact station, one-mile of ADA-compliant boardwalk that ends in two wildlife viewing blinds, and a 0.5 mile stone dust and wood chip trail that ends in a viewing platform. There is also a parking lot for 40 vehicles.

The western portion of the refuge, which includes 3,360 acres, has been designated by Congress as Wilderness. There are about 8.5 miles of primitive hiking trails in this area and off-trail use is allowed. Except for public roads, the remainder of the refuge is usually closed to the public. Friends of Great Swamp NWR offer occasional interpretive walks in the restricted Management Area and the refuge may authorize access through a SUP.

Environmental Education

There are two well-established county environmental education centers (see Partnerships in this chapter) located on either side of the refuge: the Morris County Great Swamp Outdoor Education Center to the east and the Somerset County Environmental Education Center to the west.

Refuge staff participates in 5 to 10 events each year; however, limitations in funding and time have prevented more extensive efforts. The Friends of Great Swamp NWR provide guided walks and are developing a loan library of refuge and wildlife-related materials for area schools such as the "Swamp in a Box" and education needs. Binoculars are also available for loan to educational institutions that visit the refuge. The *Friends* also set up educational displays at local libraries and schools, and represent the refuge at local environmental fairs.

Environmental Interpretation

The refuge provides many opportunities for environmental interpretation. Visitor information is provided at the reception area in refuge headquarters, the Visitor Center, the WOC, and the Overlook and Bluebird Lot on Pleasant Plains Road. The WOC has an eight-paneled kiosk to help orient visitors to the refuge and describes relevant activities, wildlife, and habitats. The Overlook, Bluebird Lot, the WOC, and each of the four wilderness trailheads also have three-paneled kiosks. Refuge staff participate in several outreach events each year; however, limitations in funding and staff availability impeded participation in more events. Refuge staff and members of the *Friends* group are available at the Helen C. Fenske Visitor Center to answer questions and assist visitors. In addition, during certain times of year (e.g., spring and fall bird migration), refuge staff or members of the Friends of Great Swamp NWR are available at the WOCto assist visitors. Members of the *Friends* group also provide guided bird walks and work closely with staff to organize an annual Fall Festival event.

The refuge has two traveling displays for outreach events, one prefabricated refuge exhibit and one folding display that can be customized. The *Friends* group has also worked with refuge staff to develop a slide presentation and has a number of videos available.

2.7.3 Authorized Other Public Uses

Some specific non-wildlife public uses have been determined to be compatible with refuge purposes and are authorized with certain restrictions on the refuge. Examples include pedestrian travel (e.g., walking or hiking, snow-shoeing, cross country skiing) to facilitate priority public uses; recreational berry, fruit, and nut picking; Landowner access to private inholdings; bicycling and Dog Walking and horseback riding on Pleasant Plains Road. For further discussion on these non-wildlife uses, see section 2.3.4, Step-Down Plans, Findings of Appropriateness, and Compatibility Determinations

2.8 Cultural, Archaeological, and Historic Resources

2.8.1 Introduction and Historic Registers

To assist in developing the CCP for Great Swamp NWR and to ensure compliance with the NHPA, FWS contracted with JMA to complete a detailed updated overview of the cultural resources of the refuge. Building off a previous overview completed in 1978 (Thomas 1978), JMA completed a document describing the current status of known cultural resources (JMA 2010). Unless otherwise cited, the information presented in the cultural resources section has been summarized from this report.

The JMA report (2010) identified 123 cultural resources within the refuge's approved acquisition boundary. According to the report, 100 are within or intersect parcels FWS has acquired interest in or currently owns. The remaining 23 are located within parcels that have not been acquired by FWS at this time. Thirty-two of the identified cultural resources are considered prehistoric sites (i.e., before 1750), 57 are from the historic era (1750 to mid-1900s), 3 have prehistoric and historic components, and 31 are standing structures. To date, no sites within the acquisition boundary are listed on the National Register of Historic Places (NRHP) or the New Jersey Register of Historic Places. Two sites within the acquisition boundary have been characterized as eligible for listing on the NRHP, one pre-historic site and one standing structure. The pre-historic site (GRS-097P; 28-MR-212) was recommended for eligibility based on a single Munsee-incised ceramic shard of the Late woodland period [1300 Before Current Era (BCE) – European Settlement] (Harris and Ziesing 2010). The structure, Baird Tenant House (GRS-077S), is a rare intact example of a once locally common house type, the East Jersey cottage and was therefore recommended for eligibility (Harris and Ziesing 2010).

2.8.2 Onsite History and Resources

Prehistoric Resources

Analysis of artifacts recovered within and around Great Swamp NWR demonstrates that prehistoric use by people likely began in the Paleo-Indian Period and continued through the Woodland Period (the last prehistoric period). The Paleo-Indians at this time may have hunted such species as mastodon, caribou, and giant beaver in the lower elevations of the swamp, while the women collected berries, roots and bird's eggs (Parrish and Walmsley 1997). Of the 35 prehistoric sites identified, only 7 have had radiocarbon dating. Dates from these artifacts range from between 2576 BCE to 2151 BCE; however, professional analysis of another artifact indicates that people have used the Great Swamp since about 10,000 years ago (about 8,000 BCE). Most of the artifacts recovered are flakes (i.e., knives and points), although other artifacts include pottery and steatite bowls. Because of the agricultural history of the area, it is not surprising that all of the known prehistoric sites have experienced some level of disturbance, primarily from plowing.

Circa 8,000 BCE, the climate began to warm, causing certain species, such as the mastodon, to become extinct and deciduous forests to flourish. These changes resulted in an alteration of the Native American's way of life, including expanding food-gathering techniques to include fishing and gathering of nuts and wild plants. The main time span represented on the refuge is Late Archaic to the Transitional Archaic (4000 BCE to 1000 BCE). Prehistorically, much of the refuge was a combination of peat, swamp, and grasslands. Based on this information, known site locations, and artifacts recovered, researchers believe that Late

Archaic and Woodland groups were likely using the area seasonally to exploit available resources (plants and animals) with only transient or semi-permanent camps. Late Archaic sites appear to be located on areas of high ground within the lowlands, while Late Woodland sites appear to be associated with navigable waterways.

Native peoples in the area belonged to the Lenape (or Delaware people), an association of tribal groups connected by shared culture and language. They were known as peace keepers and were often called upon by other tribes to help settle disputes (Delaware Tribe of Indians 2009). The Lenape were divided into three major groups, the Munsee (Wolf clan), Unami (Turtle clan), and Unalachtigo (Turkey clan) (Mauser 2009). Local Native Americans began practicing farming by the Late Woodland Period (900 to 1650) (Parrish and Walmsley 1997). They raised crops such as maize, beans and squash, gathered wild plants, and hunted both for food and to sell fur to European traders (Mauser 2009). Typically, women were in charge of crops and gathering while men were responsible for hunting, fishing, and preparing the fields for planting (Mauser 2009).

As with other Native Americans, the Lenape were forced to move west as European settlers arrived. Over the last 300 plus years, most of the Lenape moved through Pennsylvania, Ohio, and Indiana before dividing into two groups in Illinois (Delaware Tribe of Indians 2009). Both groups eventually settled in Oklahoma, the majority with the Cherokee in Bartlesville and the rest in Anadarko. A third group split off early and moved north through New York, settling in Ontario, Canada where there are currently several settlements. Federally recognized Lenape Tribes from the New Jersey area include the Stockbridge Munsee Community of Wisconsin and the Delaware Nation (from Anadarko, OK) (Small 2009). In May of 2009, the Delaware Tribe of Indians voted in a secretarial election to re-establish its status as an independent federally recognized Tribe (Delaware Tribe of Indians 2010).

Early European Historic Resources

Circa 1600, the first European settlers arrived in the Great Swamp region. Upon arrival, they encountered the Lenape Indians. The Lenape coexisted with the settlers and often traded furs in exchange for knives, glass beads, scissors and cloth (Parrish and Walmsley 1997). Consequently, the Lenape were decimated by diseases, such as smallpox, cholera, and measles, to which they had no immunity. In addition, they were often forced to sell their land and move west as European establishment increased. The first recorded transaction between the Lenape and Europeans occurred near Great Swamp in 1708. According to the "Old Indian Deed," (dated August 13, 1708) 30,000 acres were purchased by British investors for:

> "*…ye Summe of thirty pounds of cash, ten stran'd-water blankets, half a barr'l of wine, one barrel of rum, two barrels of sider, three files, one gun-boer, one auger, four pistolls, four cutlasses, ten gunnes, one hundred barros of lead, half a barrel of powder, ten white blankets, twenty shirts, and one hundred knives".*

European settlement began in the area during the last decade of the 1600s with the Dutch, followed by the English. However, there is no documentation or evidence of European settlement in the Great Swamp area prior to 1708. In fact, Great Swamp remained largely a swamp until the middle of the 18th century. It was heavily wooded by this time, and the land was more valued for its timber than for farming. The desolate nature and rich resources of Great Swamp played an important strategic role during the American Revolution. The Crossroads of the American Revolution Study conducted by the National Park Service and

the State of New Jersey recognized it as a truly significant site of the American Revolution (NPS 2002; Harris and Ziesing 2010). During the winters of 1777 and 1779 to 1782, George Washington used the high ground areas immediately around Great Swamp for his camp sites. The Morristown area was chosen by Washington because of its strategic location between New York and Philadelphia and the natural fortifications that surround Morristown including the Watchung Mountains, Long Hill and surrounding swamplands (Harris and Ziesing 2010). The rich natural timber and agricultural resources of the region, including those of Great Swamp, also factored into his decision to utilize the Morristown Area for winter encampments. Timber from the Great Swamp was likely used to make wagon wheel rims and log cabins for the army during the winter campaigns (NPS 2002a; Harris and Ziesing 2010).

As the 19th century approached, local populations expanded and economic demand for agricultural products increased (Momsen 2007). Settlement within the present-day Great Swamp NWR likely began at this time as did the conversion of refuge's western swamplands to agricultural fields. Records suggest that by the mid-1800s, a majority of the lowest elevations in the basin may have been logged. By 1844, farmers were draining the marshlands and began planting crops such as foul meadow hay; however, logging activities resulted in flooding, which lead to crop failure. In a report prepared by the New Jersey State Geologist, dated 1899, "cutting was most severe about 1850, and from 1850 to 1860 was the period of maximum deforestation" (Collins and Anderson 1994). During the late-1800s, Great Swamp's woodlands were further logged in response to the demand for lumber to construct boats for the Morris Canal, railroad ties, and fruit baskets; fuel for mills and iron forges; shingles; and pitch, turpentine, and rosin for shipyards (Cavanaugh 1978). In spite of these intense land pressures during this period, Pleasant Plains remained only known settlement within Great Swamp through the early 1900s.

During the early 1900s, local land use patterns again underwent change, as agricultural land was converted to country or vacation homes and estates for the affluent urban population. This appears to have protected the northern portion of the swamp from being suburbanized. In the 1950s land use was further altered by middle-class expansion and the advent of subdivisions and suburban commuters.

Dumping and asbestos disposal also became an issue in the 1900s. Two landfills were created, a large landfill on the north side near Green Village and a smaller landfill on the southern edge of the refuge. Of the 60 historic sites currently identified, 5 are thought to date from the 18th century or have 18th century components (all farms), 27 are thought to date from the 19th century (26 farms or farmsteads along roads), the remainder are thought to be from the 20th century.

Chapter 3

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Alternatives Considered, Including the Service-Preferred Alternative

- Introduction
- Actions Considered, but not Included in Alternatives
- Actions Common to All of the Alternatives
- Refuge Management Alternatives: Goals, Objectives, and Strategies

3.0 Introduction

Each of the four management alternatives identified below are defined by refuge goals and objectives. As we described in chapter 1, developing refuge goals was one of the first steps in our planning process. We have developed goals that are broad, descriptive statements of our desired future condition for refuge resources. By design, the goals are less quantitative, and more prescriptive, in defining management targets. Goals also articulate the principal elements of refuge's purposes, vision statement, and provide a foundation for developing specific management objectives and strategies. Our goals are common to all four alternatives.

In developing this CCP, we considered a range of possible management objectives that would help us meet the above referenced goals. Objectives are incremental steps toward achieving the relevant goal. Objectives vary among the alternatives and form the basis for strategies, monitoring refuge accomplishments, and evaluating the success in meeting our goals. The FWS guidance in "Writing Refuge Management Goals and Objectives: A Handbook" (USFWS 2004b) recommends that objectives be "SMART" by possessing five key properties: (1) Specific; (2) Measurable; (3) Achievable; (4) Results-oriented; and (5) Time-fixed. A rationale accompanies each objective to explain its context and importance.

The next step in developing a CCP/EA for Great Swamp NWR involved identifying strategies to support each objective. These strategies are specific actions, tools, techniques, or a combination thereof that we may use to achieve a specific objective. The list of strategies supporting each objective is the series of actions to be implemented and evaluated.

We grouped objectives into "alternative themes." For example, we considered themes such as "current management" (e.g. the "no action alternative," "enhance biological diversity and public use opportunities," "maximize forest habitats," and "maximize priority public uses"). We then developed four alternatives after evaluating how each respective objective complements the other objectives. We also evaluated the alternatives for their compatibility with refuge purposes, and the feasibility of accomplishing the objectives in a reasonable time frame and budget. The four alternatives were scrutinized for their feasibility in managing the refuge for a 15-year period. The selected alternatives represent a reasonable range of proposals for achieving the refuge purpose, vision and goals, and addressing the issues described in chapter 1. Unless otherwise noted, all actions will be implemented by refuge staff with the assistance of partners and volunteers.

Alternative A is the "no action" alternative, which is defined as "continuing current management." This alternative describes the FWS current management priorities and activities, and serves as a baseline for comparing and contrasting alternatives B, C, and D.

Alternative B is the FWS preferred alternative because it combines the actions that most closely achieve Great Swamp NWR purposes, vision, and goals, the mission of the Refuge System, and responds to public issues. This alternative emphasizes management of specific refuge habitats to support viable populations of focal species whose habitat needs benefit other species, especially those of conservation concern, while maintaining some early successional habitats that provide popular and high quality wildlife viewing opportunities. Habitats will be reconfigured and maintained to create large (greater than 50 acres), contiguous patches to promote wildlife use, increase connectivity, decrease fragmentation, increase maintenance efficiency and reduce equipment, maintenance and fuel costs. The total number of acres of

refuge land that would undergo intensive management would decrease. Within 5 years, open water habitat will be evaluated to determine the ecological costs and benefits of maintaining, enhancing, or allowing succession in each of the impoundments. Alternative B emphasizes habitat for priority bird species identified for BCR 28 and BCR 29, as well as for PIF Physiographic Areas 9 and 10. Habitat for federally listed species, including the bog turtle and Indiana bat, is also prioritized in the preferred alternative. In developing Alternative B, we consulted with the NHP and NJWAP to identify State and regional species and vegetation communities of conservation concern. Alternative B also addresses the Refuge System's mandate to manage habitat in accordance with the BIDEH policy (601 FW 3). This alternative proposes to improve wildlife viewing and photography opportunities in a variety of habitats, as well as expand partnerships and increase public outreach. We would increase outreach to urban populations in the vicinity of the refuge including Newark and New York City and encourage new visitation from urban population centers. We are also proposing additional hunting opportunities at the refuge, including an archery deer hunt and spring turkey hunting. We are proposing these additional hunting opportunities to comply with our mandate to provide additional opportunities for wildlife-dependent recreation when they are found to be compatible. The turkey population in the vicinity of the refuge has increased since turkeys were reintroduced to the area in the 1980s and the population can support a spring hunting season. We would increase the number of environmental education programs and efforts to draw urban populations to the refuge. Alternative B attempts to balance public use with resource protection.

Alternative C emphasizes management to maximize core forest habitats, while maintaining large (greater than 50 acres) contiguous patches of actively managed grasslands and scrub-shrub habitats. Compared to alternatives A and B, this alternative would more strictly follow the BIDEH policy to guide management to restore, where practical, the distribution of natural communities of the Great Swamp that would have resulted from natural processes without the influence of human settlement or management intervention. This alternative recognizes that refuge habitats and wildlife populations are not ecologically independent from the surrounding landscape and, that by taking a long-term regional perspective, the refuge can best contribute to higher conservation priorities at greater scales. Management direction is primarily derived from regional plans and directives, including relevant BCR and PIF plans and the NJWAP, which prioritizes forest and successional shrub habitats in the Northern Piedmont Plains region of the State. Alternative C would continue to provide actively managed habitats in select areas to maintain wildlife viewing and photography opportunities for refuge visitors, as well as vital habitat for the refuge's species of conservation concern. These areas would also be more accessible to refuge staff for performing management activities, such as mowing, since a majority of these areas would be located adjacent to roadways and small isolated tracts would be allowed to succeed. Although some open water habitat would be eliminated (i.e., Pools 3A and 3B), the refuge would continue to maintain open water habitat for waterfowl use. Similar to alternative B, this alternative also proposes to improve public use opportunities, as well as expand partnerships and increase public outreach.

Alternative D emphasizes expanding wildlife-dependent priority public uses on the refuge. Public use and access would be maximized to the greatest extent practical, while minimizing impacts to wildlife, through the creation of new trails, observation towers, and parking lots. In addition, fishing opportunities would be provided in select areas of the refuge. This alternative would maximize public outreach, enhance and develop new environmental interpretation and education programs, aggressively expand partnerships, and increase staff presence at programs and events. In general, refuge habitats would be managed similarly to alternative B; however, this alternative would increase open water habitat to improve public viewing opportunities.

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We developed a habitat management map and a public use map for alternative B; a habitat management map for alternative C; and a public use map for alternative D. Using Geographic Information Systems (GIS) mapping tools and data sets, the habitat maps are intended to help readers visualize where the refuge would likely conduct habitat management strategies on the ground in each alternative. The habitat management maps are not meant to identify exact locations for implementing a particular strategy on the ground. Explanation of habitat management strategies are detailed further in the objectives section of each alternative. During the implantation phase, the refuge staff will have the management discretion to determine the specific strategies to apply to particular sites, as well as, the level, and timing of these applications. These details will be developed in the Habitat Management Plan and annual habitat management work plans (see "Refuge Step-Down Plans" below).

The public use maps are intended to show where the refuge would add new infrastructure for visitors, such as new trails, parking lots and pull-offs, and new observation platforms. The exact location of the new trails and other infrastructure to be built will also be decided during the implementation stage or during development of a VSP (see "Refuge Step-Down Plans" below) with the help of engineers and other professionals.

3.1 Actions Considered, but not Included in Alternatives

Elimination of hunting programs

The planning team reviewed the hunting program on the refuge and determined that the existing hunting program is effective in maintaining a healthy deer population, healthy forest ecosystems, and providing a quality public hunting opportunity. We determined that because hunting opportunities in the area are limited, that eliminating all hunting opportunities on the refuge would have a detrimental impact on the health of the deer population in the area, habitats, and the public that participates in hunting. We have included minor changes to the hunting programs in each of the alternatives.

Non-motorized Boating Access to the Passaic River and Great Brook

Currently, we do not provide access across refuge lands to the Passaic River or Great Brook. A number of individuals requested canoe/kayak access to these rivers across refuge lands. There are existing access points off refuge from which boaters can paddle upstream along the Passaic River along the western boundary of the refuge. We have determined that while portions of the Passaic River may be considered navigable; we are concerned about the potential for impacts to species and habitats, including endangered species adjacent to these streams if we provided access to the Passaic River or Great Brook. The area that would be impacted by creating access points is adjacent to sensitive waterfowl nesting areas and would cross potential bog turtle habitat. Therefore, we have not included river access in any of the alternatives.

3.2 Actions Common to All of the Alternatives

All of the alternatives share certain actions that are required by law or policy, or; they may be administrative actions that do not necessarily require public review, but we want to highlight them in this public document. They may also be actions that we believe are critical to achieving the refuge's purpose, vision, and goals. The following actions are common to all alternatives:

- use an adaptive management approach, including strategic habitat conservation, where appropriate
- construct additional facilities to improve administrative infrastructure
- control pest plants and animals
- monitor and abate diseases affecting wildlife health
- facilitate or conduct biological research and investigations
- address climate change
- issue special use permits
- protect cultural resources
- develop an off-site interpretation program
- complete findings of appropriate use and compatibility determinations
- provide refuge staffing and administration
- complete refuge step-down plans
- improve inventory and monitoring programs by maintaining an organized data management system

3.2.1 Developing Refuge Step-Down Plans

The FWS planning policy identifies 25 step-down plans that may be applicable on any given refuge. We have identified and prioritized the plans below as the most relevant to this planning process. These plans will be modified and updated as new information becomes available. Completion of these plans supports all five refuge goals.

All of the alternatives require the completion of these step-down management plans, as described below:

- an HMP, immediately following CCP approval
- a Wilderness Stewardship Plan, within 2 years of CCP approval

- a VSP, within 2 years of CCP approval
- an FMP, within 5 years of CCP approval
- Hazardous Waste Site Operation and Maintenance Plan, within 5 years of CCP approval
- Hunting Plan, within 1 year of CCP approval
- Population Management Plan, within 10 years of CCP approval
- Law Enforcement Plan, within 5 years of CCP approval (see discussion below)

We will use the objectives in the alternative selected for the final CCP to write refuge step-down plans. Each of the step-down plans will contain specific strategies and implementation schedules for achieving refuge goals and objectives identified in the CCP. Some plans require annual revisions, while others require revision every 5 to 10 years. In addition, some plans may require additional NEPA analysis, public involvement, and compatibility determinations before they can be implemented.

Habitat Management Plan

An HMP will define management areas, treatment units, treatment types or methods, management actions, and success measurement over the next 15 years. An HMP is the first step in achieving the objectives of goals 1, 2, and 3, regardless of the alternative selected for implementation. For example, the HMP will incorporate the selected alternative's habitat objectives developed herein and will also identify more precise descriptions of the locations of the actions and strategies that will be implemented over the 15-year time frame of the CCP. The HMP will also address prescribed burning as a management tool. In this CCP, the goals, objectives, and list of strategies under each objective identify how we intend to manage habitats on the refuge. Both the CCP and HMP are based on current resource information, published research, and our own field experiences. Our methods, timing, and techniques will be updated as new, credible information becomes available based upon the principles of adaptive management. To facilitate our management, we will regularly maintain our GIS database, documenting any major vegetation changes on at least a 3-year basis. As appropriate, actions listed in "Actions Common to All Alternatives" will be incorporated into the HMP.

Wilderness Stewardship Plan (WSP)

A WSP guides the preservation, stewardship, and use of a particular wilderness area. A WSP is a step-down management plan (602 FW 1.6, 602 FW 4, and 610 FW 3) that provides detailed strategies and implementation schedules for meeting the broader wilderness goals and objectives identified in this CCP. The WSP will provide specific, measurable stewardship strategies, as well as indicators, standards, conditions, or thresholds that define adverse impacts on wilderness character and values. The WSP will describe stewardship actions that will be implemented to preserve wilderness character and reduce or prevent adverse impacts to the wilderness area. Lastly, the WSP will describe new and continued monitoring and research needs, appropriate and compatible uses and associated determinations, and Minimum Requirement Analyses (MRAs) for refuge management activities and commercial services. A

WSP for the refuge will be necessary in achieving the objectives of goals 1, 3, 4, and 5 regardless of the alternative selected. The WSP will be updated, as necessary.

Visitor Services Plan

A VSP is a step-down management plan that documents approved recreational activities, identifies the structure of the visitor services program, and discusses operational limitations, biological constraints, and partnership opportunities. A VSP will guide visitor services and ensure recreational uses are compatible with the Refuge System mission and the purposes of the refuge. The plan will set goals, determine measurable objectives, identify strategies, and establish evaluation criteria for all visitor services. A VSP for the refuge will be needed in order to accomplish the objectives of goals 4 and 5, regardless of the alternative selected.

Fire Management Plan

An FMP enables the refuge to consider a full range of appropriate fire suppression strategies and to conduct prescribed fires. An FMP defines a program to manage wildland fires and assures that wildland fire management goals and components are coordinated. The Department and FWS require that every area with burnable vegetation have an approved FMP. The goal of wildland fire management is to plan and make decisions that help accomplish the mission of the Refuge System. Without a FMP, prescribed fires cannot be conducted and only wildfire suppression strategies may be implemented. Prescribed fire will be included in the HMP since it will be used as a habitat management tool. The FMP will identify and integrate all wildland fire management and related activities within the context of this approved CCP. The FMP will be reviewed and/or revised at a minimum of 5-year intervals, or when significant changes are proposed, such as if major land use changes occur adjacent to refuge lands (621 FW 2.3C-4).

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Hazardous Waste Site Operation and Maintenance (O&M) Plans

A Hazardous Waste Site O&M Plan documents the FWS approach for maintaining the integrity and monitoring the effectiveness of the remedial actions that have been implemented at contaminated sites on the refuge. O&M plans have been developed and implemented for the two major remediated sites on the Refuge (OU 3 and Harding Landfill). OU3 remediation was performed by FWS pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) process and was completed in 1998. The 6-acre site was removed from EPA's NPL in 2010. The 1-acre Harding Landfill remediation was completed in 2001 pursuant to a presumptive remedy agreement with EPA and NJDEP. Both O&M plans have provisions for 5-year reviews at which time they can be modified to address changing conditions. The Refuge Contaminants Biologist is responsible for implementing both plans, evaluating their effectiveness and making changes as necessary. Currently, both plans involve quarterly

inspections, annual collection and analysis of groundwater, surface water and sediment samples, and maintenance of native grass cover.

The third major contaminated site on the Refuge is the Rolling Knolls Landfill. This site is currently in the CERCLA remedial investigation phase. The work is being performed by private parties under EPA oversight. Approximately 30 acres of the more than 100-acre landfill is within the refuge boundary on the east side of the refuge within the Wilderness area. Therefore, once remediation is completed, an O&M plan will be developed by the responsible parties and approved by EPA. FWS will have opportunity to review and comment on the plan. It will not be the responsibility of the Refuge to perform any O&M activities. However, all O&M reports and data will be reviewed by the Contaminants Biologist in coordination with EPA.

An additional minor site requiring O&M is the former Bardy Field. The former agricultural site was remediated under a plan approved by FWS and NJDEP, prior to purchase by FWS. O&M consists of visual inspections by the Refuge Contaminants Biologist and periodic mowing of approximately 20 acres to maintain a grass cover and prevent establishment of woody vegetation.

Hunting Plan

The purpose of the Hunting Plan is to establish guidelines for hunting that will provide the public with a quality wildlife-dependent recreational experience, an opportunity to use a renewable resource, and the ability to maintain wildlife populations at levels compatible with refuge habitat. Although a Deer Hunting Plan currently exists in draft form, a Hunting Plan will be developed that will also include wild turkey. The Hunting Plan will describe the species covered by the plan; the objectives of refuge hunts; compatibility and conformance with refuge purposes; measures taken to avoid conflicts with other management objectives (i.e., biological, public use, and administrative); conduct of the hunt; procedures for consultation and coordination with others; hunter requirements and regulations; data collection and monitoring; and funding and staffing requirements to conduct the hunts. The hunting program will be reviewed and updated annually by refuge staff. Refer to section 2.7.2, Priority Public Uses, Hunting for additional information.

Law Enforcement Plan

A Law Enforcement Plan describes the refuge's policies, rules and regulations, and standard operation procedures for the law enforcement program.

3.2.2 Refuge Staffing and Administration

In all the alternatives, our objective is to fiscally sustain levels of annual staffing, fleet, facilities, equipment, and supplies that allow us to achieve refuge purposes, as interpreted by the goals, objectives, and strategies in this draft CCP/EA. We achieved many of our most highly visible projects since refuge establishment through special project funds that typically have 1 to 2 year durations. Although those funds are still vital, their flexibility is limited, because they cannot be used for any other priority project that may arise, and there is often no reliable source for sustaining recurring work over the longer term. Funding for land acquisition derives primarily from two sources: the LWCF and the Migratory Bird Conservation Fund. We generally direct the funds from those sources at specific acquisitions.

In 2007, our Regional Directorate completed the "Strategic Workforce Plan for National Wildlife Refuge System in Region 5" (Phase 2; January 16, 2007) to support a new 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 would be operating and maintenance funds. Our strategy is to improve the capability of each refuge manager to do the highest priority work, and not to have most of a refuge budget tied up in inflexible fixed costs. This strategy was successful for a few fiscal years; however, we now anticipate a level or declining budget environment, which will impact flexibility in managing financial resources and may have implications for the level of permanent staffing. A new round of workforce planning began in 2013 in response to the sequester and anticipated future budget reductions.

In appendix D, we identify the different levels of staffing needed to successfully implement each alternative; however, our budgets are determined annually by Congress and distributed through our Washington and Regional offices before arriving at field stations. In all alternatives, within the constraints or opportunities of our budget and in conformance with future workforce, plans, we would seek to fill any currently approved but vacant positions, which we believe are necessary to accomplish our highest priority projects. Alternatives B, C, and D also propose additional staff to provide depth in our biological and visitor services programs.

3.2.3 Appropriateness and Compatibility Determination

The requirements for appropriateness and compatibility determinations are described in chapter 1. Appendix B includes draft appropriateness and compatibility determinations to support the activities in alternative B, the FWS-preferred alternative. The final CCP will include the approved compatibility determinations for the alternative selected. Only those activities that we have determined to be compatible and meet or facilitate refuge purpose, goals, and objectives will be allowed. (603 FW 2) (USFWS 2000d).

When the FWS acquires land within the current acquisition boundary in full, fee-simple ownership, we would consider public access and compatible public recreation, and other refuge uses, consistent with what is currently permitted or proposed, on existing refuge lands. All tracts of land considered for acquisition are reviewed for compatible priority public uses, which may get incorporated into the management of the parcel. In addition, all parcels are acquired under the primary purposes of refuge. Any potential conflicts are researched and resolved by a Department Solicitor prior to acquisition. When a conservation easement, or a partial interest, is purchased, the FWS objective is to obtain all rights determined necessary to ensure protection of the federal trust resources of that parcel. At a minimum, the purchase would include development rights; however, we may also seek to obtain the rights to manage habitats, and/or to manage public use and access, if the seller is willing and we have funding available.

3.2.4 Wildlife-Dependent Recreational Program

In 2006, wildlife observation, photography, and environmental interpretation were identified by the Regional Office as the refuge's lead areas of emphasis (USFWS 2009c). This determination was made based on careful consideration of our natural resources, existing staff, operational funds, existing and potential facilities, and which programs we would be most effective in providing "quality" opportunities for visitors.

The Policy Analysis and Science Assistance (PASA) Branch of the USGS, in cooperation with the FWS, has been a conducting a study of refuge visitation that provides useful data at the national, regional, and field station levels. This survey effort allows for a better understanding of visitors' recreational, educational

and informational experiences, and measures satisfaction with current services, access, and facilities. USGS conducted a visitor survey at the refuge in fall 2010 and spring 2011. While all priority public uses are important, wildlife observation and environmental interpretation will receive greater emphasis as the refuge prioritizes resources for visitor services in this draft CCP/EA. As always, we look to our partners, friends, and/or other volunteers to help develop and assist with the refuge's public use programs.

3.2.5 Refuge Operating Hours

Refuge lands that are open to the public are open for visitation 7 days a week, year round, from sunrise to sunset. The entire refuge is closed to the public from sunset to sunrise to ensure visitor safety and to protect refuge facilities and resources. The refuge headquarters, located at 241 Pleasant Plains Road, is open from 8:00 a.m. to 4:30 p.m., Monday through Friday. The WOC is open from sunrise to sunset and is staffed by volunteers on weekends during spring and fall.

The Helen C. Fenske Visitor Center (Visitor Center), located at 32 Pleasant Plains Road, is open from 12:00 p.m. to 4:00 p.m. on Thursdays and Fridays, and 10:00 a.m. through 4:00 p.m. on Saturdays and Sundays. The Visitor Center also contains the Friends of Great Swamp NWR Nature Shop. North Gate on Pleasant Plains Road opens 30 minutes before and closes 30 minutes after Visitor Center hours to allow travel between the Visitor Center and other refuge facilities. South Gate opens at sunrise and closes 15 minutes before sunset daily.

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The refuge manager has the authority to issue a SUP to authorize access outside of these timeframes. For example, researchers may be permitted access at different times, if necessary, for successful completion of a research project.

3.2.6 Commercial and Economic Uses

There are currently no commercial or economic uses on the refuge and none are proposed under any of the alternatives.

3.2.7 Reserved Rights

While purchasing land to complete the refuge boundary, the FWS has acquired land with reserved rights, rights-of-way, leases, and other agreements. Most include rights-of-way to run power transmission lines and gas pipelines across the refuge to serve commercial and residential interests. Other types of agreements listed in realty files include flooding and drainage rights, riparian rights, and access rights. There are also 13 life estates currently listed in realty files for land owned by the refuge. A life-use reservation is established when a landowner chooses to sell land to the FWS in fee simple, while retaining the right to occupy an existing residence. As the name implies, life- estates apply to the seller's lifetime or to a specific number of years. After the appraisal is approved and before making an offer, the FWS

discounts from the appraised value of the buildings and land the value of life use, based on the age of the owner and the term of the life estate. The occupant is responsible for the upkeep on the reserved premises (USFWS 2011b).

The refuge will follow policy guidance when any of these reserved rights are exercised. Specifically, the refuge will follow 50 C.F.R. 29.21-8 for electric power transmission line rights-of-way and 50 CFR 29.21-9 for rights-of-way for pipelines for the transportation of oil, natural gas, synthetic liquid, or gaseous fuels, or any refined product produced there from. The refuge will also ensure compliance under the refuge compatibility policy (603 FW 2) and BIDEH policy (601 FW 3). Depending on the location, nature and extent of disturbance required to exercise reserved rights on refuge lands, other laws may apply. In general, the refuge will coordinate with all private parties exercising their rights to ensure the protection of refuge resources. The refuge will issue SUPs, as necessary, to manage these uses and to ensure that impacts to refuge resources are minimized to the greatest extent practicable.

3.2.8 Additional Office Space

With the addition of the Helen C. Fenske Visitor Center, refuge staff are now housed in three different buildings, which incurs additional costs associated with utilities and maintenance. In addition, the FWS is currently assessing the viability of collocating multiple offices onto FWS managed lands. There is potential to provide office space at the refuge for employees of the Office of Law Enforcement or Ecological Services. The current Visitor Center plans include the addition of a multi-use wing. The refuge will pursue the potential for the design and funding of additional office space to house all of the refuge staff and additional FWS staff in one structure. The refuge will comply with all wetlands laws and regulations for such an addition. Under this scenario, the existing pole barn that is located behind the Visitor Center would be converted to additional maintenance, visitor services program, and/or storage space.

3.2.9 Community Relations

Knowing that public lands cannot survive without the constituency that supports them, the refuge will continue to uphold and build relationships that promote sound stewardship through partnerships developed in the communities we serve. The refuge will continue to work with community organizations, such as the GSWA, attend township meetings, and participate in other venues. Refuge staff will maintain an ongoing dialogue with our congressional delegation, the State of New Jersey, the Somerset and Morris County Commissions, local elected officials, the business community, and refuge neighbors. We will foster a spirit of cooperation with all of our stakeholders and be transparent in our management of lands entrusted to us by the American people.

3.2.10 Cultural Resources

As a Federal land management agency, we are entrusted with protecting historic structures and archaeological sites on refuge land, which are eligible for or listed on the National Register of Historic Places. The FWS archaeologists in the Regional Office keep an inventory of known sites and structures and ensure that we consider them in planning new ground disturbing or structure altering changes to the refuge. We consult with the New Jersey Historic Preservation Office (SHPO) concerning projects that might affect sites and structures, and conduct archaeological or architectural surveys, when needed. Projects can usually be redesigned to avoid affecting National Register eligible sites or structures.

Under all alternatives, we will conduct an evaluation of the potential to impact archaeological and historical resources as required, and will consult with SHPO. We will be especially thorough in areas along the rivers and streams where there is a higher probability of locating a site. These activities will ensure we comply with Section 106 of the NHPA, regardless of the alternative. That compliance may require any or all of the following: a State Historic Preservation Records survey, literature survey, or field survey.

3.2.11 Land Acquisition

The refuge currently comprises 7,768 acres of wildlife habitat. The refuge has an approved acquisition boundary that would allow for the refuge to expand to 9,429 acres. Under all alternatives, we would continue to pursue acquisition from willing sellers of the 1,661 acres that remain in private ownership within the refuge's approved acquisition boundary. The tracts identified for acquisition include a variety of habitat types, along with residential, commercial, and agricultural land (including nurseries and greenhouses). In the past, lands that the refuge acquired that were disturbed or developed have been restored to natural habitat conditions. Other lands within the approved acquisition boundary include land that is owned by a Natural Lands Trust and four Farmland Preservation properties (map 2-3). Other lands adjacent to the refuge include the Fairmont Country Club, a portion of which is located within the eastern portion of the approved acquisition boundary. The former Rolling Knolls Landfill is located adjacent to the northeast boundary of the refuge. Approximately 40 acres of the former landfill is owned by the refuge and situated within the Wilderness Area (refer to section 2.1.4, Chemical Contaminants, for further information).

In general, the refuge acquires additional tracts of land through monetary purchases, land donations, and in rare circumstances, land exchanges. Our preference would be to acquire new lands in fee simple since that method ensures maximum management control and flexibility; however, the acquisition method would also take into consideration the needs and desires of the present landowner. As we continue to acquire new lands, we will manage them in accordance with the goals, objectives, and strategies under the approved alternative.

As land is considered for acquisition by FWS, the habitat types, habitat connectivity, and associated wildlife populations and plant community values are factored into the FWS decisions about priorities. Once land is acquired, we would determine future management of the site based on the particular habitat type that it contains in relation to the habitat types on adjacent lands. For example, new land acquisitions that contain pasture may be considered for continued grassland management for grassland obligate bird species if there are at least 50 acres of habitat within the newly acquired property or the land is contiguous with existing refuge lands currently being managed for grassland. Lands that contain wetland habitat would be protected and we would consider increasing the adjacent transition area (or buffer) to improve riparian corridors, prevent soil erosion, and reduce habitat fragmentation. We would consider managing land that contains forest edge habitat for successional forest management to provide young, dense vegetation for early successional priority bird species. Alternatively, forested habitat that is contiguous with stands of forest on existing refuge lands may be protected and managed to improve forest interior breeding bird habitat or to maintain movement corridors between the refuge and other protected lands in the watershed.

3.2.12 Land Conservation Partnerships

All alternatives include the refuge's continued participation in land conservation partnerships with the goal of permanently protecting and sustaining federal trust resources and other unique natural resources of the

refuge. An important component of this goal is to improve connectivity between conservation tracts to increase habitat patch size and reduce fragmentation. The Preferred Alternative includes provisions for increased partnerships with local land conservation agencies, such as the Nature Conservancy and the township and county environmental education centers. Under alternative C, the refuge would increase coordination with regional partnerships, such as PIF, to encourage dynamic, landscape-level, multi-partner efforts. Existing and potential partners include other federal agencies, state agencies, private conservation organizations, local communities, educational institutions, private businesses, and private landowners.

3.2.13 Youth Conservation Corps

The Youth Conservation Corps (YCC) Act of 1970 (16 U.S.C. 1701-1706, 84 Stat. 794) establishes permanent programs within the Departments of the Interior and Agriculture for young men and women between the ages of 15 and 18 to perform specific tasks on lands and waters administered under the jurisdiction of these Secretaries (USFWS 2010f). Within the FWS, YCC participants perform various tasks on national wildlife refuges, national fish hatcheries, research stations, and other facilities (USFWS 2011c). The YCC programs are conducted for 8 to 10 weeks during the summer, most of which is spent outdoors. All participants are expected to gain an appreciation and understanding of the environment and America's conservation heritage equal to one full academic year of study (USFWS 2010f).

The refuge formerly participated in the YCC program, which generally consisted of a crew of 6 to 24 persons and one crew leader for every six enrollees. In the past, YCC crews accomplished many important tasks in support of our biological programs, visitor services programs, and maintenance needs. Alternatives B and D propose to re-establish the YCC program as a tool for targeted outreach and recruitment of urban and minority youths.

3.2.14 National Natural Landmark

The National Natural Landmarks (NNL) Program was established by the Secretary of the Interior in 1962 under the authority of the Historic Sites Act of 1935 (16 U.S.C. 461 *et seq.*) to identify and encourage the preservation of geological and biological features that were determined to represent nationally significant examples of the Nation's natural heritage (NPS 2009). NNL are selected for their outstanding condition, illustrative value, rarity, diversity, or value to science and education (NPS 2008). The NNL Program has involved private, municipal, state, and federal landowners. Participation in the program is voluntary.

A portion of Great Swamp NWR was designated as a Registered NNL in 1966. The Great Swamp NNL currently consists of 3,852 acres, all of which is located on the refuge and primarily in the Wilderness Area. The refuge was chosen for the registry as an "exceptional example of the natural history of the United States" (USFWS 1987). The designation recognizes Great Swamp's unique blend of unspoiled forest, swamp, and marshland that provides habitat for a variety of wildlife species (NPS 2009). All alternatives will uphold the founding purposes for the establishment of the NNL and the refuge will work with the NPS to further the purposes of the NNL in keeping with the purposes of the refuge and the mission of the FWS. For additional information on the National Natural Landmark Program, please visit *http://www.nature.nps.gov/nnl.*

3.2.15 Invasive Species

The Refuge System has identified management to control the establishment and spread of invasive plants as a national priority.

The objective is to ensure no new non-native plant species become established on the refuge and to control or eliminate the spread of those species that already exist. To the extent possible, invasive species will be eradicated. A variety of control methods, including chemical, biological and mechanical control methods, will be used to maximize treatment effectiveness while minimizing risks following the FWS Integrated Pest Management (IPM) approach to controlling invasive species (569 FW 1).

Within the historically disturbed and early successional forested areas, species such as garlic mustard, wineberry, Japanese honeysuckle, multiflora rose (*Rosa multiflora*), tree-of-heaven, Japanese stiltgrass and long-bristled smartweed may be observed. Certain species, such as reed canary grass, purple loosestrife and common reed, are highly capable of creating monotypic cultures and are most common in heavily manipulated wetland areas and along utility rights-of-way. Beginning in 1995, 500,000 *Galerucella* beetles were released, resulting in a significant reduction in purple loosestrife by 2005. Invasive plant species that have been documented nearby but not on the refuge include sycamore maple (*Acer pseudoplatanus*), poison hemlock (*Conium maculatum*), common water hyacinth (*Eichhornia crassipes*), and cutleaf blackberry (*Rubus laciniatus*), among others.

In conjunction with the HMP, we will develop a list of species of greatest concern on the refuge, identify priority areas, and establish monitoring and treatment strategies (see section 2.5.4 and table 2-17 above for a list of species and existing treatment strategies). In addition, refuge staff will refer to the National Wildlife Refuge System Invasive Species Management Strategy, dated May 2003, for additional tools, processes, and strategies. The 2003 report is complemented by a technical report issued in May 2004 by USGS and others, entitled "The Invasive Species Survey: A Report on the Invasion of the National Wildlife Refuge System" (Simonson et al. 2004). These reports together give both a status review and a management strategy for combating invasive species. In addition, we will remain current with FWS policy revisions currently being reworked to facilitate implementation. Other strategies will include:

- Institute proper care of all refuge equipment to avoid introduction or transport of invasive plants.
- Require researchers on the refuge to take steps to prevent the transportation of terrestrial invasives, aquatic invasives, and pathogens.
- Work with state and federal agencies to prevent introduction of invasive species and prioritize efforts.
- Implement outreach and education programs, including signage, where appropriate, and actively support state initiatives on this topic.
- Work with partners, such as local greenhouses and landscaping companies, to educate the public about the ecological problems caused by invasive plants and to promote the sale of native plant alternatives.

Implementing this program supports refuge goals 1, 2, and 3 relating to the conservation of all wetland, upland and aquatic habitats, as well as goal 4 relating to outreach and environmental education.

3.2.16 Monitoring and Abatement of Wildlife and Plant Diseases

The FWS Manual chapter on Disease Prevention and Control (701 FW 7) is not yet published. In the meantime, we derive guidance on this topic from existing refuge plans and specific directives from the FWS Director. In all alternatives, we will conform to these plans and any specific directives when monitoring and abating wildlife and plant diseases.

Avian Diseases

Avian Influenza

Avian influenza A viruses occur naturally among birds worldwide, which includes many different strains of the virus (NJDEP 2007c). Avian influenza is very contagious among birds and some of these viruses are capable of making certain domesticated species, especially chickens, turkeys and ducks very sick and die (CDC 2010). The strains are classified as "low pathogenic" or "high pathogenic," which refer to the potential for the viruses to kill poultry, not infect humans. The "low pathogenic" strain may go undetected and usually causes only mild symptoms, such as a drop in egg production or ruffled feathers (CDC 2010). The rate of low pathogenic viruses in waterfowl typically peaks in late summer and early fall (NJDEP 2007c). The highly pathogenic form spreads very rapidly through flocks of poultry, affects multiple internal organs, and has a mortality rate that can reach 90-100 percent, often within 48 hours (CDC 2010).

The strain that has been receiving considerable attention worldwide is the highly pathogenic Eurasian form, known as H5N1. H5N1 is a very deadly strain of virus for chickens and other domestic birds. Although H5N1 has not yet been detected in North America, there is some concern that wild birds may spread the virus into North America during migration (NJDEP 2007c). The refuge monitored waterfowl for the highly pathogenic strain of avian influenza during the summer of 2009. Results were negative. Monitoring will continue as the threat dictates.

West Nile Virus (WNV)

WNV was first documented in the Western Hemisphere during a 1999 outbreak in the New York City metropolitan area. By 2003, WNV was documented in 46 states and caused illness to more than 9,800 people (USGS 2011c). Infectious mosquitoes carry WNV in their salivary glands and infect susceptible bird species during feeding. Infected birds containing high levels of WNV in their blood act as reservoir hosts, infecting other mosquitoes (USGS 2011c). WNV is only transmitted to humans and other animals through the bite of an infected mosquito. WNV has been detected in dead birds of at least 326 species (CDC 2009a). Although birds, particularly crows and jays, infected with WNV can die or become ill, most infected birds do survive (CDC 2009b). In 2011, 42 dead bird infections were documented in New Jersey, nine of which were in Morris County. Dead bird infections were documented from late July through mid-October (USGS 2011d). Seven human disease cases were documented in New Jersey in 2011, one case each occurring in the Counties of Atlantic, Hudson, Mercer, Middlesex, Morris, Ocean, and Union (USGS

Pamela Wells

2011e).

Migratory Bird Disease Contingency Plan

The 2003 Migratory Bird Disease Contingency Plan was developed to provide techniques and strategies to minimize the effects of contagious disease in migratory birds. The primary goals of the plan are to (1) prevent the establishment of new or exotic bird diseases; (2) reduce bird mortality to disease; (3) diminish disease impacts; and (4) reduce spread of contagious disease (USFWS 2003c). Reducing spread and diminishing impacts may be accomplished through partial or entire emergency closure of refuge or water level manipulation, as needed, to either concentrate or disperse birds. The ESA must be considered when reducing disease impacts to minimize or eliminate negative impacts on endangered or threatened species or their habitats.

Other Diseases

White Nose Syndrome

As discussed in chapters 1 and 2, the first documented case of WNS was reported near Albany, New York in the winter of 2006-2007. WNS is characterized by the colonization of a psychrophilic, or "cold-loving," fungus on the muzzle, ears, and flight membranes of hibernating bats (Blehert, et al. 2008); however, the presence of the fungus is typically only observable on approximately half of bats affected. The fungus has been identified as *Geomyces destructans.* Affected bats may exhibit low body weights and abnormal behaviors, including early emergence from hibernation and movement to colder areas of caves. WNS quickly spread to hibernacula of several other New England states the following winter. In 2008 to 2009, the syndrome spread as far south as Virginia and included the states of New Jersey and Pennsylvania (USFWS 2010c). Since it was first documented, WNS has been confirmed in 20 states and 4 Canadian provinces, and is expected to continue spreading (USFWS 2012d). WNS has been detected in states as far west as Oklahoma (USFWS 2012d).

In 2009, WNS was confirmed in five hibernacula in New Jersey, including Hibernia mine, both Mount Hope mines, and Upper and Lower Copper mines (NJDEP 2009a). Data suggests that at least some of the refuge's Indiana bats winter in Hibernia and Mount Hope mines (Kitchell 2011). A majority of the bats hibernating in Hibernia mine are little brown bats, with lesser amounts of Indiana bats and Northern long-eared bats (Valent 2011). Visual signs of the fungus and behavioral changes were observed in Hibernia mine in January 2009 and mortality was evident in March and April 2009 (Valent 2011). In February 2010, NJDFW estimated 93 percent mortality in Hibernia mine (Valent 2011). The presence of WNS in New Jersey has resulted in at least a 50 percent decline in *Myotis* species (Valent 2011).

WNS has caused the death of more than 5.5 million bats in eastern North America since it was identified in the winter of 2006 to 2007 (USFWS 2012d). In some hibernacula (caves or mines where bats hibernate in winter), approximately 90 to 100 percent of bats are dying (USFWS 2010c). More than half of the 45 bat species living in the United States rely on hibernation for winter survival. Eleven cave-hibernating bats, including four endangered species and subspecies, are already affected by or are potentially at risk from WNS (USFWS 2012d). The majority of bats dying in the Northeast have been little brown bats; however, WNS has also affected tri-colored, Northern long-eared, big brown, Eastern small footed, and Indiana bats (USFWS 2010c).

Amphibian Chytrid Fungus

The amphibian chytrid fungus, *Batrachochytrium dendrobatidis* or *Bd,* is a rapidly emerging pathogen that is linked to global declines in amphibian populations (Kolby et al. 2009). *Bd* has been severely impacting amphibian populations worldwide as animals become infected with a disease known as chytridomycosis (USFWS 2010c; Borrell 2009; AARK 2011). The disease attacks the skin of the amphibian and makes trans-dermal respiration difficult. These disease also attacks neurological systems and impacts behavior. As Great Swamp NWR is home to diverse group of New Jersey amphibians, this fungal infection has the potential to have serious implications to the ecology of the refuge. *Bd* has been identified in New Jersey (NJDEP 2011b) and the ENSP is currently testing amphibians throughout New Jersey, including Great Swamp NWR, for disease presence. ENSP is working to determine if the disease impacting or has impacted frog and salamander populations within the State.

Chronic Wasting Disease (CWD) and CWD Surveillance and Contingency Plan

CWD is a transmissible spongiform encephalopathy occurring in North American cervids (members of the deer family), including white-tailed deer, mule deer, elk, and moose (USGS 2007). The disease is not known to infect livestock or humans at this time (USGS 2011a). CWD belongs to a group of rare, fatal and transmissible diseases of the central nervous system. Infected animals display progressive weight loss, as well as behavioral changes, including decreased social interaction, loss of awareness, and loss of fear of humans. Diseased animals may also exhibit increased drinking, urination, and excessive salivation (USGS 2007). Since it was first observed in 1967 in a captive deer facility in Colorado, the disease has been documented in free-ranging populations in 15 states and 2 Canadian providences (USGS 2011b).

Since 1998, the NJDEP Division of Fish and Wildlife, in conjunction with others, has conducted annual CWD surveys by collecting tissue samples from deer taken during the State's hunting season. To date, all samples collected have tested negative for the disease (NJDEP 2005b; NJDEP 2006; Stanko 2011 personal communication). The statistical analysis of these findings indicate that if CWD was present it would be in less than one-half to one percent of the State's adult herd (NJDEP 2005a).

The 2008 CWD Surveillance and Contingency Plan provides Great Swamp NWR with guidelines for management actions to proactively reduce the risk or impact of CWD on station resources, conduct surveillance, and respond to CWD presence should the disease be detected on or near refuge land (USFWS 2008e). This plan places high priority on coordinating actions and sharing resources with other state and federal agencies.

Epizootic Hemorrhagic Disease (EHD)

EHD is a common viral disease in deer that is contracted from the bite of a species of midge known as *Culiocoides sonorensis*. EHD is typically localized and does not spread from deer to deer. It cannot be transmitted to humans and although livestock can be infected, the disease is relatively benign in livestock. New Jersey has documented occasional, localized outbreaks of EHD in various parts of the State for more than 50 years. EHD was reported in Salem County in 2010 and in East Amwell Township (Hunterdon County), Hopewell Township (Mercer County) and Hillsborough (Somerset County) in 2011 (NJDEP 2011d). EHD outbreaks were confirmed at the refuge in circa late 1950s, 2007, and 2011. The 2011 outbreak was severe and resulted in notable declines in the refuge's deer population (refer to section 3.2, alternative A, goal 4, objective 4.1, table 3-1).

Infected deer initially lose their appetite and fear of humans, then grow progressively weaker and often salivate excessively. As the disease progresses, the infected deer breathe heavily and develop a fever,

often causing the deer to go to water. Eight to 36 hours after the onset of observable signs, the infected deer pass into a shock-like state, become prostrate and die. Deer typically die within 5 to 10 days of infection (NJDEP 2011d).

Rabies

Rabies is a preventable, viral disease of mammals, including humans. The virus is found in the saliva of a rabid animal and is transmitted by a bite, or possibly by saliva contamination of an open cut or mucus membranes (i.e., nose, eyes or mouth) (CDC 2011). If left untreated, rabies attacks the nervous system and causes death. Rabies occurs most often in wildlife, particularly raccoons, bats, skunks, groundhogs, coyotes, and foxes. These animals represent 95 percent of the cases in the United States. Less than 1 percent of bats carry rabies and human attacks by bats are extremely rare. In New Jersey, cats account for the vast majority of domestic rabies cases. Farm animals, dogs, and other domestic pets can also become infected from wild animals. Small rodents such as rats, mice, chipmunks, and squirrels are rarely infected. Rabid animals typically exhibit abnormal behaviors, such as aggression, nervousness, friendliness, excessive drooling and foaming at the mouth (NJDHSS and Communicable Disease Service 2007).

Refer to sections 2.1.5 and 2.1.7 for additional information on wildlife and plant diseases.

3.2.17 Protecting Wetlands, Riparian Corridors, and Rare Habitat Communities

The refuge provides vital brooding, nesting, feeding, and resting habitat for a variety of migratory bird species, including waterfowl. Although established primarily for migratory birds, the refuge's mosaic of forested wetlands, emergent wetlands, open water, and various successional stages of upland vegetation provides habitats for a diversity of wildlife species. The refuge's habitats are recognized as important community types in the NJWAP (2009), the FWS Significant Habitats and Habitat Complexes of the New York Bight Watershed Report (1997), and the NJDEP Natural Heritage Program.

The 2008 NatureServ study revealed the presence of one rare vegetation association, known as Floodplain Pool (globally imperiled), which is described as an herbaceous community that may form a continuous bed along the side of slowly flowing water in larger streams, or be characteristic of smaller channels within the floodplain of the larger streams (Sneddon 2008). The Floodplain Pool Association is mapped along portions of the Passaic River, Black Brook and Great Brook. The New Jersey NHP database revealed three historic records of rare wetland plants on or immediately adjacent to the refuge, including featherfoil, water-plantain spearwort, and black-girdle woolgrass. Featherfoil was confirmed on the refuge by Brooklyn Botanic Garden botanists during the 2011 BioBlitz. In addition, water horehound, a State-ranked imperiled or vulnerable plant, was also identified by Bowman's Hill Wildlife Preserve during a vegetation survey in 2008. No other rare plants were recorded on or adjacent to the refuge. Further information about rare plant species and communities is provided in chapter 2.

3.2.18 Research

One of the major purposes of Great Swamp NWR was to serve as an "Ecological Laboratory" for study (USFWS 1987). Accordingly, numerous academic, professional and volunteer research and monitoring activities have occurred at the refuge. Research and monitoring at Great Swamp NWR has been vital in the management of the refuge while also contributing to the academic community. Some examples of recent research projects and refuge studies include roost selection and landscape movements of female

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Indiana bat; wood turtle and bog turtle surveys and telemetry data collection; waterfowl banding and counts; and vernal pool surveys.

In 1967, 746 acres in the eastern portion of the present Wilderness Area were declared a Research Natural Area by the Director of the FWS. This area, known as the M. Hartley Dodge Research Natural Area, contains natural shrub swamp habitat and many small upland islands (USFWS 1987). A Research Natural Area is defined as "any tract of land or water that supports high quality examples of terrestrial or aquatic ecosystems, habitats, and populations of rare or endangered plant or animal species, or unique geological study of the features, and is managed in a way that allows natural processes to predominate with minimal human intervention" (USDA 2012). Under certain circumstances, intentional manipulation may be used to maintain the unique features for which the research natural area was established (USFWS 2012e). Activities in research natural areas are generally limited to research, study, observation, monitoring, and educational activities that are non-destructive, non-manipulative, and maintain unmodified conditions.

The FWS encourages and supports research and management studies on refuge lands that will improve and strengthen natural resource management decisions. Research by non-FWS personnel is generally conducted to further the understanding of the natural environment and to improve the management of the refuge's natural resources. Much of the information generated by the research is applicable to management on and near the refuge. In many cases, this type of research ensures the perception of un-biased and objective information gathering, which can be important when using the research to develop management recommendations for politically sensitive issues. The refuge manager encourages and seeks research relative to approved refuge objectives that clearly improves land management and promotes adaptive management. The refuge will also consider research for other purposes that may not directly relate to refuge-specific objectives, but contribute to the broader enhancement, protection, use, preservation, and management of native populations of fish, wildlife and plants, and their natural diversity within the region of flyway.

The refuge will continue to encourage scientific study and research by colleges, universities, volunteers, and qualified organizations, which is directed toward fulfillment of refuge objectives. Typically, the refuge manager will approve permits for research projects that provide a direct benefit to the refuge or that will strengthen our decisions for managing natural resources for biological or public use programs on the refuge. The refuge manager may also consider research requests that do not relate directly to refuge objectives but instead relate to the protection or enhancement of native species and biological diversity in the region. Requests may also be considered if the research supports the goals of ecological conservation teams, such as the Atlantic Coast or Appalachian Mountains Joint Ventures and the Eastern Brook Trout Joint Venture and the Appalachian and North Atlantic Landscape Conservation Cooperatives.

All researchers will be required to submit detailed research proposals following the guidelines established by FWS policy and refuge staff. SUPs will also identify the schedules for progress reports, the criteria for determining when a project should cease, and the requirements for publication or other interim and final reports. All publications will acknowledge the FWS and the role of FWS staff as key partners in funding

and/or operations. We will ask our refuge biologist(s), other divisions of the FWS, USGS, select universities or recognized experts, and the NJDFW for peer review and comment on research proposals and draft publications, and will share research results internally, with these reviewers, and other conservation agencies and organizations. To the extent practicable, and given the publication type, all research deliverables will conform to FWS graphic standards.

Projects, such as those involving listed species, will require additional State and FWS permits. Research projects will not be approved until all required permits are received and the consultation requirements under the ESA have been met.

3.2.19 Adaptive Management

As climate, habitat, visitation, and social conditions are likely to change over the next 15 years, and pursuant to FWS policy, the refuge will use adaptive management to respond to changing conditions that impact the ability to achieve or refine the objectives and strategies of this CCP. All alternatives will employ adaptive management as a method to ensure that we detect and respond to new information, conditions or events quickly. This requires that we establish and maintain a monitoring program.

We must adapt our strategies to respond to new information, spatial and temporal changes, threats, or environmental events that may or may not have been predicted. We will continually evaluate management actions, both formally and informally, through monitoring and research to determine whether our initial assumptions and predictions are still valid.

The refuge manager is responsible for changing management strategies if they do not produce the desired conditions. Significant changes may warrant additional NEPA analysis and public comment. Minor changes that do not alter the objectives analyzed in this CCP will not require additional analysis or public comment. In general, we have the ability to increase monitoring and research that support adaptive management without additional NEPA analysis, assuming the activity is determined to be compatible by the refuge manager. Many of our objectives identify monitoring needs, including climate change, threatened and endangered species, disease, invasive species, and pests.

NEPA requires site-specific analysis and disclosure of impacts for all major federal actions. Other routine administrative and management activities that have been found, individually and cumulatively, to have no significant effect on the environment, are categorically excluded from the NEPA requirements to prepare detailed environmental documents. Those generally include administrative actions.

3.2.20 Site Restoration and Removing Surplus Structures

Under all alternatives, the refuge would continue to address surplus structures currently located on FWS-owned lands, and would continue to restore previously disturbed or developed sites to the character of historic habitat conditions. Surplus structures include old residences, barns, and hunting platforms that are in disrepair and are deemed unnecessary by refuge management. These structures are not necessary and affect the aesthetic values of the refuge. Additionally, surplus structures have often not been structurally sound and have created a public safety hazard. For Great Swamp NWR, surplus structures are acquired as a part of the active land acquisition program. If we acquire land that has a building, we evaluate whether we will be able to use the building or if it should be removed.

Under alternatives B, C, and D, the refuge would improve the trail system by eliminating less used and dead-end trails. These trails will be restored to natural conditions through active planting if necessary, or vegetation will simply be allowed to succeed.

In this draft CCP/EA, we propose the following with respect to surplus structures and unnecessary trails:

- Within 3 years of acquiring property that has a structure on it or impervious surface (such as pavement), the refuge will determine whether the structure is surplus to refuge needs and, if it is, remove the structure, assuming funding and staffing are available. The refuge would restore the site by re-grading it to the natural topography and hydrology, and revegetating it with native species to establish desirable conditions.

- Within 5 years of acquiring property that contains access roads, contingent upon staff and funding, the refuge may implement procedures to retire and restore any unnecessary roads to promote watershed and resource protection.

Implementing this program would support refuge goals 1, 2, and 3 by protecting wetlands from erosion and sedimentation; increasing groundwater infiltration and decreasing stormwater runoff; reducing transportation pathways for invasive species; and reducing edge habitat and fragmentation.

3.2.21 Fire Management

Prescribed fire is not currently used on the refuge; however, prescribed fire has been identified as a potential management tool for grassland and scrub-shrub habitats in alternatives B, C, and D. Under these alternatives, the refuge would evaluate and use fire as a management tool, where and when appropriate. Further details and guidance on using prescribed fire for habitat management can be found in the refuges FMP. A draft FMP was prepared for the refuge in 2008 (refer to section 3.1.5 above). An updated FMP will be prepared upon completion of the CCP (refer to section 3.1.1). The FMP is available for review by request by contacting the refuge.

3.2.22 Climate Change

The FWS has prepared a Strategic Plan for addressing climate change, which will help guide refuge actions, including planning, strategic habitat conservation, and adaptive management practices. These actions will help us address climate change effects on refuge resources. In general, the refuge will continue to work with partners and encourage research and monitoring activities, which will help build an information base to aid in the monitoring of changes and development of strategies to mitigate significant impacts over time. We will use adaptive management to evaluate conditions as they relate to our ability to meet our management objectives and integrate new management decisions into existing plans based on sound science and best professional judgment.

The refuge recognizes that conditions related to global climate change may affect our ability to meet long term biological objectives. In New Jersey, long-term data document an increase in average temperature and a rise in sea level that is consistent with observed and predicted global trends (NJDEP 2008d). In general, spring is arriving earlier, summers are becoming hotter, and winters are becoming warmer with

less snow. Refer to section 2.1.7 for further details on observed and predicted effects of global climate change.

Global daily satellite data, available since 1981, indicates earlier onset of spring 'greenness' by 10-14 days over 19 years, particularly across temperate latitudes of the Northern Hemisphere (Myneni et al. 2001; Lucht et al. 2002). Field studies confirm these satellite observations. Many species are expanding leaves or flowering earlier. There is evidence that the first flowering date of some plants has been advanced by an average of 4 days per degree centigrade over the past 100 years in temperate zones (Memmott et al. 2007). According to some climate change models, phenological shifts resulted in a reduction of floral resources available to 17 to 50 percent of all pollinator species due to a reduced temporal overlap between the pollinators and their floral food resources (Memmott et al. 2007). Specialized species with a limited range of food hosts may be especially vulnerable to these climate induced disruptions. As with other ecological predictions related to global climate change, we could expect great variation in responses among different species or the same species in various locations and conditions (Ibanez et al. 2010).

Increased CO_2 driven photosynthesis within some forests may result in increased growth and productivity rates for some species. This increased growth may result in more efficient water use caused by increased CO_2, demand for soil nutrients, and accelerated decomposition rates and could potentially offset some CO_2 production by providing increases in carbon storage. However, such benefits could be neutralized by forest loss due to land use changes (Frumhoff et al. 2007).

Field, et al. (2007) reports that several species of animals in North America are responding to the effects of climate change. For example, the increase in average spring temperature have led to earlier nesting for 28 migrating bird species on the east coast (Butler 2003) and to earlier egg laying for tree swallows (Dunn and Winkler 1999). Several frog species appear to be responding by initiating breeding calls 10 to 13 days earlier than a century ago (Gibbs and Breisch 2001). Many North American species have shifted their ranges, typically to the north or to higher elevations (Parmesan and Yohe 2003). Red fox have expanded northward into northern Canada, resulting in the retreat of the competitively subordinate arctic fox (Hersteinsson and Macdonald, 1992).

Habitat specific and migratory species, especially northern forest birds, have been determined to be particularly vulnerable to global climate change (NABCI 2010). A number of less common Great Swamp NWR forest passerines and neotropical migrants, such as wood warblers (*Dendroica* spp.), yellow-bellied flycatcher (*Empidonax flaviventris*), veery (*Catharus fuscenscens*) and hermit thrush (*Catharus gluttatus*) have all been predicted to decline as a result of rising global temperatures (NABCI 2010; Frumhoff et al. 2007). Changes in migratory timing, including the seasonal availability of food resources, would be a major contributing factor to these declines (NABCI 2010). Monitoring habitat specific species may be useful in assessing the long-term effects of climate change to the refuge's biota.

Northern grassland areas are expected to become drier with increased evapotranspiration caused by global climate change impacts. It is also suspected that increased atmospheric carbon dioxide may contribute to faster succession of woody species in grassland habitats (NABCI 2010). Approximately 50 percent of grassland bird species of the United States, including the State-listed bobolink (*Dolichonyx oryzivorus*), are expected to be impacted by global climate change (NABCI 2010). Christmas bird count data indicates that grassland birds were the only general group of birds unable to shift north in response to global climate

change over the last 40 years. This inflexible response has been attributed to the poor quality of northern grassland habitats (NABCI 2010).

Changes in global temperature may influence rainfall patterns and subsequent flow and cycling of water within ecological systems. Weather instability (including an increase in short-term droughts and floods) resulting from global climate change may impact water recharge or input timing, reduce storage capacity, and increase drought or flooding (NABCI 2010). Increase in precipitation during winter and spring months may exacerbate flooding conditions during snowmelt. Within the Northeast, winter flooding, precipitation and high flow periods are expected to increase by as much as 20 to 30 percent with increased rainfall impacts under varying levels of emissions (Frumhoff et al. 2007). Some studies have projected two to five fold increases of extremely hot summer days and increases in short-term (one to three month) warm season droughts in the Northeast. Subsequent low flow (least amount of water volume within a stream) periods during summer seasons may be prolonged for northeastern streams. Water demands within ecosystems may also seasonally increase within the region due to increases in plant productivity and subsequent evapotranspiration (Frumhoff et al. 2007).

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Since insects are poikilothermic (cold-blooded) animals and sensitive to temperature fluctuation, climate change may also result in redistributions of pest insects and subsequent forest impacts (Logan et al. 2003). Warmer winters and possible increased drought conditions could have the effect of increasing insect infestations. Drought conditions stress trees, which can also increase their susceptibility to insect pests (IPCC 2007). As growing and reproductive seasons are prolonged, some insects, including pest insects, will likely produce more generations per season (Ibanez et al. 2011). Insects that may benefit from warming scenarios may include the wooly adelgid, emerald ash borer, and gypsy moth. Certain parasitic fungi and other diseases, including Dutch elm disease, white pine blister rust, and beech bark disease are also expected to benefit from climate change (Frumhoff et al. 2007).

Recommendations for forest management include planning for potential changes in plant communities and maintaining and increasing native and natural diversity to create a more resilient forest community. Under alternatives B and D, habitats would be maintained as large (greater than 50 acres), contiguous patches, where possible, to promote wildlife use, increase connectivity, decrease fragmentation, and reduce edge habitat. Alternative C emphasizes management to maximize core forest habitats while maintaining large (greater than 50 acres), contiguous patches of actively managed grasslands and scrub-shrub habitats. Larger, mature trees with well established root systems will likely fair better during drought conditions then smaller, less developed trees. In addition, a more mature and contiguous forest cover will help maintain cooler temperatures on the forest floor which creates more conducive conditions for natural regeneration and benefits associated wildlife. Increasing patch size and connectivity of forest habitats may also improve its resiliency to changes in average and seasonal temperatures and precipitation patterns over the next 50 years.

3.2.23 Wilderness Review

As described in chapter 1, the Great Swamp Wilderness Act of 1968 designated the eastern portion of the refuge, comprised of 3,660 acres, as Wilderness Area. Great Swamp NWR wilderness was the first Wilderness Area designated within the Department of the Interior.

Although a portion of the refuge is already designated as Wilderness, Refuge System planning policy requires that we conduct a wilderness review during the CCP process. A wilderness review is the process we follow to identify and recommend for congressional designation Refuge System lands and waters that merit inclusion in the NWPS. The wilderness review process includes three phases:

- Inventory – We identify lands and waters that meet the minimum criteria for wilderness. These areas are called Wilderness Study Areas (WSAs).

- Study – We evaluate WSAs to determine if they are suitable for Wilderness designation.

- Recommendation – We use the findings of the study to determine if we will recommend the area for designation as Wilderness in the final CCP. The Wilderness recommendations are proposed from the Director through the Secretary and the President to Congress in a Wilderness Study Report. Only Congress can designate Wilderness. By policy, the FWS manages WSAs, recommended, and proposed Wilderness Areas to preserve their wilderness character and thereby retain Congress' option to designate the area as Wilderness at some future time.

Our inventory of the refuge determined that approximately 170 acres within the southwestern portion of the Wilderness Area met the eligibility criteria for a WSA, as defined by the Wilderness Act (610 FW 4). The results of the wilderness review are included in appendix B.

3.2.24 Wild and Scenic River Review

As discussed in chapter 1, we are required to review river segments that cross the refuge for their potential for inclusion in the National Wild and Scenic River System. As a first step, we reviewed the National Rivers Inventory. The inventory is a listing of more than 3,400 free flowing river segments in the U.S. that are believed to possess one or more "outstandingly remarkable" natural or cultural values judged to be of more than local or regional significance. Great Swamp NWR is adjacent to a section of the Passaic that is potentially eligible as a Botanic segment. The inventory also includes Great Brook which runs through the refuge.

Refuge staff will work with the NPS Rivers, Trails, and Greenways Program to determine the most appropriate way to move forward with designation and management. Over the last 40 years, refuge staff have restored portions of Great Brook.

3.2.25 Conducting Additional NEPA Analysis

NEPA requires site-specific analysis and discussion of Federal actions and their impacts, either in an a EA or in an EIS. NEPA categorically excludes routine administrative and management activities from that requirement. Generally, those include the administrative actions listed in chapter 3. Most of the major

actions proposed in the four alternatives and fully analyzed in this draft CCP/EA are described in enough detail to comply with NEPA, and would not require additional environmental analysis. The following projects fall into that category:

- Enhance refuge's priority public use programs.
- Create new trails, trail connections, observation towers, and parking facilities.

The following is a list of actions under alternatives B, C, and D that may require further NEPA analysis:

- Construction of a new headquarters facility, visitors center additions, and associated parking.
- Construction of a new or replacement of the bridge over Great Brook on Pleasant Plains Road at North Gate.
- Implement changes to the refuge's hunt program.
- Major changes to impoundment management.

3.3 Refuge Management Alternatives: Goals, Objectives, and Strategies

We designed four management alternatives that characterize different ways of managing the refuge over the next 15 years. Each alternative includes goals, objectives and strategies that were designed to enhance the quality, effectiveness, and sustainability of our management priorities. They include an array of management actions that, in our professional judgment, work toward achieving the refuge's purpose, vision, and goals, the mission of the Refuge System, and would make a significant contribution to conserving natural resources in the region. Accomplishing management strategies is dependent upon sufficient staff, funding, and continued participation of our conservation partners. Refer to section 3.0 above for an explanation of goal, objective, and strategy development.

Alternative A: No Action

Introduction

Alternative A satisfies the NEPA requirement of a "no action" alternative, which is defined as "continuing current management." Alternative A describes the refuge's existing management priorities and activities and serves as a baseline for comparing and contrasting alternatives B, C, and D. Alternative A portrays current, planned, and approved management activities. It describes projects planned, funded, or underway. Actions described under this alternative would be continued.

Also under alternative A, we would continue current levels of public use and outreach as described in chapter 2. Management would sustain these priorities as completely as possible within the limitations of current staffing, funding, and the present involvement of our conservation partners.

The refuge staff currently consists of the following permanent positions: a Wildlife Refuge Manager (GS-13); Deputy Wildlife Refuge Manager (GS-12); Contaminants Biologist (GS-12); Wildlife Biologist (GS-11); Visitor Services Manager (GS-12); Visitor Services Specialist (GS-7/9); Engineering Equipment Operator

(WG-10); Land Management Law Enforcement Officer (GS-7); and Maintenance Worker (WG-7). The refuge also includes one temporary staff: an administrative assistant (GS-4). The refuge also partially funds a temporary Fish and Wildlife Biologist (GS-7) stationed at Wallkill River NWR who also works at Great Swamp and Cherry Valley NWRs. An Administrative Officer located at Wallkill River NWR provides part-time support to Great Swamp NWR for budget, bill paying, purchases, and payroll.

The refuge has undergone numerous renovations recently, including improvements to the headquarters, Visitor Center, WOC, refuge quarters, Pleasant Plains Road, and the Wilderness Area. Recent renovations and improvements to the refuge headquarters include replacement of lights with high-efficiency fluorescent fixtures, installation of an emergency generator, insulation of ductwork, replacement of oil burner with a heat pump system, and repaving of the parking lot and service road to the shop. These renovations will make the headquarters more energy efficient thereby reducing the refuge's carbon footprint and providing long-term cost savings. Numerous interior and exterior repairs and renovations were performed on refuge quarters. Some renovations were undertaken to make the quarters more energy efficient, including replacement of windows, while others were necessary to bring the units up to code, such as upgrading of electrical systems. Other improvements included installation of vinyl siding, exhaust fans, and hardwired smoke detectors; replacement of exterior doors, a deck, well pumps, light fixtures, appliances, and gutters; repair of a septic pump; and painting.

Improvements to the Visitor Center included activation of an alarm system, the installation of a new informational kiosk in front of the building, and installation of a donated bench, which is made of 100 percent recycled plastic, along the Bockhoven loop trail. In addition, the *Friends* planted wildlife-friendly native gardens around the Center and recently opened a "Nature Detectives" trail for children. These improvements will enhance visitor's experiences. Renovations to the WOC included replacement of a well pump and drainage pipes; re-grading, graveling and paving of the entrance road and parking lot; installation of several donated 100 percent recycled material benches; and repairs to sections of the boardwalk.

Maintenance and improvements to refuge roads, trails and parking lots included re-grading, placement of gravel, repaving, repair of damaged boardwalks and bridges, installation of signs, and roadside ditch cleaning. On Pleasant Plains Road, the manually operated North Gate was replaced with an automatic solar-powered gate. The automatic South Gate was also replaced, which included the installation of an energy efficient light emitting diode (LED).

The refuge also has multiple projects planned that have not yet started, including but not limited to:

- Convert the Visitor Center septic mound from maintained lawn to native wildflowers.
- Upgrade electric capacity at the Visitor Center pavilion.
- Install an informational kiosk at the Bockhoven trailhead.
- Repair or replace the vault toilet at the Bluebird parking area.
- Replace boundary, informational, and directional signs around refuge.
- Repave Pleasant Plains Road from the North Gate to the cul-de-sac.

- Replace broken pipe gates at service road entrances.
- Repair skylights in Pole Barns at the shop and Visitor Center.
- Replace perimeter lighting at Cement Plant and rewire interior lights.
- Refuge Quarters: install wood stove inserts, replace roof, replace windows, correct drainage problem, renovate bathrooms, replace flooring, interior painting, install vinyl siding, demolish two houses and one barn, replace heating oil tanks, and install generator transfer switches.

Continual maintenance, repairs, and renovations are necessary to ensure that refuge facilities, infrastructure, and equipment are safe and enjoyable for staff and the public to use.

USFWS/Gary Zahm

Many of the objectives in alternative A do not strictly follow the guidance in the FWS goals and objectives handbook because we are describing current management decisions and activities that were established prior to this guidance. Rather, our descriptions of these activities were derived from a variety of formal and informal management decisions and planning documents.

Map 3-1 illustrates the habitat management strategies of alternative A and map 3-2 illustrates the public use strategies.

GOAL 1: Provide high quality diverse freshwater emergent wetlands with naturally varying hydric regimes, including wet meadows, freshwater emergent marsh, and open water wetland habitats dominated by native plants for migratory birds, endangered and threatened species and priority conservation species.

Objective 1.1 (Non-Forested Wetlands and Open Water)

Maintain approximately 1,000 to 1,050 acres of high quality non-forested wetland habitat with the following conditions: mix of vegetation, less than 15 percent invasive species, variety of native grasses, forbs, sedges and rushes, and shallow flooded areas. Emergent wetlands consist of wet meadows, freshwater emergent marsh, and open water wetland habitats.

Rationale

Wetlands, in general, are critical natural resources because they perform a variety of important functions, including improvement of water quality through nutrient cycling, prevention of shoreline erosion, flood attenuation, groundwater recharge, and critical habitat for a diversity of plant and animal species, as well as providing aesthetic and recreational opportunities (Balzano et al. 2002).

Since the 1780s, New Jersey has lost approximately 39 percent of its wetlands, from an estimated 1,500,000 acres to approximately 916,000 acres in the 1970s (Tiner 1985; Balzano et al. 2002). Approximately 20 percent of this loss likely occurred between the 1950s and 1970s (Balzano et al. 2002). Wetlands were drained primarily for crop production and pastures and filled for residential development,

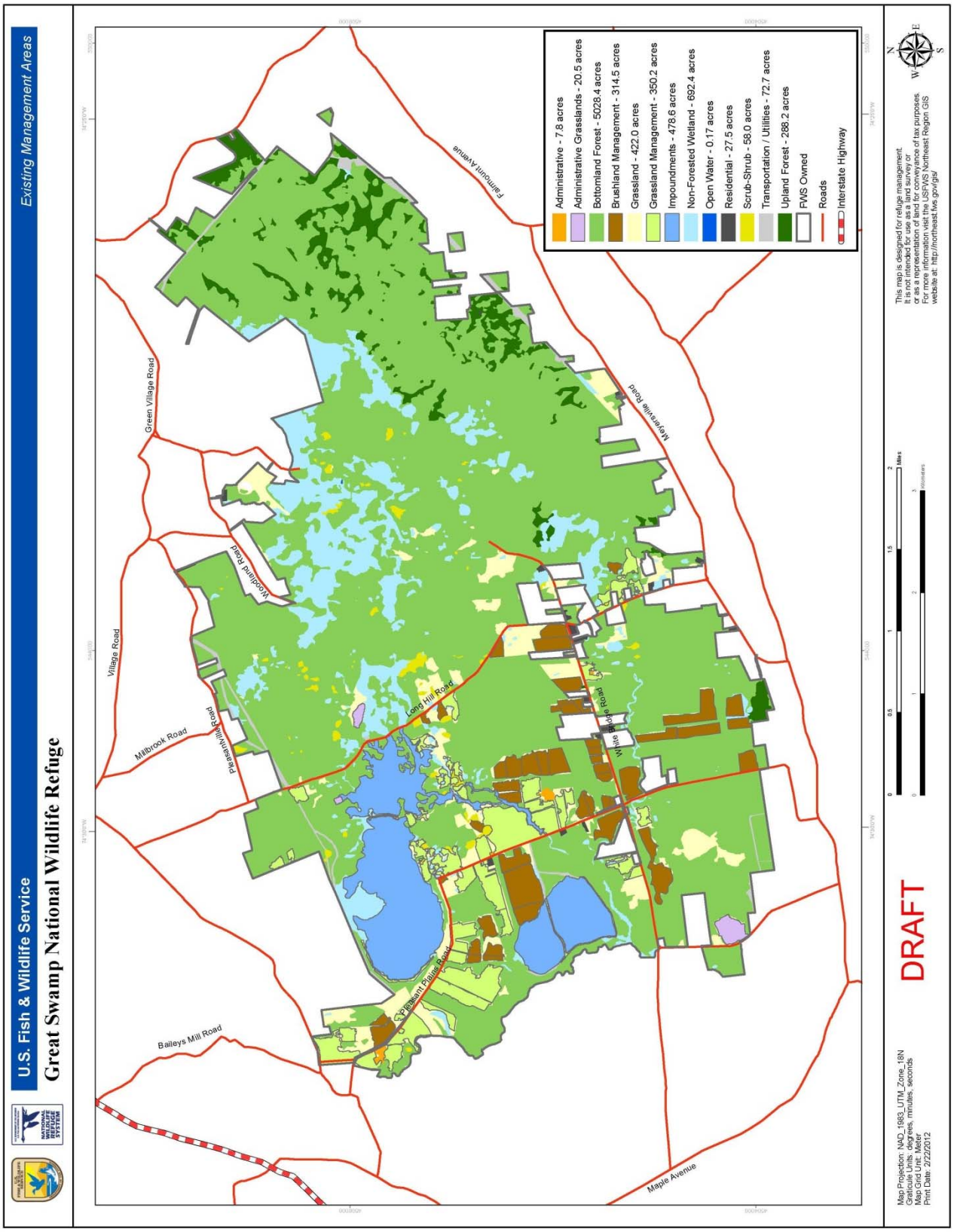
transportation, industrialization, and landfills. Despite the implementation of the Freshwater Wetlands Protection Act in 1987, wetlands are still being lost and disturbed in the state at a rate of approximately 150 acres per year between 1988 and 2001 (Balzano et al. 2002).

The Northern Piedmont Plains contains more than 9,880 acres (4,000 hectares or 15.4 square miles) of emergent wetlands, most of which occur in Great Swamp NWR, Hackensack Meadowlands, Black Meadows, and Saw Mill Creek Wildlife Management Area (NJDEP 2008a). As discussed in chapter 2, land uses that pre-date the refuge resulted in extensive logging to clear land for agriculture and for timber production, as well as extensive wetland ditching and draining. In the 1960s, refuge staff began plugging the previously constructed drainage ditches and creating short dikes with small water control structures in attempt to restore the previously drained wetlands. The refuge currently contains approximately 690 acres of non-forested wetlands and open water habitat, as well as 480 acres of impoundments (refer to objective 1.2 below for impoundments).

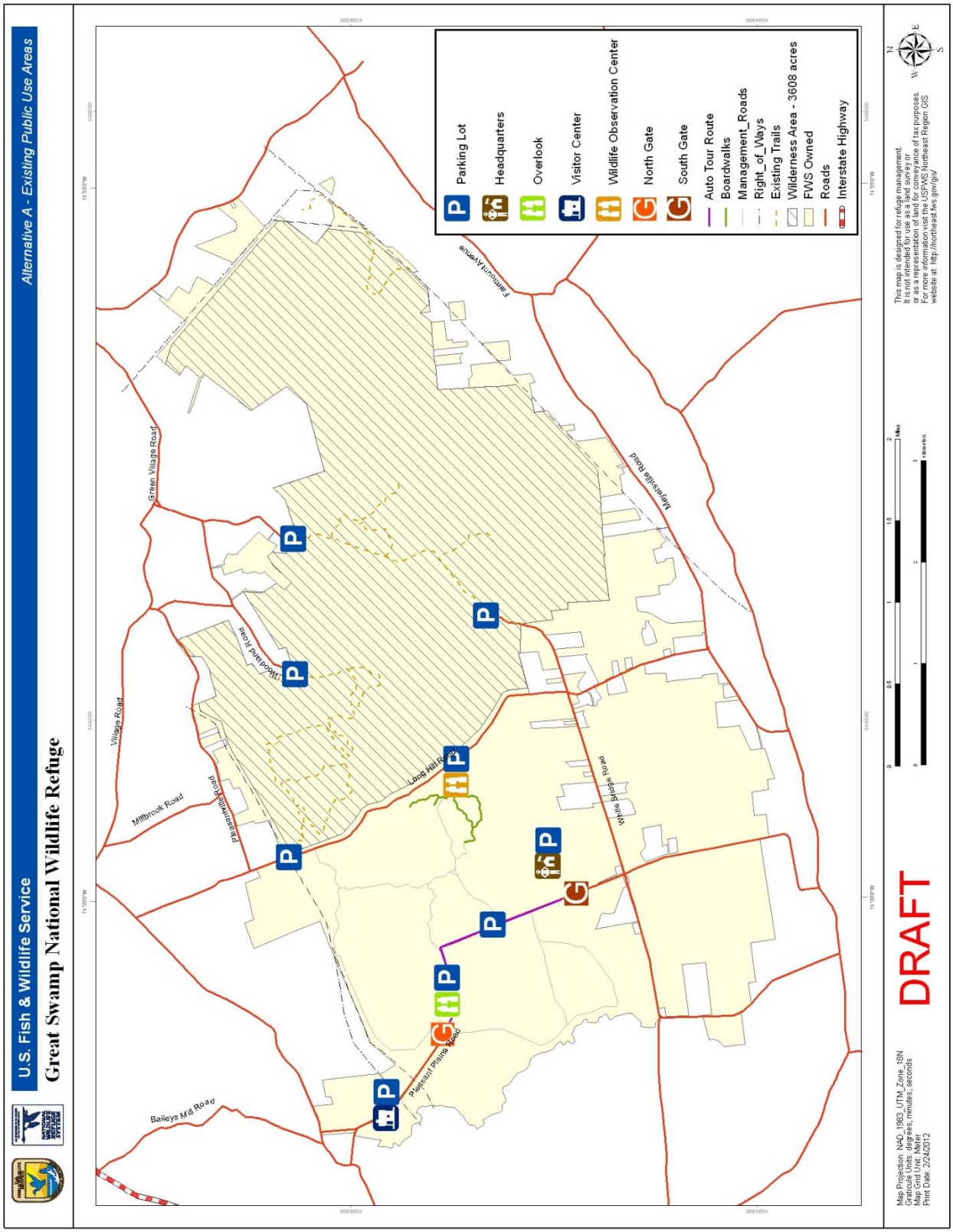
Since the primary purpose of the refuge is to provide foraging, resting and staging habitat for migratory waterfowl, maintaining a mixture of open water and open marsh will continue to benefit several waterfowl species listed as priorities (highest, high, or medium) in the BCR 28 and 29 Plans, including American black duck, Canada goose (migratory Atlantic), hooded merganser, mallard, wood duck, and other waterfowl species that comprise the many thousands of ducks that pass through the refuge during migration. These habitats also benefit other species, such as the pied-billed grebe, a species of management concern for the FWS in the Northeast region and a species of greatest conservation concern as listed under the NJWAP. Great Swamp NWR is recognized by the New Jersey Important Bird Area (IBA) Program for providing breeding, foraging, and wintering habitat for various waterfowl species, including American black duck, mallard, northern pintail, American widgeon, and green-winged teal. Waterfowl was one of the important criteria utilized in designating Great Swamp NWR as an IBA.

In addition to migratory waterfowl, the refuge's non-forested wetlands and open waters provide habitat for a variety of birds, reptiles, and amphibians, including the bog turtle. The Northern population of the bog turtle is federally listed as a threatened species and State-listed as endangered. The New Jersey NHP's ranking system identifies the bog turtle as G3 (globally, either very rare and local throughout its range or found locally in restricted range because of other factors making it vulnerable to extinction throughout its range) and S1 (critically imperiled in New Jersey because of extreme rarity) (Natural Heritage Program 2008). The NJWAP lists the species as a high priority with a goal to increase and stabilize the population in the Piedmont region of New Jersey. Among the contributing factors to the decline of bog turtles is habitat destruction due to development; illegal collection; wetland ditching, flooding and filling; water quality degradation; and forest succession or invasive species encroachment. Bog turtle populations inhabit areas on refuge, which are locally uncommon and unique. Bog turtles require open wetlands, generally with a scrub/shrub component, with perennial groundwater seepage and typically several inches of mucky substrate (generally greater than 4 inches). Protection of this species' habitat will benefit other key refuge resources of concern, including the spotted turtle, wood turtle, American bittern, and northern harrier.

Threats to the refuge's non-forested wetlands and open water habitats include invasive species, particularly purple loosestrife and common reed; increased flow and sedimentation from upstream development; water quality degradation (i.e., non-point source pollution); altered hydrology due to historic ditching and channeling; flooding and drought; forest succession; and lack of occasional fire.



Map 3-1: Existing Habitat Management



Map 3-2: Existing Public Use Opportunities

Active management of non-forested wetlands and open water habitat in the Management Area consists primarily of invasive species control (i.e, purple loosestrife and common reed grass) and where necessary, suppression of woody plant succession. Suppression of woody plant succession and invasive species is critical to maintain quality basking and nesting habitat for various herptile species. Although management in the Wilderness Area is already limited to non-mechanical and non-motorized techniques, very little active management occurs in these areas since this area historically experienced less land alteration and as a result, has fewer occurrences of invasive species.

Strategies:

- Continue to conduct invasive species management, when and where necessary. Some examples of management include the release of *Galercucella* spp. beetles to control purple loosestrife and application of herbicides to control common reedgrass.

- Continue to manage select fields through a rotational mowing program. Management does not currently include prescribed burning.

- Continue to maintain and restore, when necessary, bog turtle and wood turtle habitats.

- Continue to permit the release of raptors, waterfowl, and other species from The Raptor Trust at the refuge.

- Continue to conduct vegetation and wildlife surveys, such as waterfowl banding data collection and bog turtle and wood turtle surveys to monitor trends, especially for species of conservation concern.

- Continue to cooperate with partners, students, and volunteers to conduct vegetation and wildlife surveys and research.

Objective 1.2 (Impoundments):
Maintain the five impoundments, encompassing approximately 485 acres, with the following conditions: water levels ranging between 0-18 inches (averaging 6-12 inches); mix of native vegetation dominated by native forbs, grasses, and aquatic plants for the benefit of wildlife, particularly waterfowl, and restrict invasive species to less than 15 percent cover.

Rationale
The emergent wetlands and open waters of the refuge provide vital wintering and breeding habitat for a variety of waterfowl. The emergent plant community also provides a rich environment for aquatic macroinvertebrates, which in turn provides an important food source for wildlife, especially waterfowl and wading birds. Between 1969 and the early 1980s, five impoundments with low level dikes and water control structures were constructed in order to provide wildlife habitat and influence plant composition and abundance. The refuge currently manages the impoundments for marsh habitat that contains a diversity of wetland vegetation similar to natural marsh habitat in northern New Jersey. Waterfowl breeding and foraging habitat has traditionally been a major focus of management at Great Swamp NWR and the protection of waterfowl is a key element of the refuge's original purpose. The primary objectives of the impoundments are to maintain and improve native emergent vegetation communities, to increase habitat diversity within a wetland, and to provide open water for the resting, staging and foraging activities of

migratory and resident waterfowl. Because of the water level differences within individual impoundments, often a single impoundment will help meet multiple objectives within the same year.

The refuge's impoundments encompass approximately 480 acres and are diverse, including areas of emergent, scrub-shrub and forested wetlands. Pool 1 consists of approximately 116 acres and receives water from Great Brook, Middle Brook, and direct precipitation. This pool contains primarily herbaceous species with some open water and buttonbush stands. The dominant vegetation in Pool 1 is cattail, burreed, mild water pepper, wool grass, buttonbush, bulrush, and willow. The purpose of Pool 1 is to provide waterfowl roosting, brooding, feeding, resting, and loafing habitat during migration (USFWS 1987; USFWS 2003b).

Pool 2 consists of approximately 295 acres and receives water from Primrose Brook, Great Brook, and precipitation (USFWS 2003b). This pool contains persistent herbaceous vegetation, as well as a high diversity of red maple swamp and flooded timber (USFWS 1987). The dominant plants are cattail, swamp rose mallow (*Hibiscus moscheutos*), burreed, wool grass, smartweeds (*Polygonum* spp.), pickerelweed, common reed grass, willows, and some live and standing dead timber in the northwest section of the impoundment (USFWS 2003b). The purpose of Pool 2 is to provide habitat for wildlife, particularly passerines and waterbirds, as well as roosting and feeding habitat for waterfowl during migration (USFWS 1987; USFWS 2003b).

Pools 3A and 3B encompasses approximately 55 and 88 acres, respectively, and are naturally occurring marshes with a mixture of herbaceous vegetation. Pool 3A is dominated by burreed, cattail, wool grass, buttonbush, and various other shrubs. Pool 3A receives water from Pool 2 via a feeder ditch Water Control Structure (WCS) #23, Pool 3B via WCS #34, and precipitation (USFWS 2003b). The pool was managed as a green timber impoundment favoring mast production of oaks (USFWS 1987). Pool 3B receives water from Pool 3A through WCS #34, Middle Brook via WCS #35, and precipitation. The pool is characterized by stands of cattail, buttonbush, and various other shrubs, ash (*Fraxinus* spp.), willow, red maple (*Acer* rubrum), pin oak (*Quercus palustris),* bulrush, swamp rose mallow, burreed, tussock sedge (*Carex* spp.), arrow arum, purple loosestrife, and common reed grass. The purpose of Pools 3A and 3B is to provide feeding and roosting habitat for waterfowl during migration (USFWS 2003b). The pools are frequently used by migratory waterfowl, herons, bitterns, rails, and marsh wrens (USFWS 1987).

Middle Brook Pool is approximately 17 acres in size and receives water from Pool 1 through WCS #5, and a 100-foot emergency spillway between Pool 1 and Middle Brook, and some small ponds, during times of flooding (USFWS 2003b). The upper reaches of the pool are dominated by tussock sedge. During a draw down, the lower portions of the pool are dominated by smartweeds, millets, sedges, burreed, wool grass, cattail, and swamp rose mallow (USFWS 2003b). Middle Brook Pool is used by nesting waterfowl and as a loafing area for Canada geese (USFWS 1987). The purpose of this pool is to provide feeding and roosting habitat for migratory waterfowl (USFWS 2003b).

Water levels are generally maintained between 6 to 12 inches; however, water levels can vary between 0 to 18 inches in some areas of the impoundments. Some impoundments are drawn down periodically (i.e., every 7 years) to alter plant composition and thereby provide a diversity of habitats among the impoundments (USFWS 2003b). During a drawdown year, the water is drawn down for one growing season which allows annual plant species to germinate and mature. The residual seeds from these annuals provide migratory and resident waterfowl with a nutritious food source when the pool is re-flooded

in late-summer/early fall. Dead and decomposing plants also provide food for many kinds of invertebrates that, in turn, provide a protein source for waterfowl, wading birds, shorebirds, and herptiles, such as spotted turtles and wood turtles. The cover from the perennials, with scattered openings, provides ideal conditions for waterfowl broods and migrating waterfowl. Additionally, the interspersion of emergent vegetation and small irregular water areas results in habitat conditions suitable to marsh-nesting birds.

In addition to the five major impoundments, a small 4-acre impoundment was constructed near the refuge headquarters to serve as an observation pond for visitors. This pond is particularly popular with visitors in the season following a mechanical set back of plant succession and is often considered a "must stop" for birders (Byland 2001). Early in the season the water is held at a depth of 4 to 6 inches to attract early waterfowl migrants. Every few years, the impoundment is drawn down completely after the shorebirds have left and the soils are disked to set back perennial plants. Water is pumped back into the impoundment a few weeks later to create a moist soil condition. The most common plants observed in the impoundment include sedges, pondweeds (*Potamogeton* spp.), blunt spikerush (*Eleocharis obtusa*), common water plantain (*Altisma plantago-aquatica*), and seedbox (*Ludwigia alternifolia*) (USFWS 2003b). Although much smaller than the impoundments, this pool attracts a variety of shorebirds in numbers that compare to or occasionally exceed the larger impoundments (Byland 2001).

Strategies:

- Continue to manage impoundments as natural marsh habitat with similar vegetation and characteristics as marsh habitat in northern New Jersey.
- Continue to maintain impoundments with minimal manipulation, except conduct draw-downs every 7 years to mimic a natural drought cycle.
- Continue to conduct repair and/or maintenance of water control structures, as needed.
- Continue to capture and relocate beaver, when necessary, to prevent dam building and flooding in undesired areas.
- Continue to conduct vegetation and wildlife surveys, such as waterfowl banding data collection and marsh bird surveys, to monitor trends, especially for species of conservation concern.
- Continue to cooperate with partners, students, and volunteers to conduct wildlife and vegetation surveys and research.

GOAL 2: Create and maintain an interspersion of scrub-shrub, grassland, and successional wet meadows comprised of native vegetation at various successional stages to enhance breeding and foraging habitat for priority species of conservation concern.

Objective 2.1 (Grasslands)

Maintain approximately 375 acres of high quality grassland habitat with the following conditions: a mix of vegetation with heights ranging from 3 to 36 inches; less than 15 percent invasive species; and a mix of native grasses and forbs for the benefit of native wildlife species.

Rationale

USFWS/Steve Maslowski

Prior to the Revolutionary War and through the early-1900s, much of the GSW was logged and cleared for agriculture, primarily "foul meadow" hay. Grassland species, such as Eastern meadowlarks, bobolinks, upland sandpipers, woodchucks, and voles increased as hayfields and pastures expanded during the early 19th century (Foss 1992; Foster and Motzkin 2003). Repeated attempts at draining, ditching, and stream alteration occurred in the Great Swamp Basin through the mid-1900s. Failure to effectively drain and manage flooding of the swamp eventually caused farming to be abandoned as unprofitable and too difficult to maintain and many farmers moved away. By the 1940s and 1950s, many of the remaining farmhouses were occupied by non-farming families, commuters, and local business owners, and abandoned farm fields began to naturally re-vegetate. After the establishment of the refuge, acquired fields that were managed for haying when in private ownership were continued to be managed as grasslands or early-successional wet meadows with shrub cover ranging from 6 to 60 percent, depending upon mowing frequency (Sneddon 2008).

The grassland management program maintains approximately 350 acres of permanent grass and nesting cover. Individual fields are generally small, ranging in size from less than 1 acre to 49 acres (USFWS 1987). The grassland fields require active management to prevent natural plant succession. Thirty six (36) fields are maintained in a desired stage of succession by mowing and cutting of woody vegetation on a 1 to 3 year rotational basis. Between 150 and 250 acres are mowed each year. Rotational mowing generally takes 2 to 3 weeks per year to accomplish by refuge staff. Select small, isolated fields were eliminated from the mowing program to allow succession to scrub-shrub after the Biological Review (2006) determined these fields are non-beneficial to grassland birds (Bitler 2011). Mowed fields also increase the visibility of various wildlife species for the public, improve overall aesthetics, and reduce wildfire potential (USFWS 1987).

The grassland fields provide food for various rodents, green browse for wildlife, and suitable hunting areas for raptors and other predators. The fields are frequently used by various songbirds, including the eastern bluebird. In 1976, the refuge began a bluebird nest box program. There are approximately 160 boxes on the refuge, which are maintained primarily by volunteers. Great Swamp NWR has one of the largest breeding populations of bluebirds in New Jersey because of this highly successful nest box program.

Threats to the refuge's grassland habitats include invasive species, particularly multiflora rose; succession to scrub-shrub or forest; and altered hydrology due to historic trenching, ditching and channelization. Some on-site early successional upland grasslands have management constraints due to the presence of remediated landfills and must be maintained as open fields as part of the O&M requirement.

Strategies:

- Continue to perform rotational mowing of grassland fields within the Management Area on 1 to 4 year rotational basis.

- Continue to conduct invasive species management, when necessary.
- Continue to conduct vegetation and wildlife surveys, such as breeding bird surveys, to document species and trends.
- Continue to cooperate with partners, students, and volunteers, such as New Jersey Audubon Society, to conduct vegetation and wildlife surveys and research.
- Continue to cooperate with partners, such as the Friends of Great Swamp, to maintain and monitor existing artificial nesting and roosting structures.

Objective 2.2 (Scrub-Shrub)

Maintain approximately 315 acres of actively managed scrub-shrub habitat with the following characteristics: varying stages of shrub succession; mix of native woody vegetation and herbaceous vegetation for the benefit of wildlife, especially American woodcock, and less than 15 percent invasive species.

The refuge contains approximately 55 acres of naturally-occurring scrub-shrub habitats consisting of varying stages of succession containing a mix of native woody and herbaceous vegetation; areas of persistent saturation or ponding; and less than 15 percent invasive species. These areas require less management to maintain as opposed to the more heavily managed areas described in the preceding paragraph. For example, refuge staff would conduct monitoring and respond to invasive species as necessary.

Rationale

In the United States, scrub-shrub habitats are found in natural systems, as well as in human altered systems, such as old fields and utility right-of-ways. Scrub-shrub habitats are characterized by low, multi-stemmed woody vegetation in young or stunted stages of succession. These habitats may be densely clustered or consist of a mosaic of low woody cover interspersed with herbaceous cover (USDA 2007). Trees may be present, but are widely spaced or scattered. Habitats consisting of woody shrubs and herbaceous plants have structural diversity that provides nesting sites, escape cover, and food for wildlife (Oehler et al. 2006). The edges of scrub-shrub habitats also provide hunting areas for predatory birds, such as kestrels (USDA 2007).

Early successional wildlife habitats have become critically rare in much of the eastern United States, especially in the Northeast, primarily due to land use changes (DeGraaf and Yamasaki 2003; Oehler 2003). Regional threats to these habitats include forest succession, multiple mowings in a single growing season, invasive species, and clearing for agriculture, residential, and other urban uses. Early successional habitats are less common than they were in pre-settlement times in several regions of the Northeast, specifically southern and south-coastal New England and the coastal mid-Atlantic region. The landscape of the Northeast is dominated by man-altered habitats and human uses; therefore, maintaining early-successional habitats similar to pre-settlement levels is not possible (DeGraaf and Yamasaki 2003).

The refuge actively manages approximately 315 acres of scrub-shrub habitat, also known as brushland. The managed scrub-shrub fields are mowed or cut on 2 to 6 year rotational cycles to maintain a desired stage of succession; however, rotational cycles may be delayed up to 8 years due to access or equipment issues. The refuge includes an interspersion of habitat types produced by the management of grasslands

and brushlands, which substantially increases ecotonal areas and promotes wildlife diversity (USFWS 1987). Well-managed scrub-shrub habitats are critical for birds (USDA 2007).

Natural shrublands are among the most endangered ecosystems in the United States (DeGraaf and Yamasaki 2003). The refuge contains approximately 55 acres of natural shrublands. The refuge's naturally occurring shrub-swamp and wooded marsh habitat types range from seasonally wet scrub-shrub wetlands to permanently or semi-permanently flooded tussock sedge wooded marsh, containing shrubs and young trees growing on hummocks. These naturally occurring shrub habitats support many bird species of high priority in BCR 28 and 29 Plans during nesting and/or during migration, including blue- and golden-winged warblers, Canada warbler, field sparrow, willow flycatcher, and Eastern towhee. The golden-winged warbler, currently being considered for Federal listing, occasionally utilizes the refuge. In addition to birds, herptile and mammal resources of concern benefit from these habitats.

Most wildlife associated with natural scrub-shrub and early successional habitats were once considered generalist species; however, these species have since been determined to be specialists in vegetation structure or area requirements (DeGraaf and Yamasaki 2003). One hundred thirty-nine species of reptiles, amphibians, birds, and mammals either prefer (17 species) or utilize (122 species) shrub and old field habitats (Oehler et al. 2006). Of 40 bird species associated with shrubland habitats, 22 are experiencing significant population declines in the eastern United States (Oehler et al. 2006). A few species in the region are limited to non-forested habitat types, including the northern harrier (*Circus cyaneus*), savannah sparrow (*Passerculus sandwichensis*), and vesper sparrow (*Pooecetes gramineus*) (DeGraaf and Yamasaki 2003). Certain scrub-shrub bird species have not adapted to suburban conditions, such as brown thrashers (*Toxostoma rufum*), eastern towhees (*Pipilo erythrophthalmus*), and field sparrows (*Spizella pusilla*), and as a result, are now declining across the region (DeGraaf and Yamasaki 2003). In addition, 58 species of butterflies and moths in the Northeast are dependent upon shrublands, 56 of which are considered rare (Oehler et al. 2006).

One wildlife species that uses scrub-shrub habitat at the refuge is the American woodcock. The American woodcock is identified as highest priority in BCR 28 and a high priority in BCR 29. This species is also identified as a high continental concern and high regional responsibility for both PIF Physiographic Regions 9 and 10. The NJWAP sets a population goal for the Piedmont Region to increase this species. Woodcock was also identified as a priority in the North American Shorebird Plan for the Atlantic Flyway. The American woodcock, a key early successional management species, is a FWS priority species that has responded well to the staggered rotational management at Great Swamp NWR. According to a Biological Review Report for Great Swamp NWR, the refuge's woodcock data (singing route surveys between 1985 and 2006) indicated relatively stable populations relative to declining statewide populations (USFWS 2006). Under the refuge's current Upland Management Plan (1988), a total of 477 acres were targeted specifically for woodcock management with four cover type needs (singing grounds, feeding, nesting, and roosting cover). Areas were identified to be cut on a staggered rotation to provide field, brush, and early successional stages. An additional 131 acres were targeted for brushland habitat to increase wildlife diversity (USFWS 2006). In addition to American woodcock, management of these habitat types also benefit a suite of wildlife species at the refuge. According to the Biological Review Report (2006), field surveys suggest that the refuge supports fair numbers of scrub-shrub birds, including willow flycatcher, eastern kingbird, gray catbird, brown thrasher, eastern towhee, indigo bunting, and field sparrow.

Strategies

Management of All Scrub-Shrub Habitats

- Continue to conduct invasive species management, when necessary.

- Continue to periodically conduct breeding bird surveys in shrub communities to identify species and monitor trends, especially for birds of conservation concern.

Management of Actively Managed Scrub-Shrub Habitats:

- Perform rotational mowing and cutting on 2 to 6 year cycles to maintain desired stage of succession and prevent succession to forest habitat.

GOAL 3: Maintain a mosaic of wetland and upland forest, consisting of native understory species of varying densities and structure, to maximize the potential utilization by priority resources of concern.

Objective 3.1 (Forest)

Maintain between 6,000 and 6,500 acres (4,000 to 4,500 acres of bottomland forest; 1,500 to 2,000 acres of upland forest) of forest with the following characteristics: interspersion of mixed aged, native bottomland and upland forest habitats with less than 15 percent of invasive species; areas of persistently flooded bottomland forest; and approximately 35 acres of known woodland vernal pool habitat.

Rationale

Prior to European settlement, the composition and density of forests within the region may have been modified through fires set by Native Americans. Several land surveys conducted in the area in the early 1700s documented tree species such as swamp white oak, maple, poplar, beech, elm, and ash (Harris and Ziesing 2010). Prior to the Revolutionary War, early settlers logged the land that presently encompasses the refuge, particularly in the eastern portion (present day Wilderness Area), and farmed much of the open areas and shrub communities of the western portion of the refuge (Momsen 2007). Records suggest that by the mid-1800s, a majority of the lowest elevations in the Great Swamp basin may have been logged. Repeated attempts at draining, ditching and stream alteration occurred through the mid-1900s. Failure to effectively drain and manage flooding of the swamp eventually caused farming to be unprofitable and too difficult to maintain and many farmers moved away. By the 1940s and 1950s, abandoned farm fields began to naturally re-vegetate. Recent threats to New Jersey's forests include habitat fragmentation; invasive species; development and associated encroachment; change in hydrology (i.e., increase in flooding, siltation, erosion) due to development; browsing pressure by white-tailed deer; forest succession to a climax stage (impediment to regeneration); and parasites, disease, and infestations, such as gypsy moth, Dutch elm disease, bacterial leaf scorch, and chestnut blight.

As discussed in section 2.1.5, the soil disturbances caused by agriculture resulted in soil homogeny (mixing) and depletion of key elements, such as carbon and nitrogen, which can last for decades or longer (Momsen 2007). In addition, late season harvests left agricultural soils exposed to harsh winter weather and subject to erosion. These soil impacts may have influenced current vegetation structure and composition. The dichotomy of vegetation patterns in the eastern (Wilderness Area) and western portions (Management Area) of the refuge reflect, in part, the differences in historic land use and land cover. The eastern portion of the present day refuge, while disturbed through logging, was not subject to the intensive soil and hydrologic alteration that resulted from agricultural practices. The western portion of the refuge

has undergone soil disturbance from the clearing, ditching, and plowing associated with farming. As a result, the present day Wilderness Area vegetation patterns are consistent with the influence of post-glacial deposits that characterize the geologic history of the region. The pin-oak swamps and other vegetation communities of the western portion of the refuge more reflect post-colonization agricultural use (Momsen 2007).

The Northern Piedmont Plains contains approximately 82,780 acres (33,500 hectares or 129.3 square miles) of forest, including upland, wetland and riparian habitats (NJDEP 2008a). The largest patches of forested land occur in a scattered network of public natural lands, with the largest patch in Great Swamp NWR (NJDEP 2008a). The largest contiguous bottomland forested areas are located within the Wilderness Area of the refuge. These areas are dominated by red maple in the canopy. The Management Area of the refuge contains a mosaic of tracts of bottomland forest habitat, primarily in the southwestern and western portions of the refuge. The majority of upland forested areas are centrally located on the refuge and are dominated by American beech and oak species. Small upland "islands" of hardwood forest, dominated by American beech and chestnut oak (*Quercus prinus*), are also scattered throughout bottomland forest habitats within the Wilderness Area.

Active management of forested areas in the Management Area consists primarily of invasive species control (i.e., Japanese barberry and Japanese wisteria) and selective thinning to encourage understory growth. Although management in the Wilderness Area is already limited to non-mechanical and non-motorized techniques, very little management occurs in these areas since this area historically experienced less land alteration and as a result has fewer occurrences of invasive species.

Forests of Great Swamp NWR are known to support several priority resources of concern, including Indiana bat, barred owl, and various forest dependent birds (i.e., wood thrush). The Indiana bat is a federally and State-listed endangered species; the NJWAP has been targeted for increase in Piedmont populations of this species. The refuge is documented as having maternal roost colonies for Indiana bat in New Jersey (Kitchell 2008). Maternal roosts are typically established in agricultural areas with fragmented forests. Roosting by Indiana bat occurs within the Management and Wilderness Areas of the refuge where an interspersion of forests, scrub-shrub, open water, and wet meadow exists (Kitchell 2008). Foraging occurs primarily in and around forested habitats that include pole-stage mixed-oak forest, floodplain forest, upland forest, and forested wetlands (Butchkoski and Hassinger 2002; Gardner et al. 1991; Humphrey et al. 1977; Murray and Kurta 2004; Romme et al. 2002, Sparks et al. 2005). Pregnant or lactating bats forage primarily within wooded or riparian corridors, streams, associated floodplain forests, and impounded bodies of water; however, they will sometimes use hedgerows, upland forest, early successional fields, and croplands (Kitchell 2008). Refer to section 2.6.1 for additional details on the habitat preferences and requirements of the Indiana bat.

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The barred owl is a State-listed threatened species, which also has been targeted for increase in Piedmont populations in the NJWAP. Forests within Great Swamp NWR support a significant population of this

species. Barred owls require large tracts of undisturbed forest dominated by mature and old growth stands and high canopy cover (Bosakowski et al. 1987; Bosakowski 1989). Barred owls prefer older stands but earlier stages of forest succession will be used if a suitable number of large diameter trees or snags is present (Allen 1987). In eastern North America, barred owls generally maintain established territories year-round with home ranging from 213 to 914 acres in size (Beans and Niles 2003). Although the barred owl is most often associated with densely forested woodlands, this species is not restricted to specific vegetative associations in their foraging activities. These owls have been documented foraging for amphibians traveling to and from vernal pools (Kenney and Burne 2002). Deciduous forests, especially riparian and lowland areas, are the most frequently recorded forest types for nesting throughout North America. A typical nest tree is tall, decadent, and has a suitable cavity or a nest site greater than 25 feet above the ground (Allen 1987). Barred owls have been known to use hawk nests when tree cavities are not available (Beans and Niles 2003). Owl sites were located a considerable distance (mean of 2,204 feet) from houses and other buildings (Bosakowski and Smith 1997), showing a significant avoidance of human disturbance and habitat alteration in northern New Jersey. This species demonstrates long-term site fidelity in areas that remained undisturbed (Bent 1937; Bosakowski et al. 1987).

The refuge supports various forest-interior breeding birds including wood thrush, eastern wood peewee, scarlet tanager, veery, and red-eyed vireo. The wood thrush is of the highest rank in BCR 28 and a high priority in BCR 29. Both PIF Physiographic Areas 9 and 10 designates this species as the highest (1A) priority. Wood thrush is listed as both a Bird of Conservation Concern and a Species of Regional Concern for the USFWS. Robbins (1979) estimated that a minimum area of 247 acres is required to support a viable breeding population of wood thrush. The forest patches required by this species for successful reproduction result in the protection of numerous other migratory and breeding forest interior birds at Great Swamp NWR, including but not limited to Cerulean warbler, Canada warbler, Prothonotary warbler, Louisiana waterthrush, veery, Cooper's hawk, red-headed woodpecker, Acadian flycatcher, and eastern screech owl.

The refuge currently maintains approximately 200 wood duck nesting boxes, which are established within bottomland forest and scrub-shrub areas. Each year, the wood duck boxes are maintained and monitored by refuge staff and volunteers. According to the biological review (2006), the refuge has had a successful wood duck box program with consistent data collection, documentation, evaluation, and box maintenance. Data collected at Great Swamp NWR was highly influential in the development of national recommendations for proper box placement and the reduction of dump nesting.

The refuge contains approximately 35 acres of vernal pool habitat. Vernal pools are essential habitat for portions of the life cycles of many species, and are also the favored habitat for considerably more species, particularly amphibians, that use them for breeding and foraging in an area of reduced predation (Kenney and Burne 2002). Vernal pool habitats support many other priority species, including spotted turtle and wood turtle, and may occasionally be utilized by barred owls for foraging. Vernal pools are indispensable to biodiversity both locally and globally. In New Jersey, seven species are dependent on vernal pools (i.e., obligate vernal pool species), including blue-spotted salamander and wood frog (New Jersey Division of Fish & Wildlife 2008). In New Jersey, threats to vernal pool habitat include development, which often results in filling and clearing of surrounding vegetation; change in hydrology due to irrigation wells; overuse of fertilizers and pesticides; and mosquito control efforts (biological, chemical, and hydrological changes). Roadways near vernal pool habitats also contribute to high mortality due to vehicular traffic during annual migrations by amphibian species. Protection, maintenance, and enhancement of vernal pools, as well as the surrounding vegetated buffer, are critical for vernal pool-dependent wildlife. The refuge's vernal pools

are monitored annually in early spring for amphibian presence and reproduction as part of an on-going USGS study. Habitat management of the vernal pools includes tree thinning and installation egg mass attachment sites, such as logs.

Strategies

- Continue to conduct invasive species management, as necessary.
- Continue to allow dead trees and snags to persist (i.e., no cutting or removal) for various wildlife species, including bats, woodpeckers, owls, and other wildlife species.
- Continue selective cutting using chainsaws or other techniques.
- Continue to maintain existing Atlantic white cedar (*Chamaecyparis thyoides*) plantings.
- Continue to maintain wood duck boxes and perform nest box checks.
- Continue to conduct vegetation and wildlife surveys, such as Indiana bat surveys, to monitor trends, especially for species of conservation concern.
- Continue to cooperate with partners, students, and volunteers to conduct vegetation and wildlife surveys, such as bat emergence counts.
- Continue to monitor, maintain, and restore vernal pool habitat, where practical.

GOAL 4 Provide opportunities for visitors of all ages and abilities to enjoy wildlife-dependent recreation, appreciate the cultural and natural resources of Great Swamp National Wildlife Refuge, and increase their understanding and support of the refuge's mission.

Objective 4.1 (Hunting)

Maintain the deer population at a level that does not negatively impact wildlife habitat and the integrity of ecological communities and provide quality, safe, compatible hunting opportunities according to State regulations and seasons through a refuge permit system.

Rationale

During the winter of 1969 to 1970, formal complaints of excessive deer herbivory were received by both the refuge and the State. Moderate to severe browse lines were apparent on plantings around refuge residences, at the WOC, and on adjacent properties. Heavy browsing occurred on many plant species including red maple, red cedar, spruce, blueberry, white pine, yew, and arborvitae. Refuge and State personnel determined that the deer herd exceeded the carrying capacity of the environment and that deer damage would continue if control was not instituted. Control through hunting was deemed most desirable from administrative, economic, recreational, and practical standpoints (USFWS 2009).

The first deer hunt was held in 1974. Deer hunting is the only form of hunting currently authorized on the refuge. The annual deer hunt occurs every fall and consists of five days; including a 1 day youth hunt,

followed shortly thereafter by a 4 day general hunt. Hunting follows the New Jersey State Statutes and Regulations; detailed regulations and information are included in handouts sent to each of the hunters that purchase hunting permits for the refuge. Regulations are also published in the State's annual hunting digest. The first Deer Hunting Plan was submitted and approved in 1973, and subsequently revised and approved in 1979 and 1987. A draft 2009 plan has been prepared; however, this plan is being held pending completion of the CCP. Deer Hunt Programs are prepared annually under the scope of the current approved Hunt Plan. The draft Deer Hunting Plan states that approximately 275 hunters will be allowed in the field at any one time yielding a maximum hunter density of approximately one hunter per 23 acres (USFWS 2009); however, in 2011, the hunter density was one hunter to 35 acres (USFWS 2012h). Deer hunting is permitted on approximately 82 percent of the total refuge area with the remaining area designated as Safety Zones around residences, facilities, and roads. There are 31 parking lots available throughout the refuge to distribute hunters and facilitate access for this public use.

The primary goals of the refuge's Deer Hunt Program are to: (1) Maintain a white-tailed deer population that allows for a diverse and healthy forest understory and assures continuing production of tree seedlings to maintain forest cover in perpetuity; (2) Avoid a truncated buck age class structure and maintain a more natural buck age class distribution; and (3) Provide a safe and high quality outdoor experience for refuge deer hunters (USFWS 2012h). To achieve these goals, harvest strategies and regulations are implemented, evaluated annually, and adjusted when necessary to carry out the objectives of the Program. Program objectives are to: (1) maintain deer at a moderate density of 20 deer per square mile; (2) maintain a male age class structure where at least 30 percent of the bucks are greater than or equal to 3 years old; and (3) implement necessary safety precautions to prevent accidents (USFWS 2012h).

White-tailed deer are an integral part of the wildlife resources found at the refuge. They are enjoyed by the viewing public and by hunters that participate in the annual public hunt. Deer, at a moderate density, provide critical ecological functions in contributing to plant species diversity and nutrient turnover. For example, deer browsing reduces the dominance of shrubs that form dense thickets, facilitating growth of other species, and thus, promoting ecological diversity (Royo et al. 2010). Deer also represent a significant vector of seed dispersal via ingestion and subsequent defecation (Myers et al. 2004), and serve as important seasonal prey to coyotes, bobcats, black bears (Miller et al. 2003, Turner et al. 2011, Northeast Deer Technical Committee 2009). However, in the absence of the intense predation pressure in which deer populations evolved, the species has the potential to grow beyond its biological carrying capacity (BCC) at a local and regional scale (Northeast Deer Technical Committee 2009).

While deer at moderate densities serve critical ecological functions, deer at high densities are known to significantly and negatively impact forest health. Overbrowsing can eliminate the woody and herbaceous understory layer in forest stands, including seedlings and saplings of canopy trees. Rare plants may be lost entirely and the understory vegetation may become dominated by unpalatable plants [e.g., ferns, grasses, and sedges (Horsley et al. 2003); striped maple, American beech (Kain et al. 2011); and sugar maple (Anderson and Katz 1993)]. Less palatable, invasive plants (e.g., Japanese barberry) also may become established, outcompete native regenerating plants and become pervasive in the understory (Tilghman 1989, Miller et al. 1992). Ultimately, overbrowsing reduces habitat quality and results in the decline of many species that depend on well-developed, native understory. Long-term, forest composition changes, succession is altered, and the result is a loss of ecological diversity (Warren 1991, Rooney 2001, Horsley et al. 2003, Cote and Rooney 2004, Crimmins et al. 2010, Kain et al. 2011, Tanentzap et al. 2011). Competition for food, shelter, resting, and rearing cover becomes greater between wildlife species when

deer populations exceed the refuge's carrying capacity. Overabundance of deer populations is one of the most challenging problems facing wildlife managers (Warren 1997).

In addition to reducing forest health, overpopulated herds exhibit reduced herd health, manifested by increased prevalence of parasites and disease, reduced body weights, and lower reproductive and winter survival rates (Miller et al. 2003, Northeast Deer Technical Committee 2009). High deer densities also increase the extent that human-wildlife conflicts occur, such as a greater number of deer/vehicle collisions, increased damage to landscape plants and agricultural crops, and an increased abundance of deer ticks (*Ixodes dammini*) that spread Lyme disease (Miller et al. 2003; Northeast Deer Technical Committee 2009). In the early 1970s, the refuge documented severe "browse lines" in forested habitat due to excessive deer herbivory, as well as reduced herd health attributed to disease and starvation problems (Roscoe and Howard 1974).

Deer populations are managed primarily by State agencies through regulated hunting seasons, and currently, hunting remains the only practical available option (Palmer et al. 1980, Northeast Deer Technical Committee 2009). Other techniques including: (1) trapping and transferring excess deer to other locations, (2) using fencing and repellents to manage conflicts, (3) using fertility control agents, (4) providing supplemental food, (5) controlling deer herds with sharpshooters, and (6) reintroducing large predators are all limited in applicability, prohibitively expensive, logistically impractical, and technically infeasible (Conover 2000, Northeast Deer Technical Committee 2009).

Each year, the number of deer on the refuge is estimated by using data from summer spotlight surveys, fall hunter harvest, and deer browse surveys. The population is then regulated by using different harvest strategies, bag limits, and weapon types. Using these population control techniques the refuge has successfully reduced the deer population from approximately 40 deer per square mile to 20 deer per square mile since hunting began (USFWS 2009). Since the deer population has been reduced, the forest understory has improved though more data are needed to quantify the improvement. Relative trends in deer numbers based on spotlight and harvest data are provided in the table 3-1 below.

According to the National Wildlife Refuge Visitor Survey 2010/2011, there is generally high satisfaction among refuge hunters with regard to Great Swamp NWR's current hunting program (Sexton et al. 2012). During the CCP scoping process, the refuge received comments regarding its hunting program from county and township representatives, non-profit organizations, and individuals. A majority of comments received from these entities supported the refuge's hunting program; however, a few individuals expressed their disapproval of the program.

TABLE 3-1: RELATIVE TRENDS IN DEER NUMBERS BASED ON SPOTLIGHT AND HARVEST DATA FOR GREAT SWAMP NWR (1999-2012)		
Year	Total Deer Spotlighted[1]	Total Deer Harvested
1999	N/A	197
2000	196	215
2001	188	190
2002	306	271
2003	150	178
2004	123	187
2005	167	150
2006	150	102
2007	95	85[2]
2008	85	79
2009	85	113
2010	75	121
2011	104	41[2]
2012	35[2]	18

Notes:
[1] – Spotlight results do not include fawns, which are difficult to observe in tall vegetation.
[2] – After EHD outbreak.

Strategies

- Continue to host annual deer hunt consisting of 1 day youth and 4 day regular season.
- Continue to coordinate with adjacent land managers, including county environmental education centers and NJDFW to encourage cooperative, managed deer hunts.
- Continue to permit use of shotgun and muzzleloader.
- Continue to use antlerless-deer-first or either-sex harvest strategies to regulate the harvest of fawn-bearing females to control deer numbers and protect wildlife habitat.
- Continue to adjust bag limits to allow for an increase or decrease in antlerless harvest, depending on the refuge deer population.
- Continue to evaluate new land acquisitions and incorporate those lands deemed suitable into the hunting program. Additional of new hunting lands would be contingent on a change in the Code of Federal Regulations.
- Continue to provide parking in designated areas for hunting.
- Continue to conduct deer spotlight surveys to obtain population trend data.
- Continue to provide special accommodations to individuals possessing a State disabled hunting license/permit, or a Golden Access Passport, if they qualify.

Objective 4.2 (Fishing)

Fishing is not currently authorized on the refuge.

Rationale

Although fishing is identified in the Improvement Act as a priority public use ("Big Six" public use); multiple resource, access and safety issues at Great Swamp NWR have resulted in the activity not being allowed.

Although the refuge has found some evidence of unauthorized fishing, demand for the activity on the refuge has remained limited. Amongst the general visitor population, approximately 75 percent of those surveyed did not consider fishing "somewhat important" or "very important" when visiting Great Swamp NWR. The largest proportion of visitors surveyed (45 percent) considered fishing "very unimportant" with reference to their visit (Sexton et al. 2012). In addition, off-site fishing derbies previously hosted by the refuge were discontinued as interest and participation in the program declined.

Some of the larger open waters, such as the Passaic River, support a warmwater fishery dominated by panfish, pickerel, black crappie, largemouth bass, catfish, and carp. Trout are stocked by the State in the Passaic River starting at the bridge on White Bridge Road and some points downstream. Stocking only occurs in the spring when water temperatures are cooler for trout survival. The opportunities for fishing at the refuge are limited by on-site conditions. Access to fishing areas, where evidence of fishing has been identified, is limited by lack of available parking opportunities. Some of these locations are potentially hazardous for fishing due to their proximity to busy roads. Expanded safe access to fishing areas will likely require new trails and parking areas, and could not be achieved without impacts to refuge resources. A few small ponds on the refuge may have fish, but access is limited and/or ponds are located in areas not opened to the public because of wildlife disturbance issues. If wildlife disturbance were not an issue, overall, there is very limited fishing opportunity currently available.

Multiple offsite organizations and locations are generally well suited to meet local demand for fishing opportunities. The Somerset County Environmental Education Center, a close partner of Great Swamp NWR, provides a quality alternative to fishing on the refuge. The Center provides designated fishing access and parking areas on the far bank of the Passaic River immediately west of the refuge. Fishing in the river is also allowed. As mentioned above, off-site stocking occurs at the White Bridge Road Bridge (Passaic River). Other opportunities for fishing that have been discussed, such as expansion of open water and stocking of existing refuge ponds are limited by resource allocation and an anticipated complex wetland and environmental permitting process.

Strategies

- Continue to enforce the "no fishing" policy.

Objective 4.3 (Wildlife Observation, Photography and Public Access)

Provide high quality wildlife observation and photography opportunities by facilitating various forms of access. Allow pedestrian and some vehicular access to large portions of the refuge in ways that minimize impacts to wildlife. Access may be expanded in special circumstances such as during the annual deer hunt or through the issuance of a SUP.

Rationale

Wildlife observation and nature photography represent two of the six priority public uses ("Big Six" public uses) identified in the Improvement Act. Providing these opportunities for the public promotes visitor appreciation and support for refuge programs as well as habitat conservation efforts in the GSW and region. The refuge offers many opportunities to view and photograph wildlife, plants, and habitats, as well as opportunities for artists to sketch or paint landscapes and wildlife in its natural habitat. Photography and painting provides wholesome, safe, outdoor recreation in a scenic setting. The refuge also allows commercial photography, filming, or audio recording as these activities may support or enhance the priority public use of wildlife photography. The refuge permits the public to use several different modes of access to facilitate opportunities for wildlife observation and photography. The permitted modes of access have been determined to minimize conflicts and impacts to the refuge's resources.

According to the 2010-2011 National Wildlife Refuge Visitor Survey for Great Swamp NWR, conducted by USGS, visitors reported that they participated in a variety of refuge activities over the past 12 months, including wildlife observation (64 percent), bird watching (62 percent), hiking (57 percent), and photography (36 percent). In addition, a comparison of importance and satisfaction ratings for visitor services indicated that visitors were very satisfied with the activities they reported as very important, including wildlife observation, photography, bird watching, and hiking opportunities. In addition, visitors reported that they were very satisfied with informational kiosks, exhibits about the refuge, and wildlife observation structures (Sexton et al. 2012).

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Strategies

- Continue to maintain approximately 8.5 miles of trails in the Wilderness Area and four parking lots at the trail heads.
- Continue to provide unrestricted daytime access by foot in the Wilderness Area.
- Continue to maintain 1.5 miles of boardwalk and three wildlife observation blinds at the WOC.
- Continue to provide 31 parking spaces at the WOC and multiple hunter-designated parking areas.
- Continue to maintain the Wildlife Tour Route, a self-guided, interpretive road in the Management Area of the refuge.
- Continue to maintain the Overlook and Bluebird parking lots.
- Continue to permit self-guided photography.
- Continue to permit painting or sketching of landscapes and wildlife in its natural habitat without inhabiting pedestrian or vehicular traffic.

- Continue to prohibit public access on refuge management roads in Management Area.
- Continue to maintain refuge gate hours. North Gate is open during Visitor Center hours. South Gate is open during daylight hours.
- Continue to maintain refuge public use infrastructure, including boardwalks and trails.
- Continue to allow commercial filming, photography or audio recording on the refuge with an approved SUP.
- Continue to keep the refuge open only during daylight hours.

Objective 4.4 (Non-Wildlife Recreational Opportunities)

Allow select non-wildlife dependent recreational activities that have been determined appropriate and compatible. Certain non-wildlife dependent recreational activities are permitted in very specific locations to avoid impacts to wildlife, plants, and habitats.

Rationale

Some recreational activities are not dependent on the presence of fish and wildlife, nor dependent on the expectation of encountering fish and wildlife. Although not directly related to wildlife, non-wildlife dependent activities draw visitors and ultimately promote appreciation for the refuge, its resources, and the Refuge System. Some non-wildlife dependent recreational activities are disruptive or harmful to fish, wildlife or plants, or may interfere with the use and enjoyment of a refuge by others engaged in wildlife-dependent recreation. These uses may more appropriately be conducted on private land or other public lands not specifically dedicated for wildlife conservation. All non-wildlife dependent recreational activities must be determined appropriate in accordance with the Policy on Appropriateness (603 FW1) and compatible in accordance with the Policy on Compatibility (603 FW 2).

Strategies

- Continue to permit jogging, bicycling, and horseback riding on the 2.5 mile section of Pleasant Plains Road that is owned and controlled by the refuge.
- Continue to permit walking of properly licensed, leashed dogs on the 2.5 mile section of Pleasant Plains Road that is owned and controlled by the refuge, as well as in designated parking areas, including the Visitor Center and WOC parking lots.
- Continue to issue SUPs on a case-by-case basis.
- Allow virtual (i.e. no physical objects placed on the refuge) geo-caching to promote awareness and use of the refuge.
- Continue to allow cross-country skiing and snow-shoeing in areas open to the public.

Objective 4.5 (Environmental Education)

Participate in educational programs that are designed to meet State curriculum standards.

Rationale

Environmental education is identified in the Improvement Act as a priority public use ("Big Six" public use). Environmental education in the Refuge System incorporates on-site, off-site, and distance-learning materials, activities, programs, and products that address the audience's course of study, the mission of the Refuge System and the management purposes of the refuge. The goal of environmental education is to promote awareness of the basic ecological foundations for the interrelationships between human activities and natural systems. Through curriculum-based environmental education, both on- and off-refuge, refuge staff and partners hope to motivate students and other persons interested in learning the role of management in maintaining healthy ecosystems and conserving our fish and wildlife resources.

The refuge participates in limited educational programs that are designed to meet State curriculum standards. The Visitor Services program is in the process of increasing the number of programs offered by the refuge. In 2011, approximately 25 programs were hosted. Environmental education programs are hosted on and off the refuge. The Friends of Great Swamp also offer environmental education programs and materials. The Friends developed an educational tool known as "Swamp-in-a-Box", which consists of a loanable box containing educational materials that support topics related to science, wildlife, habitats, history, and math. The box typically contains videos, posters, activities, worksheets, a vocabulary list, and Great Swamp NWR brochures. The "Swamp-in-a-Box" program is loaned free of charge to any school group, home-school group, Scout troop, or other community organization. The program is designed to help increase knowledge, understanding, awareness, and stewardship for a NWR. The program is intended for Kindergarten through Grade 12 teachers and students, and is designed to meet New Jersey State Core Curriculum Standards. The Friends also maintain the "Discovery Den" which is located in the Visitor Center. The Discovery Den provides self-guided, hands-on projects, puzzles and games, exhibits, and educational activities for children and adults.

Strategies

- Continue to develop and present environmental education programs on- and off-site.
- Friends of Great Swamp continue to provide educational materials to schools ("Swamp-in-a-Box") and co-host with the refuge three teacher workshops per year.
- Continue limited partnership with county education centers which previously utilized the refuge for educational purposes.
- Continue to host the Congressional Youth Advisory Council, when possible.
- Continue refuge internship program for promising natural resources students.
- When possible, continue trading or sharing interns with partners to provide interns with a broader educational experience and to stimulate interest and motivation.

Objective 4.6 (Environmental Interpretation)

Provide environmental interpretation opportunities that foster stewardship of the environment and reflect the purposes of the refuge and the mission of the Refuge System.

Rationale

Environmental interpretation is identified in the Improvement Act as a priority public use ("Big Six" public use). Interpretation is an educational activity aimed at revealing relationships, examining systems, and exploring how the natural world and human activities intertwine. One of its goals is to stimulate additional interest and positive action. Interpretation is both educational and recreational in nature. That is, participants voluntarily become involved in interpretive activities because they enjoy them, and in the process, they learn about the complex issues confronting fish and wildlife resource managers. Although audiovisual media, exhibits, demonstrations, and presentations are often advantageous and necessary components in interpretation, the program emphasizes first-hand experience with the environment.

In 2009, the Helen C. Fenske Visitor Center was opened to provide informal education to visitors. The development of the center has allowed for the development of displays and expanded educational program space. The Visitor Center exists primarily to offer environmental interpretation by providing exhibits, displays, and audiovisual media that serve to educate the public about the refuge's resources. The center also contains meeting space for demonstrations, presentations, and other interpretative programs, as well as offices for the refuge's Visitor Services staff. An adjacent pavilion is also used for outdoor educational programs. In addition, the Friends of Great Swamp have their Nature Shop, library, and Discovery Den at the Center. The Visitor Center and refuge headquarters also facilitate hunting, wildlife observation, and photography by providing information about where and when visitors can engage in those activities.

The refuge hosts three monthly programs regularly, including *Refuge Rambles, Second Sunday* programs, and *Let's Go Exploring with Ranger Dave*.

- *Refuge Rambles* is a program that is hosted the first Sunday of each month. The first program was held in November 2011. This program consists of a 1-hour interpretive tour, which is guided by refuge staff or an interpretive volunteer.

- Rotating topics are held the second Sunday of each month. The program focuses on conservation topics (i.e., bats, bluebirds, etc.) and is provided by refuge staff or a volunteer that is an expert on the topic.

- *Let's Go Exploring with Ranger Dave* is a program that began in January 2012. This program is held the fourth Sunday of each month and is designed for children ages 6 to 12. The program includes an indoor activity, which is followed by an outdoor activity that promotes exploring. Proposed topics include "*What do animals do during the winter?*" (e.g., hibernation, migration, etc.) and "*Who's tracks are those?*" (e.g. identification of tracks and scat).

In addition, the refuge currently hosts about 10 annual programs, including the *Wildflower Identification Walk, Fall Festival, Sunset Walks* during National Wildlife Refuge Week*, Woodcock Walk, Volunteer Orientation, Christmas Bird Count,* and *Great Backyard Bird Count.* The *Sunset Walks* and *Fall Festival* are among the most popular annual programs.

The Friends of Great Swamp offer the majority of the environmental interpretation programs on the refuge, such as guided tours of the refuge. Interpretative tours include a description of the history of the refuge and the purpose of the Refuge System; exploration of habitats found on the refuge; and identification of plants and wildlife.

Strategies

- Continue to maintain and expand as resources allow kiosks, interpretive displays and signs at the Visitor Center, WOC, wilderness trailheads, parking lots, and headquarters.
- Continue to maintain the existing self-guided, interpretive Wildlife Tour Route.
- Continue to host interpretive programs at refuge and in local communities.
- Continue providing environmental interpretation materials and literature at refuge facilities and trailheads.

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- Continue to maintain and expand refuge information on the Web site, including wildlife and plant lists.
- Continue to have Friends of Great Swamp provide the majority of environmental interpretation tours and programs.
- Continue to request and consider visitor feedback to guide future environmental interpretation programs.
- Continue to utilize the Visitor Center pavilion for environmental interpretation programs.

GOAL 5 Collaborate with the local community and partners to complement biological and visitor services programs on the refuge and throughout the watershed.

Objective 5.1 (Volunteers and Partnerships)

Maintain relationships and cooperate with partners, organizations and volunteers to accomplish the purposes of the refuge and the mission of the Refuge System.

Rationale

Partners, volunteers, interns, and other youth and community service participants contribute significantly to the refuge's biological, public use, and maintenance programs. Their work includes wildlife surveys,

invasive species identification and control, bluebird and wood duck box monitoring and maintenance, visitor services support, environmental interpretation programs, and cleanup or grounds maintenance. In 2010, approximately 200 volunteers contributed over 15,000 volunteer hours.

Each year, Great Swamp NWR allows certain special events to occur throughout the refuge, including areas generally closed to the public. The refuge does not administer these events, but rather controls participant access to the refuge in areas and at times typically closed to the public. For example, several special birding events, including the "World Series of Birding" (hosted by New Jersey Audubon Society), "Christmas Bird Count" (sponsored by National Audubon Society), "Big Sit" (hosted by Bird Watcher's Digest), and "Owl Prowls" (hosted by The Raptor Trust) are held at the refuge each year. These events not only provide ample opportunities for wildlife observation, a priority wildlife-dependent public use, but also provide the refuge with valuable avian data at no additional cost from experienced bird watchers. Over time, the species lists submitted from the various events have provided information useful for monitoring bird populations and updating the refuge's bird list. These events also improve recognition and appreciation for the refuge, the Refuge System, and the FWS among neighbors, local leaders, conservation organizations, and elected officials, thereby generating support for conservation in the region.

Strategies

- Encourage the Friends of Great Swamp and other volunteers to continue to support and promote the refuge.

- Continue to partner with Great Swamp Watershed Association to provide consistent watershed protection in the communities surrounding the refuge.

- Continue to partner with The Raptor Trust, Morris and Somerset County Environmental Education Centers, NJDEP, and private corporations.

Objective 5.2 (Public Outreach)

Participate in events with local partners to advocate resource conservation and stewardship and to promote the mission of the refuge and the Refuge System.

Rationale

Public outreach is two-way communication between the FWS and the public to establish mutual understanding, promote involvement, and influence attitudes and actions with the goal of improving joint stewardship of our natural resources (USFWS 2001c). Public outreach improves recognition of the refuge, the Refuge System, and the FWS among neighbors, local leaders, conservation organizations, and elected officials, thereby generating support for conservation in the region. Outreach can take many forms, including off-site exhibits and displays; news media relations; internet, intranet, and Listservers; partnerships; environmental education; memberships in professional and community organizations; and Congressional relations.

Refuge staff often host or participate in local events, which facilitates direct communication with the public and raises the visibility of the refuge. Volunteers also frequently represent the refuge at local events. For example, each fall the refuge participates in a cooperative outreach program with the Morris County Park Commission. Various other municipal, county, state and federal land management agencies also participate in the event, all of which share a common theme or conservation message. The refuge staff or

volunteers distribute information about the refuge, children's nature games, and display material. The mission of the Refuge System and the refuge's purpose are conveyed to the public to raise awareness and recognition. This public event is typically attended by about 500 people.

Strategies

- Continue to maintain and improve the refuge Web site.
- Continue to maintain key partnerships with The Raptor Trust, Great Swamp Watershed Association, and the Somerset County and Morris County Environmental Education Centers, among others.
- The Friends of Great Swamp continue to provide most outreach through presentations, guided tours, videos, and handouts.
- Continue to participate in outreach as time and resources allow.
- Participate in several large outreach events each year.
- Continue to use nest box cameras at the Visitor Center for wildlife viewing to reach a broader audience.

Objective 5.3 (Climate change)

Recognize and respond to global climate change issues through the use of green technologies to reduce the refuge's carbon footprint. The refuge continues to incorporate the FWS Strategic Plan (finalized September 2010) as guidance for policy.

Rationale

Worldwide scientific consensus tells us that our climate is changing and that these changes are already impacting our natural resources as well as the people, communities, and economies that depend on them. The observed changes in climate have been directly correlated to the increasing levels of carbon dioxide and other greenhouse gases in the atmosphere (USFWS et al. 2012). Signs of rapidly changing climate are unmistakably evident, including melting glaciers, more frequent and longer heat waves, flowers blooming earlier, birds delaying their migrations, rising sea levels, and increases in global average air and ocean water temperatures (USFWS et al. 2012; IPCC 2007).

In response to accelerating climate change, the FWS prepared a plan entitled "Rising to the Urgent Challenges of a Changing Climate: A Strategic Plan for Responding to Accelerating Climate Change in the 21st Century," which was finalized in September 2010 (USFWS 2010a). The primary purposes of the plan are to present a vision for accomplishing the FWS mission in the face of accelerating climate change and to provide direction for our organization and its employees by defining our role within the context of the Department and the larger conservation community (USFWS 2010a). The plan calls for the FWS and its partners to face challenges, lay the foundation for science-based decision making in the future, and take actions now to ensure that our nation's fish and wildlife resources will thrive in the years to come.

Section 2.1.7 provides additional details regarding climate change.

Strategies

- Continue to use and expand green technology to reduce carbon footprint and impact on natural resources, including installation of solar panels, rain barrels, light sensors and timers, high efficiency lighting and HVAC systems, faucet sensors, and hybrid and electric vehicles.

Objective 5.4 (Wilderness Area)

Maintain, monitor and preserve the character of the Wilderness Area in accordance with the Wilderness Act of 1964, the Great Swamp Wilderness Act of 1968, and FWS Wilderness Stewardship Policy.

Rationale

The Wilderness Act of 1964 established the NWPS, which provides the FWS and other federal land management agencies with a process for recommending Wilderness Areas to Congress. Only Congress has the authority to designate lands and water as Wilderness. The Act directs each agency administering designated wilderness to preserve the "wilderness character" of areas within the NWPS, and to administer the NWPS for the "use and enjoyment of the American people in a way that will leave those areas unimpaired to future use and enjoyment as wilderness."

The Great Swamp Wilderness Act of 1968 designated the eastern portion of the refuge, comprised of 3,660 acres, as the first Wilderness Area in the Department of the Interior. In addition, 746 acres in the eastern portion of the present Wilderness Area were declared a Research Natural Area in 1967 by the Director of the FWS. This area, known as M. Hartley Dodge Research Natural Area, contains natural shrub swamp habitat and many small upland islands (USFWS 1987).

The Wilderness Area, although historically disturbed through logging, was not subject to the intensive soil and hydrologic alteration that resulted from agricultural practices. As a result, the vegetation patterns of the eastern portion of the refuge are consistent with the influence of post-glacial deposits that characterize the geologic history of the region. The Wilderness Area is comprised of bottomland floodplain forest and approximately 247 acres of open water that provides quality habitat for a variety of plants and animals. In fact, the Wilderness Area (i.e., southeastern portion of refuge) contains the most contiguous bottomland forested areas on the refuge, which are dominated by a red maple overstory. Small upland "islands" of hardwood forest, dominated by American beech and chestnut oak, are also scattered throughout the Wilderness Area. Although management in the Wilderness Area is already limited to non-mechanical and non-motorized techniques due to legal constraints, very little management occurs in these areas since this area historically experienced less land alteration and, as a result, has experienced fewer invasive species impacts.

Refer to alternative A, objective 4.3 above for information regarding public access opportunities in the Wilderness Area.

Strategies

- When necessary, conduct manual clearing of encroaching vegetation along Wilderness trails.

- Continue to conduct invasive species management, when and where necessary.

- Continue to maintain and restore, when necessary, bog turtle and wood turtle habitats using wilderness-appropriate methods.

- Continue to conduct vegetation and wildlife surveys, such as Indiana bat maternal roost surveys, to monitor trends, especially for species of conservation concern.

- Continue to cooperate with partners, students, and volunteers to conduct appropriate vegetation and wildlife surveys and research.

Objective 5.5 (Nuisance Wildlife Control)

Maintain biological integrity, diversity, and environmental health through control of nuisance wildlife, as necessary.

Rationale

The term nuisance wildlife is often associated with an animal that causes or has potential to cause damage to property, presents a threat to public health or safety, or causes an annoyance within, under, or upon a building. An animal that causes negative impacts to other wildlife species or their habitat may also be considered nuisance wildlife. Nuisance wildlife species can be native, non-native, or feral and are often adapted to living in fragmented habitat and in close proximity to humans. Certain species are periodically problematic at the refuge, such as raccoons, resident non-migrating Canada geese, beavers, and feral cats. Management or control of nuisance wildlife may be required to prevent impacts to other wildlife (i.e., predation, competition, and spread of disease) or habitat (i.e., undesired flooding or excessive herbivory). Control techniques are based on a broad, systematic approach using all the information available on the ecology of the pest animal or plant. Population control or reduction methods are chosen based upon their safety, effectiveness, cost, and ecological impact.

Strategies

- Continue to conduct trapping and relocation of raccoons prior to annual waterfowl banding to reduce waterfowl predation.

- Continue to eradicate mute swans and sick wildlife.

- Continue to collect non-native turtles, such as red-eared sliders, and transfer to licensed holders.

- Continue to capture feral cats and turn over to animal shelters.

- Continue to relocate beaver from impoundments to other areas of the refuge to prevent undesired flooding and associated damage to waterways or impoundments.

- Continue to perform control of nesting resident Canada geese.

- Continue to monitor and control unauthorized releases of wildlife on the refuge.

Alternative B: Enhance Biological Diversity and Public Use Opportunities

Introduction

Alternative B, the preferred alternative, is the alternative the Planning Team intends to recommend to our Regional Director for implementation. This alternative includes an array of management actions that, in our best professional judgment, work best towards achieving the refuge purposes, the vision and goals for the refuge, the mission of the Refuge System, and State and regional conservation plans. Alternative B is intended to balance the conservation of forest, non-forested and open water habitats with management of grassland and brushland habitats while enhancing compatible wildlife dependent recreational opportunities. Select habitats would be reconfigured and maintained to create large (greater than 50 acres), contiguous patches to promote wildlife use, increase connectivity, and decrease fragmentation. We believe that the actions proposed under this alternative will allow the refuge to make the most significant ecological contribution possible at the local and landscape levels within the GSW, Northern Piedmont Region, and the Refuge System. Lastly, alternative B addresses the Refuge System's mandate to consider managing refuge habitat under the BIDEH policy (601 FW 3).

The habitat types we describe support a wide variety of federal trust resources, including the federally threatened bog turtle, federally endangered Indiana bat, waterfowl, and a variety of birds of conservation concern identified in BCRs 28 and 29 and PIF Physiographic Areas 9 and 10. For each habitat type objective, we identify "focal species" whose life and growth requirements would guide management activities in that respective habitat type. Focal species were selected because they are federal trust resources, identified as priorities in local or regional resource planning documents, or Great Swamp NWR provides significant habitat for populations of those species. Focal species represent species whose habitat needs, in our professional opinion, broadly represent the habitat requirements for a majority of other federal trust species and native wildlife and plants dependent on that respective habitat type.

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Under alternative B, the hunt program would be expanded by permitting archery for deer and by opening turkey hunting. Wildlife observation and photography would be enhanced by creating trails, providing additional parking opportunities, expanding the Wildlife Tour Route, and constructing observation towers. We would expand Visitor Center hours and increase the number of environmental education and interpretation programs on and off the refuge. We would work to increase our presence in regional urban centers and to increase programs to bring urban youth to the refuge.

Figure 3-3 illustrates the habitat management strategies of alternative B and figure 3-4 illustrates the public use strategies.

GOAL 1: Provide high quality diverse freshwater emergent wetlands with naturally varying hydric regimes, including wet meadows, freshwater emergent marsh, and open water wetland habitats dominated by native plants for migratory birds, endangered and threatened species and priority conservation species.

Discussion

Wetlands are critical natural resources because they perform a variety of important functions, including improvement of water quality through nutrient cycling, prevention of shoreline erosion, flood attenuation, groundwater recharge, and critical habitat for a diversity of plant and animal species, as well as providing aesthetic and recreational opportunities (Balzano et al. 2002).

Since the 1780s, New Jersey has lost approximately 39 percent of its wetlands, from an estimated 1,500,000 acres to approximately 916,000 acres in the 1970s (Tiner 1985; Balzano et al. 2002). Approximately 20 percent of this loss likely occurred between the 1950s and 1970s (Balzano et al. 2002). Wetlands were drained primarily for crop production and pastures and filled for residential development, transportation, industrialization, and landfills. Despite the implementation of the Freshwater Wetlands Protection Act in 1987, wetlands are still being lost and disturbed in the State at a rate of approximately 150 acres per year between 1988 and 2001 (Balzano et al. 2002).

The Northern Piedmont Plains contain more than 9,880 acres (4,000 hectares or 15.4 square miles) of emergent wetlands, most of which occur in Great Swamp NWR, Hackensack Meadowlands, Black Meadows, and Saw Mill Creek Wildlife Management Area (NJDEP 2008a). As discussed in chapter 2, land uses that pre-date the refuge resulted in extensive logging to clear land for agriculture and for timber production, as well as extensive wetland ditching and draining. In the 1960s, refuge staff began plugging the previously constructed drainage ditches and creating short dikes with small water control structures in attempt to restore the previously drained wetlands. The refuge currently contains approximately 690 acres of non-forested wetlands and open water habitat, as well as 480 acres of impoundments (refer to objective 1.2 below for impoundments).

The emergent wetlands and open waters of the refuge provide vital wintering and breeding habitat for a variety of waterfowl. The emergent plant community also provides a rich environment for aquatic macroinvertebrates, which in turn provides an important food source for wildlife, especially waterfowl and wading birds. Between 1969 and the early 1980s, five impoundments with low level dikes and water control structures were constructed in order to provide wildlife habitat and influence plant composition and abundance. The refuge currently manages the impoundments for marsh habitat that contains a diversity of wetland vegetation similar to natural marsh habitat in northern New Jersey. Waterfowl breeding and foraging habitat has traditionally been a major focus of management at Great Swamp NWR and the protection of waterfowl is a key element of the refuge's original purpose. The primary objectives of the impoundments are to maintain and improve native emergent vegetation communities, to increase habitat diversity within a wetland, and to provide open water for the resting, staging and foraging activities of migratory waterfowl. Because of the water level differences within individual impoundments, often a single impoundment will help meet multiple objectives within the same year.

The refuge's impoundments encompass approximately 480 acres and are diverse, including areas of emergent, brushland and forested wetlands. Water levels are generally maintained between 6 to 12 inches; however, water levels can vary between 0 and 18 inches in some areas of the impoundments. Some impoundments are drawn down periodically (i.e., every 7 years) to alter plant composition and

thereby provide a diversity of habitats among the impoundments (USFWS 2003b). During a drawdown year, the water is drawn down for one growing season which allows annual plant species to germinate and mature. The residual seeds from these annuals provide migratory and resident waterfowl with a nutritious food source when the pool is re-flooded in late-summer/early fall. Dead and decomposing plants also provide food for many kinds of invertebrates that, in turn, provide a protein source for waterfowl, wading birds, shorebirds, and turtles, such as spotted turtles and wood turtles. The cover from the perennials, with scattered openings, provides ideal conditions for waterfowl broods and migrating waterfowl. Additionally, the interspersion of emergent vegetation and small irregular water areas results in habitat conditions suitable for marsh-nesting birds.

Since the primary purpose of the refuge is to provide foraging, resting and staging habitat for migratory waterfowl, maintaining a mixture of open water and open marsh will continue to benefit several waterfowl species listed as priorities (highest, high, or medium) in the BCR 28 and 29 Plans, including American black duck, Canada goose (migratory Atlantic), hooded merganser, mallard, wood duck, and other waterfowl species that comprise the many thousands of ducks that pass through the refuge during migration. These habitats also benefit other species, such as the pied-billed grebe, a species of management concern for the FWS in the Northeast region and a species of greatest conservation concern as listed under the NJWAP. Great Swamp NWR is recognized by the New Jersey IBA Program for providing breeding, foraging, and wintering habitat for various waterfowl species, including American black duck, mallard, northern pintail, American widgeon, and green-winged teal. Waterfowl was one of the important criteria utilized in designating Great Swamp NWR as an IBA.

In addition to migratory waterfowl, the refuge's non-forested wetlands and open waters provide habitat for a variety of birds, reptiles, and amphibians, including the bog turtle. The Northern population of the bog turtle is federally listed as a threatened species and State-listed as endangered.

Threats to the refuge's non-forested wetlands and open water habitats include: invasive species, particularly purple loosestrife and common reed; increased flow and sedimentation from upstream development; water quality degradation (i.e., non-point source pollution); altered hydrology due to historic ditching and channeling; flooding and drought; forest succession; and lack of occasional fire.

Under this alternative, we would evaluate the current impoundment management system and the benefits that are realized for waterfowl. Within three years, we would develop impoundment management recommendations based upon options for management including, maintaining current water management, creating additional open water, or other management options for the benefit of migratory waterfowl.

Objective 1.1 Tussock Sedge Wet Meadows

Within five years, maintain and restore a minimum of 40 acres of high quality, spring-fed, open wet meadow dominated by a mixture of native sedges, including tussock sedge (*Carex stricta*), with a 10-30 percent scrub/shrub component and hydric regime suitable for bog turtle.

Rationale

The Northern population of the bog turtle is a federally listed threatened species and listed as Endangered in the State of New Jersey. The New Jersey NHP's ranking system identifies the bog turtle as G3 (globally, either very rare and local throughout its range or found locally in restricted range or because of other factors making it vulnerable to extinction throughout its range) and S1 (critically imperiled in New Jersey because of extreme rarity) (Natural Heritage Program, 2008).

The NJWAP lists the species as a high priority with a goal to increase and stabilize the population in the Piedmont region of New Jersey. Among the contributing factors to the decline of bog turtles is habitat destruction due to development; illegal collection; wetland ditching, flooding and filling; water quality degradation; and forest succession or invasive species encroachment. Bog turtle populations inhabit areas on refuge, which are locally uncommon and unique. Bog turtles require open wet meadows, generally with a scrub/shrub component, with perennial groundwater seepage and typically several inches of mucky substrate (generally greater than 4 inches). Protection of this species' habitat will benefit other key refuge resources of concern, including spotted turtle, American woodcock, and various passerines, including but not limited to common yellowthroat, golden-winged warbler, song sparrow, swamp sparrow, and blue-winged warbler.

Among the contributing factors to the decline of bog turtles is habitat destruction due to development; illegal collection; wetland ditching, flooding and filling; water quality degradation; and forest succession or invasive species encroachment. Bog turtles require open wetlands, generally with a scrub/shrub component, with perennial groundwater seepage and typically several inches of mucky substrate (generally greater than 4 inches). These locally uncommon and unique areas are inhabited by Bog turtle populations on the refuge. Active management of these areas through suppression of vegetation succession and control of invasive species is necessary and will aid in providing basking habitat and increasing the probability of successful nesting.

Strategies

- Continue to conduct invasive species management, when and where necessary. Some examples of management include the release of *Galercucella* spp. beetles to control purple loosestrife and application of herbicides to control common reedgrass.

- Continue to maintain and restore, when necessary, bog turtle and wood turtle habitats.

- Continue to conduct vegetation and wildlife surveys, such as waterfowl banding data collection and bog turtle and wood turtle surveys to monitor trends, especially for species of conservation concern.

- Continue to cooperate with partners, students, and volunteers to conduct vegetation and wildlife surveys and research.

- Increase management and restoration of open, spring-fed wetlands for the purpose of benefitting the federally threatened bog turtle. Continue or increase, if necessary, monitoring of the bog turtle population.

- Where feasible, suppress woody plant succession to maintain emergent areas or restore emergent habitat to improve habitat diversity and wildlife visibility.

- Increase monitoring, early detection/rapid response (EDRR), and control of invasive species, especially in areas where change in management or land use occurs or emergent infestations develop and along dispersal corridors (roads, ditches, trails, etc.).

- Research the feasibility and risk of low density grazing for control of select woody and invasive vegetation.

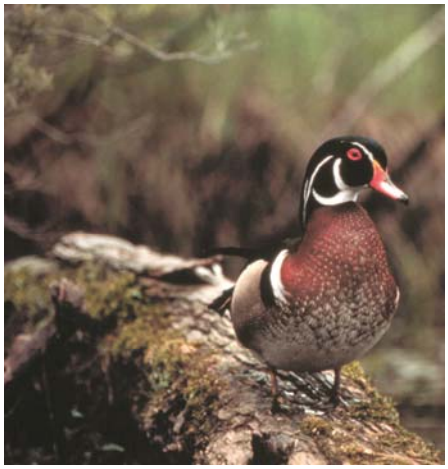
- Increase use of biological control, where possible and practical.

- Evaluate feasibility of future reintroduction of bog turtle hatchlings to increase population and genetic variability on the refuge.

Objective 1.2 Emergent Marsh – Migrating Waterfowl
Each year, maintain a minimum of 1,000 acres of spring (March-April) and fall (October-November) waterfowl migration and staging habitat consisting of shallow flooded wetlands (less than or equal to 12 inches of water) with a mix of native emergent vegetation and open water habitat, dominated by arrow arum (*Peltandra virginica*), cattail, bur-reed, woolgrass, bulrush, swamp rose mallow, buttonbush, millets (*Echinochloa* spp.), tussock sedge, duckweed (*Lemna* sp.), sedges, muskgrass (*Chara* spp.), spikerush (*Eleocharis* spp.), rice cutgrass (*Leersia oryzoides*), wild rice (*Sizania aquatica*), and pickerelweed (*Pontederia cordata*).

Rationale
The primary purpose of the refuge is to provide foraging, resting and staging habitat for migratory waterfowl. Historic management efforts to provide habitat for migratory waterfowl were successful; however, the five major impoundments require periodic removal of perennial vegetation to prevent plant succession, which leads to wetland habitat loss. Maintenance of emergence marsh also benefits some nesting waterfowl species, including mallard.

Maintaining a mixture of open water and open marsh will benefit several waterfowl species listed as priorities (highest, high, or medium) in the BCR 28 and 29 Plans, including American black duck, Canada goose (migratory Atlantic), hooded merganser, mallard, wood duck, among other waterfowl species that comprise the thousands of ducks that pass through the refuge during migration. Managing for open water/open marsh habitat will also benefit other species, such as the pied-billed grebe, a species of management concern for USFWS in the northeast region and a species of greatest conservation concern as listed under the NJWAP. Great Swamp NWR is recognized by the New Jersey IBA Program for providing breeding, foraging, and wintering habitat for various waterfowl species, including American black duck, mallard, Northern pintail, American widgeon, and green-winged teal. Waterfowl is one of the important criteria utilized in designating Great Swamp NWR as an IBA.



USFWS/James Prince

The refuge impoundments are extremely productive and dynamic habitats that provide nesting, feeding and roosting habitat for various waterbirds and shorebirds. The impoundments are especially important to migratory waterfowl. Numerous reptiles and amphibians rely on the impoundments as well. The impoundments provide a substantial percentage of the available habitat for less common or threatened nesting species, such as rails, bitterns, herons, wood ducks, hooded mergansers, and blue-winged teal, as well as a wide variety of more common birds (Byland 2001).

The impoundments are subject to short and long-term hydrological fluctuations (i.e., flooding, drought), as well as sedimentation and natural vegetation succession. As a result, the ratios of open

water and early successional habitat are variable. Under this alternative, refuge staff will evaluate each impoundment to determine the best management strategies that will benefit the refuge's priority wildlife species. Specifically, the staff will identify the factors that influence the habitats of each impoundment; determine the priority wildlife species that historically and currently rely upon each impoundment; utilize existing refuge specific data and recommendations from past studies; identify management constraints; and determine feasible management strategies that would either allow or impede vegetation succession. Most importantly, the staff will determine each impoundment's potential to make the greatest ecological contribution at a landscape scale.

Strategies

- Continue to manage impoundments as natural marsh habitat with similar vegetation and characteristics as marsh habitat in northern New Jersey.
    - Continue to maintain impoundments with minimal manipulation, except conduct draw-downs every 7 years to mimic a natural drought cycle.
    - Continue to conduct repair and/or maintenance of water control structures, as needed.

- Within 5 years, evaluate each impoundment's ecological contribution to waterfowl and other priority species (i.e., benefits, maintenance, seasonal use, and food availability). As necessary, use contractors, University researchers, or refuge staff to perform the evaluation.

    - Based on findings, develop and implement management strategies to maximize each impoundment's ecological contribution at a landscape scale.

- Continue to conduct invasive species management, when and where necessary, including increased monitoring and early detection. Some examples of management include the release of *Galercucella* spp. beetles to control purple loosestrife and application of herbicides to control common reedgrass.

- Continue to conduct vegetation and wildlife surveys, such as waterfowl banding data collection and bog turtle and wood turtle surveys to monitor trends, especially for species of conservation concern.

- Continue to capture and relocate beaver, when necessary, to prevent dam building and flooding in undesired areas.

Objective 1.3 Emergent Marsh – Breeding Marshbirds

Each year, provide a minimum of 700 acres of habitat for breeding marshbirds, including American bittern, consisting of an average mix of 50 to 70 percent vegetation and 30 to 50 percent open water with water depths often less than 4 inches (10 cm). Breeding habitats for American bittern consist of shallow marshes dominated by cattails, bulrushes, wild rice (*Zizania aquatic*), sedges, and arrow arum. Provide patches of nesting habitat ranging from 6.2 acres (2.5 hectares) to 27.2 acres (11 hectares) or larger, preferably within 98 feet (30 meters) of open water or aquatic bed vegetation habitat (USFWS 2001b). Larger patch sizes (greater than 27.2 acres) results in higher productivity (USFWS 2001b); therefore, emphasis will be placed on large patch sizes, wherever possible.

Rationale

The American bittern is listed as medium priority in BCRs 28 and 29. It is a species that is listed as Endangered (breeding) in New Jersey and is a species of regional conservation concern (USFWS). PIF Physiographic Area 9 identifies this species as a focal species, representing a suite of avian species that

utilize these habitats. Efforts to protect these habitats will also benefit other important refuge Resources of Concern species such as green heron, least bittern, black-crowned night heron, Virginia rail, king rail, sora rail, Northern harrier; and the spotted turtle. American bitterns have been found to nest in habitat that is 6.2 to 27.2 acres or larger (Gibbs et al. 1991, Gibbs and Melvin 1992, Gibbs et al. 1992). American bitterns breed primarily in freshwater wetlands containing tall, emergent vegetation of native species and avoid uniformly-aged stands of older, dense or dry vegetation (USFWS 2001b).

Some of the regional threats to bitterns include loss or degradation of habitat due to drainage, filling, and conversion to agriculture; vulnerability to habitat fragmentation, pesticides and contaminants; and non-native invasive plants, especially purple loosestrife and common reed (Mid-Atlantic/New England/Maritimes Waterbird Working Group 2006). Human activity at breeding sites may also deter bitterns from nesting or cause nest abandonment (Beans and Niles, 2003).

Strategies

- Continue to manage impoundments as natural marsh habitat with similar vegetation and characteristics as marsh habitat in northern New Jersey.

- Continue to maintain impoundments with minimal manipulation, except conduct draw-downs every 7 years to mimic a natural drought cycle.

- Conduct an evaluation of impoundment management options to determine the management regime that would provide the biggest benefit to migratory waterfowl.

- Continue to conduct repair and/or maintenance of water control structures, as needed.

- Continue to conduct invasive species management, when and where necessary. Some examples of management include the release of *Galercucella* spp. beetles to control purple loosestrife and application of herbicides to control common reedgrass.

- Continue to conduct vegetation and wildlife surveys, especially for species of conservation concern.

- Continue to cooperate with partners, students, and volunteers to conduct vegetation and wildlife surveys and research.

GOAL 2: Create and maintain an interspersion of brushland, grassland, and successional wet meadows comprised of native vegetation at various successional stages to enhance breeding and foraging habitat for priority species of conservation concern.

Discussion

The refuge contains approximately 840 acres of brushland habitats and 460 acres of early successional fields (Sneddon 2008). Brushland habitats are cut approximately every eight years to prevent it from succeeding toward immature forest habitat. Early successional fields are mowed (some annually and the others every two or four years) to prevent succession toward brushland habitat. The American woodcock, a key early successional management species, is a USFWS priority species that has responded well to the staggered rotational management at Great Swamp NWR. According to a USFWS Biological Review Report for Great Swamp NWR, the refuge's woodcock data (singing route surveys between 1985 and

2006) indicated relatively stable populations relative to declining statewide populations (USFWS 2006). Under the refuge's current Upland Management Plan (1988), a total of 477 acres were targeted specifically for woodcock management with four cover type needs (singing grounds, feeding, nesting, and roosting cover). Areas were identified to be cut on a staggered rotation to provide field, brush, and early successional stages. An additional 131 acres were targeted for brushland habitat to increase wildlife diversity (USFWS 2006).

In addition to American woodcock, management of these habitat types also benefit a suite of species at the refuge, including Eastern towhee, prairie warbler, yellow-breasted chat, blue-winged warbler, willow flycatcher, Northern harrier, Baltimore oriole and rose-breasted grosbeak. Wood turtles and Eastern box turtles also utilize the refuge's early successional habitats for foraging and basking.

Although some obligate grassland nesting bird species benefit from maintaining early successional fields, management objectives are not based on these species. Great Swamp NWR Biological Review (2006) stated that the size and habitat structure of the refuge's early successional fields are such that they will not attract significant numbers of grassland nesting birds. The latter typically require open habitats in excess of 100 acres that are free of hedgerows and other visual impediments.

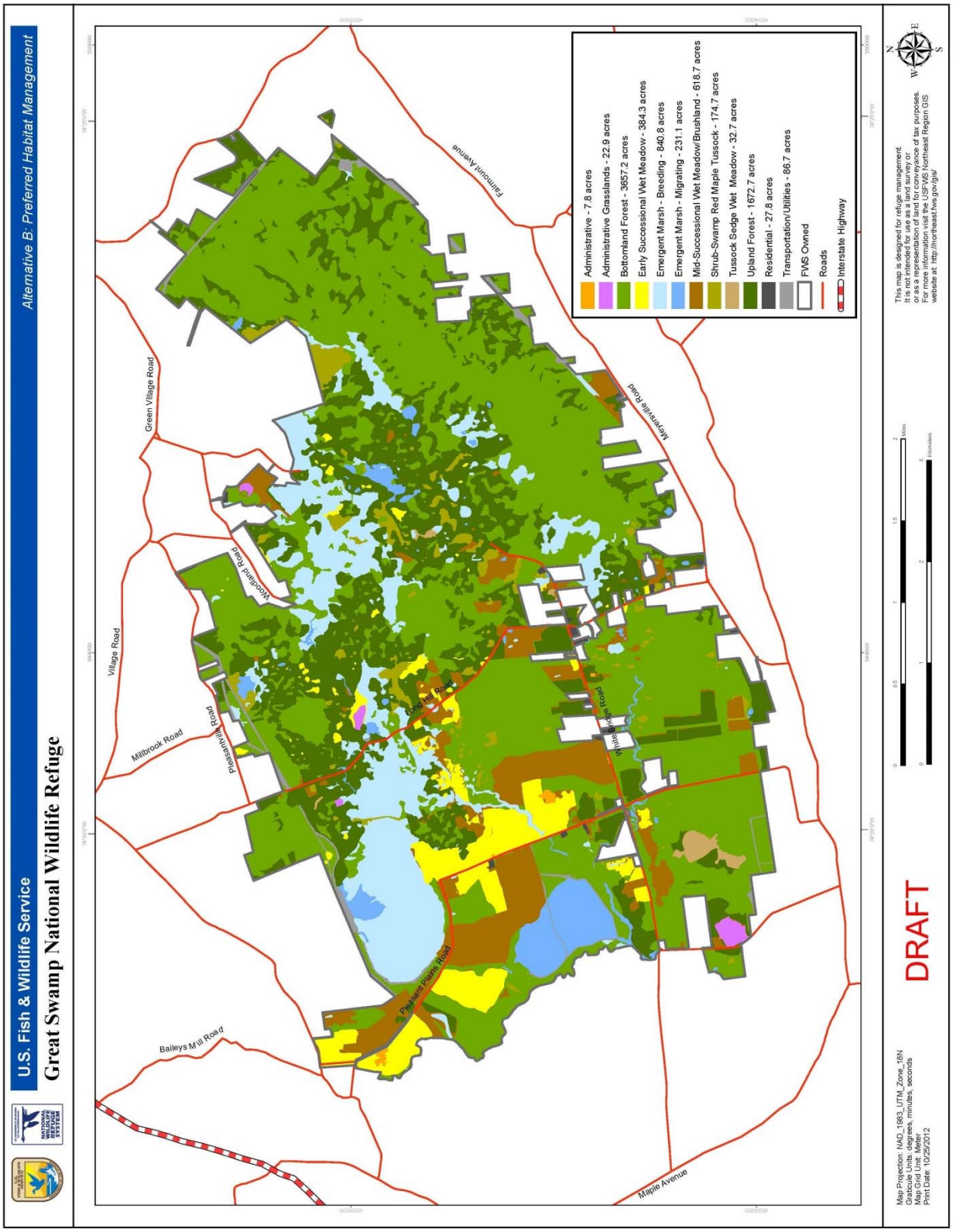
Due to maintenance requirements for remediated landfills, the refuge's remediated landfills must be periodically mowed to keep the sites in a permanent state of early plant succession. This assures that the underlying substrate remains intact and also provides habitat for species that use early successional fields.

Objective 2.1 Mid-Successional Wet Meadows/Brushland – Woodcock Nesting/Foraging & Blue-Winged Warbler Nesting

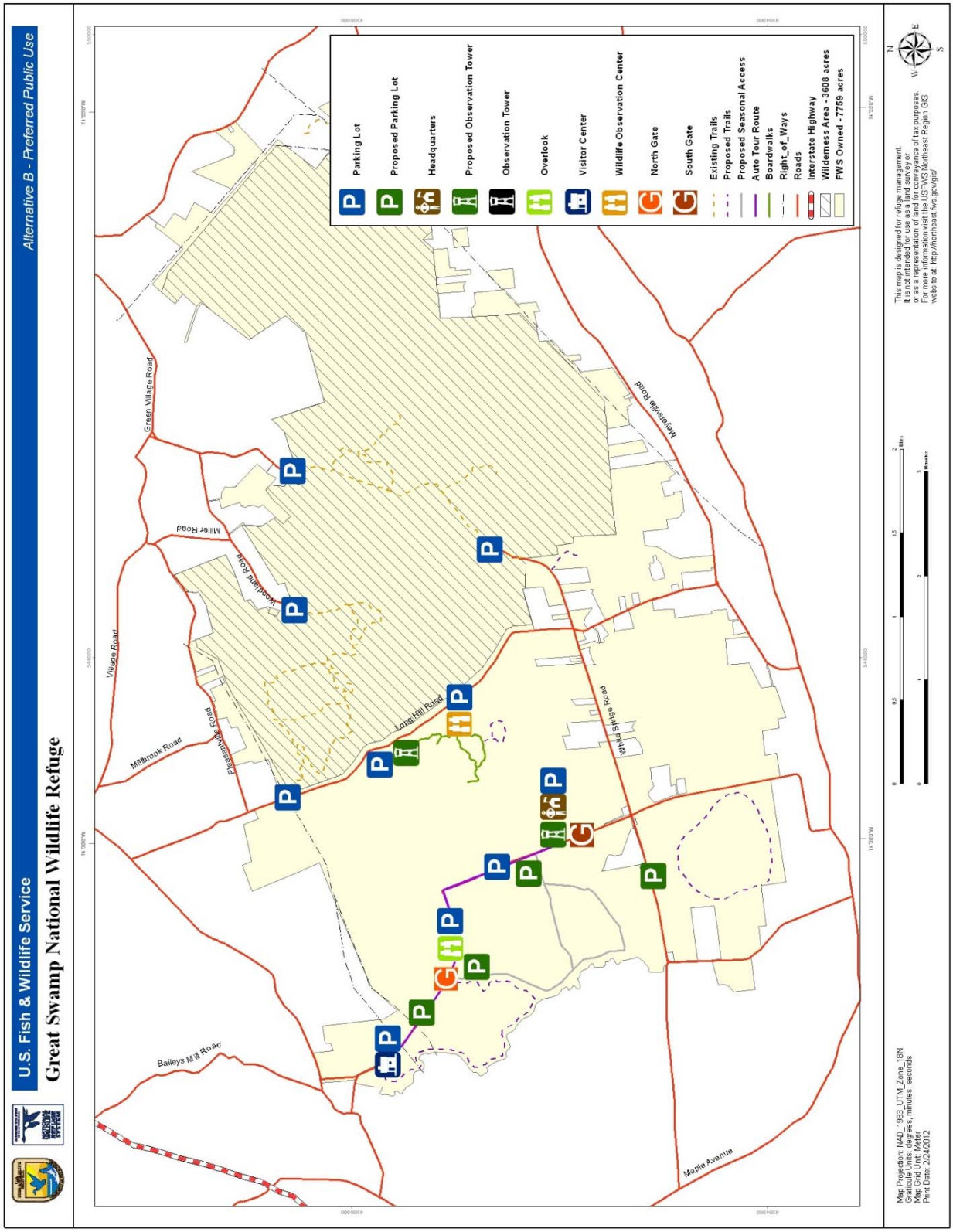
Continue to provide 500 acres of mid-successional wet meadow habitat (shrubs up to 6 feet in height at cover densities of approximately 70 percent) dominated by native species containing a mixture of shrubs and herbaceous vegetation throughout the refuge to provide foraging and breeding habitat for brushland and wet meadow-dependent birds, such as, American woodcock for nesting/brood cover and blue-winged warblers for nesting habitat. American woodcock nesting cover is ideally located within 300 feet of the male's courtship habitat (USFWS 2001c). Courtship habitats should be greater than 2.9 acres (1.2 hectares) in size and consist of open fields, pastures or brushland/forest clearings (USFWS 2001c). Nesting territories of the blue-winged warbler should range from 24 to 123 acres (10 to 50 hectares) in size (USFWS 2001d).

Rationale

A range of habitat types are included under successional wet meadow habitat, ranging from densely vegetated primarily herbaceous meadows to brushy old fields. These habitats support many species of high priority bird species in BCR 28 and 29 Plans, including American woodcock, blue-winged warbler, field sparrow, Eastern towhee, and Northern harrier.



Map 3-3: Anticipated habitat types under Alternative B



Map 3-4: Proposed public use facilities under alternative B.

Land use changes have reduced the amount of early-successional habitats (such as brushlands and grasslands) in the Northeastern United States (Oehler, 2003). Regional threats to these habitats include forest succession, multiple mowings in a single growing season and clearing for agriculture, residential, and other urban uses. As early-successional habitats have declined so have those bird species which are dependent on those habitats. Blue-winged warbler and woodcock are two species that require successional areas for reproduction. Displaying male woodcocks and nesting individuals require successional habitats with various successional stages of woody vegetation.

The American woodcock is listed as a highest priority species in BCR 28 and a high priority species in BCR 29. Significant population declines have been observed since surveys were first implemented in the mid-1960s (Woodcock Task Group et al. 2008). According to the American Woodcock Conservation Plan, New Jersey's population of singing males has declined by 83 percent since the early 1970s (Palmer 2008). The woodcock is also listed as highest priority (Tier IA) in both PIF Physiographic Areas 9 and 10. A Tier IA designation indicates a species has "*High Continental Concern and High Regional Responsibility*" (i.e., conservation in this region is critical for overall health of this species). The blue-winged warbler is a species of USFWS national and regional conservation concern and is of the highest priority in BCR 28 and medium priority in BCR 29. This warbler is listed in Tier IA in PIF Physiographic Area 9 and high priority (Tier IB) in PIF Physiographic Area 10. A Tier IB designation indicates a species has "*High Continental Concern and Low Regional Responsibility*" (i.e., species for which this region can contribute to rangewide conservation objectives where the species occurs). Both of these species have been identified as PIF focal species for their association with a suite of avian species occupying successional habitats.

Strategies

Management of All Brushland Habitats

- Continue to conduct invasive species management, when necessary.
- Continue to periodically conduct breeding bird surveys in brushland communities to identify species and monitor trends, especially for birds of conservation concern.
- Re-evaluate all existing artificial nesting and roosting structures and only maintain those required to meet the biological needs of priority conservation species. Remove artificial structures for species whose populations are now stable; however, consider maintaining a select number of structures for wildlife observation, photography, and interpretive purposes.

Management of Actively Managed Brushland Habitats:

- Where appropriate, use prescribed burning to maintain desired stage of succession.
- In conjunction with objective 2.3, cut select fragmented brushland fields more frequently to regress back to grasslands, where appropriate to create larger blocks of grassland habitat.
- Increase monitoring, early detection, and control of invasive species, especially in areas where change in management or land use occurs and along dispersal corridors.
- Perform rotational mowing and cutting on two to six year cycles to maintain desired stage of succession and prevent succession to forest habitat.

Objective 2.2 Early Successional Wet Meadows –Northern Harrier Foraging & American Woodcock Foraging/Displaying

Continue to provide 460 acres of early-successional field habitat dominated by native vegetation to provide wintering/foraging habitat for the Northern harrier and displaying/foraging habitat for American woodcock. Wet meadow habitat patches should be greater than 2.9 acres (1.2 hectares) in size to provide courtship habitat for American woodcock (USFWS 2001c) and greater than 2.47 acre (1 hectare) in size to provide foraging habitat for Northern harrier (USFWS 2001e). Additionally, 150 acres of these habitats should be maintained adjacent to riparian areas to support the refuge's wood turtle population.

Rationale

Prior to the Revolutionary War and through the early-1900s, much of the GSW was logged and cleared for agriculture, primarily "foul meadow" hay. Grassland species, such as Eastern meadowlarks, bobolinks, upland sandpipers, woodchucks, and voles increased as hayfields and pastures expanded during the early 19th century (Foss 1992; Foster and Motzkin 2003). Repeated attempts at draining, ditching, and stream alteration occurred in the Great Swamp Basin through the mid-1900s. Failure to effectively drain and manage flooding of the swamp eventually caused farming to be abandoned as unprofitable and too difficult to maintain and many farmers moved away. By the 1940s and 1950s, many of the remaining farmhouses were occupied by non-farming families, commuters, and local business owners, and abandoned farm fields began to naturally re-vegetate. After the establishment of the refuge, acquired fields that were managed for haying when in private ownership were continued to be managed as grasslands or early-successional wet meadows with shrub cover ranging from 6 to 60 percent, depending upon mowing frequency (Sneddon 2008).

Some refuge grasslands provide an ecological benefit to a variety of wildlife, including grassland birds, insect pollinators, and threatened or endangered species, such as wood turtles. The large grasslands, such as those near the Visitor Center also provide a unique visitor experience by providing exceptional wildlife viewing opportunities. Under alternative B, these highest quality grasslands will be enhanced for both wildlife and viewing by the removal of hedgerows and obstructions that create predator perches and reduce the availability of nesting areas for grassland birds. This alternative will improve the vegetation quality of these grasslands by evaluating and implementing ways to manage the flora, such as burning or plantings, to maximize their native ecological diversity and productivity.

Many of the small isolated refuge grassland areas along Pleasant Plains Road and Long Hill Road do not support obligate grassland birds or priority species, have less ecological value as grasslands, and do not provide specific benefits to refuge visitors. The lack of suitability of these smaller grassland fragments for obligate grassland breeding birds (OGBBs) is reflected in grassland bird surveys (Little 2001; Little 2004). Under alternative B, grasslands (and managed brushlands; see alternative b, objective 2.2) that do not currently support obligate grassland bird species or other priority species, such as American woodcock would be allowed to undergo natural succession. Based upon their limited patch size and location, allowing natural forest succession within these open areas will improve adjacent core forest health. Specifically, closure of these forest gaps will reduce brown–headed cowbird brood parasitism, invasive species establishment, and other impacts associated with edge effects (see Alternative B - Preferred Habitat Management map).

The Biological Review (2006) recommended that the refuge not be specifically managed for OGBBs, such as grasshopper or savannah sparrows, based on the relative size (less than 20 acre) of most grassland

patches. Many of the OGBBs that occur on the refuge are occasional because they require large tracts of land (at least 50 acres) to support a breeding population, with grasslands over 100 acres being most optimal. Short-eared owl, for example, often prefer areas of 124 acres (50 hectares) or larger for both breeding and wintering habitat (Tate 1992; Dechant et al. 1999; USFWS 2001j). With respect to OGBBs which generally prefer upland habitats, the quality of grassland habitat of Great Swamp NWR is further reduced by the interspersion of wetlands and seasonal standing water in many areas.

The grassland fields provide food for various rodents, green browse for wildlife, and suitable hunting areas for raptors and other predators. The fields are frequently used by various songbirds, including the eastern bluebird. In 1976, the refuge began a bluebird nest box program. There are approximately 160 boxes on the refuge, which are maintained primarily by volunteers. Great Swamp NWR has one of the largest breeding populations of bluebirds in New Jersey because of this highly successful nest box program.

Threats to the refuge's grassland habitats include invasive species, particularly multiflora rose; succession to brushland or forest; and altered hydrology due to historic trenching, ditching and channelization. Some on-site early successional upland grasslands have management constraints due to the presence of remediated landfills and must be maintained as open fields as part of the O&M requirement.

The American woodcock is listed as a highest priority species in BCR 28 and a high priority species in BCR 29. The woodcock is also listed as highest priority (Tier 1A) in both PIF Physiographic Areas 9 and 10. Woodcock require fields in early succession for male courtship display, which have been monitored on the refuge since 1968 (see chapter 2, section 2.6.3). The Northern harrier is listed as Endangered (breeding) in New Jersey and regularly utilizes open meadows at the Great Swamp for foraging. Additional State-listed raptors such as the Cooper's hawk, short–eared owl and American kestrel utilize these open habitats at the refuge for foraging. The wood turtle is a State-listed Threatened species that specifically utilizes patchworks of forest, wetland and successional habitats adjacent to streams. Box turtles, a State-listed Special Concern species, also regularly utilize these habitats. The NJWAP has set a goal of maintaining or increasing all of these species in the Piedmont Region of New Jersey.

USFWS/Tom Tetzner

Great Swamp NWR currently provides exceptional open field habitat for these species. Rotational mowing is conducted in late-fall and winter months, and is required to inhibit woody growth and maintain grassy conditions for nesting songbirds, foraging raptors, and displaying/nesting woodcock. Ongoing management of Great Swamp's successional fields is required for continued use by these species.

In addition to the ecological benefits stated above, the consolidation and reduced fragmentation of grasslands and open areas will result in a long-term reduction of financial and staff resources. Small fragmented fields at the refuge, some of which contain wetlands, are often time consuming to maintain. The resources required for the regular management of each fragment could be

utilized elsewhere to greater ecological or visitor benefit. Based upon current estimates, it takes four to nine staff weeks to manage fields each season.

As part of a reallocation of staff and volunteer time, box nesting programs of stable species, particularly the bluebird nest box program, will be evaluated and reduced as necessary. As mentioned in alternative A, objective 2.1, the bluebird program at the refuge has been highly successful and popular among the public and volunteers since 1976. As a result of its success at the refuge and elsewhere, bluebird populations have stabilized and the species is not prioritized under any relevant State or regional wildlife plans. Due the popularity of this historically important program, some amount of highly visible bluebird boxes will continue to be maintained in grasslands strictly for public viewing, educational, and interpretive opportunities. The maintenance of 160 bluebird boxes, however, is time consuming and the volunteer hours dedicated to their management may be more effectively utilized for management of priority species.

One of the most highly effective ways to manage and improve grassland habitats is through the use of prescribed burning. The Refuge System began using prescribed burning on wildlife refuges in the 1920s, and although other agencies ceased to use this practice during the 1930s due to the perception that all fire was “bad,” some refuges continued to burn. The Refuge System has been recognized by other agencies as a pioneer in developing and implementing scientifically-based prescribed burn plans for managing habitat and protecting wildlife (USFWS 2002b). Prescribed burning is a carefully planned and executed process. It is a cost effective and efficient tool used to restore, rejuvenate, and maintain wildlife habitat on refuges (USFWS 2008f; USFWS 2012a). Fire is known as a unique ecological process that shapes habitat structure and function, and under carefully planned conditions, it can mimic the ecological role of past fires (USFWS 2002b; USFWS 2012b). Prescribed burning benefits both human and wildlife communities. Controlled burning returns nutrients to the soil, removes dead and overgrown vegetation that can fuel large, damaging wildfires, and aids in plant germination. Fire also maintains meadow and grassland habitats, creates open water in marshes, and controls pests, disease, and non-native species, such as honeysuckle and autumn olive (USDA 2007; USFWS 2008f; USFWS 2012c). Some plant species, such as switchgrass, bluestem, and Indiangrass, rely on fire for reproduction and survival. These plant species provide nesting habitat for various migratory birds, including savannah sparrow, bobolinks, eastern meadowlarks, upland sandpipers, and some waterfowl, such as mallards and blue-winged teal (USFWS 2012c). Prescribed burns also benefit rare “secretive marsh birds,” including bitterns, rails, and sparrows (USFWS 2011d). Without periodic fire, national wildlife refuges are more vulnerable to the effects of invasive species, climate change, and severe wildfires (USFWS 2012b).

It is understood that the creation or improvement of expansive grasslands at Great Swamp NWR may not result in substantial population increases of obligate breeding grassland bird populations. This is in part due to the high individual spatial requirements of OGBBs relative to the maximum amount of available refuge grasslands, and the general lack of grasslands within the regional landscape of the New Jersey Piedmont region (USFWS 2006e). Nevertheless, this alternative acknowledges the value of maintaining the highest quality refuge grasslands in the largest contiguous blocks possible for both ecological and wildlife viewing purposes. Creation of large, contiguous patches of grasslands will increase our potential to provide habitat for some OBGGs based on the documented patch size requirements. Alternative B improves the ecological conditions of the refuge’s grassland habitat for documented grassland bird species, raptors, wildflowers, and insect pollinators while avoiding impacts to other prioritized habitats.

Strategies:

- Reconfigure vegetative communities in the Management Area to maximize patch size, reduce fragmentation, and optimize wildlife use and value. Concentrate on consolidation of the largest upland grassland patches adjacent to Pleasant Plains Road. Perform rotational mowing on one to four year rotational basis.

- When necessary, continue to conduct invasive species management, such as biological control of purple loosestrife, manual removal of Japanese stiltgrass, and herbicide treatment of common reedgrass.

- Continue to conduct vegetation and wildlife surveys, such as breeding bird surveys, to document species and trends.

- Continue to cooperate with partners, students, and volunteers, such as New Jersey Audubon Society, to conduct vegetation and wildlife surveys and research.

- Continue to cooperate with partners, such as the Friends of Great Swamp, to maintain and monitor existing artificial nesting and roosting structures. Reevaluate all existing artificial nesting and roosting structures and only maintain those required to meet the biological needs of priority conservation species. Remove artificial structures for species whose populations are now stable; however, consider maintaining a select number of structures for wildlife observation, photography, and interpretive purposes.

- Introduce prescribed burning as a habitat management tool, where possible.

- Over the short and long term, quantitatively evaluate the ecological results of habitat reconfiguration. Evaluations include pre- and post-management habitat and species surveys of consolidated grasslands, successional scrub-shrub, and forest.

- Where feasible, eliminate hedgerows that are less than 25 feet wide to create larger grassland patch sizes.

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- Research the feasibility and risk of low density grazing for control of select invasive species.

- Perform native wildlife plantings with focus on increasing plant and invertebrate diversity.

- Maintain high quality grasslands around the Visitor Center for wildlife viewing, photography, and environmental interpretation opportunities.

Objective 2.3 Shrub-Swamp and Red Maple-Tussock Sedge Wooded Marsh

Maintain 800 acres of seasonally or semi-permanently flooded tussock-sedge wooded marsh dominated by native species, including red maple saplings and tussock sedge, and lesser areas of shrub-swamp containing a variety of shrubs including alders, buttonbush, swamp rose, black willow, Southern arrowwood, highbush blueberry, sweet pepperbush, and dogwood species, with greater than 50 percent woody vegetation to provide important nesting and migratory habitat for passerines and other bird species. Wooded marsh habitats, particularly riparian shrub habitat areas, should be greater than 1.7 acre (0.7 ha) to support nesting willow flycatcher (Walkinshaw 1966).

Rationale

Shrub-swamp and wooded marsh habitat types range from naturally maintained, seasonally wet scrub-shrub wetlands to permanently or semi-permanently flooded tussock sedge wooded marsh, containing shrubs and young trees growing on hummocks. The willow flycatcher is listed as an FWS Bird of Conservation Concern and a Species of Regional Conservation Concern. This species is also listed as Tier IB in PIF Physiographic Area 10. Additionally, a goal for increasing the population has been set in the Piedmont Region under the NJWAP. The willow flycatcher generally nests in riparian sites that are moist, shrubby areas often with standing or running water, generally containing willows (*Salix* spp.). In the central and Eastern United States, this species utilizes both wet and dry upland sites. Nests are generally close to the ground in the crotches of shrubs or small trees near water (Audubon Society 2009).

These naturally occurring shrub habitats support many species of high priority in BCR 28 and 29 Plans for nesting and/or during migration, including blue-and golden-winged warblers, Canada warbler, field sparrow, and Eastern towhee. In addition to birds, herptile and mammal resources of concern will benefit from the preservation of these habitats. Spotted turtles will also utilize these habitats for foraging.

In the United States, brushland habitats are found in natural systems, as well as in human altered systems, such as old fields and utility right-of-ways. Brushland habitats are characterized by low, multi-stemmed woody vegetation in young or stunted stages of succession. These habitats may be densely clustered or consist of a mosaic of low woody cover interspersed with herbaceous cover (USDA 2007). Trees may be present, but are widely spaced or scattered. Habitats consisting of woody shrubs and herbaceous plants have structural diversity that provides nesting sites, escape cover, and food for wildlife (Oehler et al. 2006). The edges of scrub-shrub habitats also provide hunting areas for predatory birds, such as kestrels (USDA 2007).

Early successional wildlife habitats have become critically rare in much of the eastern United States, especially in the Northeast, primarily due to land use changes (DeGraaf and Yamasaki 2003; Oehler 2003). Regional threats to these habitats include forest succession, multiple mowings in a single growing season, invasive species, and clearing for agriculture, residential, and other urban uses. Early successional habitats are less common than they were in pre-settlement times in several regions of the Northeast, specifically southern and south-coastal New England and the coastal mid-Atlantic region. The landscape of the Northeast is dominated by man-altered habitats and human uses; therefore, maintaining early-successional habitats similar to pre-settlement levels is not possible (DeGraaf and Yamasaki 2003).

In comparison to grassland species, the refuge has much greater potential to support and expand viable breeding populations of regionally prioritized shrub-nesting birds. Populations of nesting field sparrow, willow flycatcher, American woodcock, blue-winged warbler, eastern kingbird, brown thrasher, and eastern towhee are all established at the refuge (USFWS 2006e; Little 2001; Little 2004). These species are

typically capable of nesting at higher densities than OGBBs. The conversion of the many remaining less than 20 acre grassland habitats into forest habitats or areas of various stages of woody succession will more effectively contribute to the on-site population of these shrub nesting species, as well as highly prioritized forest species, such as wood thrush (see alternative B, objective 3.1). In spite of the regional prioritization of shrub and forest habitats and species at the refuge, certain grassland habitats on the refuge have high ecological value for avian fauna.

As discussed above under alternative A, objective 2.2, the American woodcock is identified as highest priority in BCR 28 and a high priority in BCR 29; a high continental concern and high regional responsibility for both PIF Physiographic Regions 9 and 10; and a priority in the North American Shorebird Plan for the Atlantic Flyway. The NJWAP sets a population goal for the Piedmont Region to increase this species. Woodcock was also identified as a priority in the North American Shorebird Plan for the Atlantic Flyway. The American woodcock, a key early successional management species, is a FWS priority species that has responded well to the staggered rotational management at Great Swamp NWR. One important contribution to the regional landscape is the refuge's support of a stable American woodcock population, which uses the refuge's patchwork of grassland, scrub-shrub, forest and wetland habitats. Preservation of grassland habitat staging areas under alternative B in conjunction with nesting habitat improvements will create habitat conditions that would support woodcock. According to the American Woodcock Conservation Plan (Wildlife Management Institute 2008), a landscape-level approach to woodcock management involves using management units of 500 to 1,000 acres (202.3 to 404.7 hectares), which should support approximately 500 woodcock. Ideally, several units should be located within 1 to 2 miles (1.6 to 3.2 km) of each other to allow interchange of birds. Within management units, habitat treatments should be centered on broad-leaved deciduous or on deciduous brushland wetlands where moist soils are found. By locating (where allowable) treatments across wet areas or streams, suitable woodcock habitat will be created along a moisture gradient that will provide a consistent supply of earthworms throughout summer. Even-age forest management treatments of more than or equal to 5 acres (2 hectares) will stimulate sprouting of shade-intolerant species to create ideal woodcock habitat. Short rotation cutting cycles of no more than 20 years ensures that forested habitat will not become too mature and will not experience a decline in woodcock use.

According to a Biological Review Report for Great Swamp NWR, the refuge's woodcock data (singing route surveys between 1985 and 2006) indicated relatively stable populations relative to declining statewide populations (USFWS 2006). Under the refuge's current Upland Habitat Management Plan (1988), a total of 477 acres were targeted specifically for woodcock management with four cover type needs (singing grounds, feeding, nesting, and roosting cover). Areas were identified to be cut on a staggered rotation to provide field, brush, and early successional stages. An additional 131 acres were targeted for brushland habitat to increase wildlife diversity (USFWS 2006). In addition to American woodcock, management of these habitat types also benefit a suite of wildlife species at the refuge. According to the Biological Review Report (2006), field surveys suggest that the refuge supports fair numbers of brushland birds, including willow flycatcher, eastern kingbird, gray catbird, brown thrasher, eastern towhee, indigo bunting, and field sparrow.

Natural brushlands are among the most endangered ecosystems in the United States (DeGraaf and Yamasaki 2003). The refuge contains approximately 55 acres of natural brushlands. The refuge's naturally occurring shrub-swamp and wooded marsh habitat types range from seasonally wet brushland wetlands to permanently or semi-permanently flooded tussock sedge wooded marsh, containing shrubs

and young trees growing on hummocks. These naturally occurring brushland habitats support many bird species of high priority in BCR 28 and 29 Plans during nesting and/or during migration, including blue- and golden-winged warblers, Canada warbler, field sparrow, willow flycatcher, and Eastern towhee. The golden-winged warbler, currently being considered for federal listing, occasionally utilizes the refuge. In addition to birds, priority herptiles (e.g., wood turtle, spotted turtle, bog turtle and Eastern box turtle and blue spotted salamander) and mammal (e.g., Indiana bat, little brown bat, and Northern long-eared bat) resources of concern benefit from these habitats.

Most wildlife associated with natural brushland and early successional habitats were once considered generalist species; however, these species have since been determined to be specialists in vegetation structure or area requirements (DeGraaf and Yamasaki 2003). One hundred thirty nine (139) species of reptiles, amphibians, birds, and mammals either prefer (17 species) or use (122 species) brushland and old field habitats (Oehler et al. 2006). Of 40 bird species associated with shrubland habitats, 22 are experiencing significant population declines in the eastern United States (Oehler et al. 2006). A few species in the region are limited to non-forested habitat types, including the northern harrier, savannah sparrow, and vesper sparrow (DeGraaf and Yamasaki 2003). Certain brushland bird species have not adapted to suburban conditions, such as brown thrashers, eastern towhees, and field sparrows, and as a result, are now declining across the region (DeGraaf and Yamasaki 2003). In addition, 58 species of butterflies and moths in the Northeast are dependent upon shrublands, 56 of which are considered rare (Oehler et al. 2006).

As discussed under alternative A, objective 2.2, early successional wildlife habitats have become critically rare in much of the eastern United States, especially in the Northeast, due to land use changes (Oehler 2003). Natural brushlands are among the most endangered ecosystems in the United States (DeGraaf and Yamasaki 2003). As early-successional habitats have declined, so have those bird species that are dependent upon those habitats. Under this alternative, the refuge would continue to manage approximately 55 acres of natural brushlands. In addition, the refuge would consolidate the actively managed brushland habitats to create large (greater than 50 acre) patches. Small or isolated brushland patches that are difficult and costly to manage will be allowed to naturally succeed. The consolidation and reduced fragmentation of managed brushlands will result in improved habitat value for wildlife and a long-term reduction in maintenance costs.

The consolidation of the actively managed brushland habitats will benefit populations of regionally prioritized brushland bird species, including American woodcock, blue-winged warbler, prairie warbler, yellow-breasted chat, Eastern towhee, and field sparrow. Blue-winged warbler and American woodcock are two species that require successional areas for reproduction.

The blue-winged warbler is a species of national and regional conservation concern and is of the highest priority in BCR 28 and medium priority in BCR 29. This warbler is listed in Tier IA in PIF Physiographic Area 9 and high priority (Tier IB) in PIF Physiographic Area 10. A Tier IB designation indicates a species has "*High Continental Concern and Low Regional Responsibility*" (i.e., species for which this region can contribute to rangewide conservation objectives where the species occurs). The blue-winged warbler is somewhat of a generalist species that utilizes a variety of successional habitats that generally contain clumped shrubs and saplings. This species has a relatively large nesting territory, ranging from approximately 25 to 124 acres (USFWS 2001i); therefore, the consolidation of actively managed scrub-shrub habitat will benefit breeding populations of the blue-winged warbler. Both the blue-winged warbler

and American woodcock have been identified as PIF focal species for their association with a suite of avian species occupying successional habitats.

Prescribed burning is a cost effective and efficient tool used to restore, rejuvenate, and maintain wildlife habitat on refuges (USFWS 2008f; USFWS 2012a). Fire is known as a unique ecological process that shapes habitat structure and function, and under carefully planned conditions, it can mimic the ecological role of past fires (USFWS 2002b; USFWS 2012b). The objective of burning scrub-shrub habitats is to remove much or all of the standing vegetation and accumulated leaf litter, while leaving the rootstock and seed bank intact. With careful planning and execution, frequency and intensity of burns can be adjusted to achieve the desired plant structure (USDA 2007).

Strategies

Management of All Brushland Habitats

- Continue to conduct invasive species management, when necessary.
- Continue to periodically conduct breeding bird surveys in brushland communities to identify species and monitor trends, especially for birds of conservation concern.
- Re-evaluate all existing artificial nesting and roosting structures and only maintain those required to meet the biological needs of priority conservation species. Remove artificial structures for species whose populations are now stable; however, consider maintaining a select number of structures for wildlife observation, photography, and interpretive purposes.

Management of Actively Managed Brushland Habitats:

- Where appropriate, use prescribed burning to maintain desired stage of succession.

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- In conjunction with objective 2.1, cut select fragmented brushland fields more frequently to regress back to grasslands, where appropriate to create larger blocks of grassland habitat.
- Increase monitoring, early detection, and control of invasive species, especially in areas where change in management or land use occurs and along dispersal corridors.
- Perform rotational mowing and cutting on two to six year cycles to maintain desired stage of succession and prevent succession to forest habitat.

GOAL 3: Maintain a mosaic of wetland and upland forest, consisting of native understory species of varying densities and structure, to maximize the potential utilization by priority resources of concern.

Discussion

Prior to European settlement, the composition and density of forests within the region may have been modified through fires

set by Native Americans. Several land surveys conducted in the area in the early 1700s documented tree species such as swamp white oak, maple, poplar, beech, elm, and ash (Harris and Ziesing 2010). Prior to the Revolutionary War and through the early-1900s, much of the GSW was logged and cleared areas were then used for agriculture. By the mid-1800s, a majority of the lowest elevations in the basin may have been logged, and according to an 1899 report prepared by the New Jersey State Geologist, "cutting was most severe about 1850, and from 1850 to 1860 was the period of maximum deforestation" (Collins and Anderson, 1994). During the late-1800s, Great Swamp's woodlands were further logged. Repeated attempts of draining, ditching and stream alteration occurred through the mid-1900s; however, failure to effectively drain and manage flooding of the swamp eventually caused farming to be unprofitable and too difficult to maintain; therefore, many farmers moved away. By the 1940s and 1950s, many of the remaining farmhouses became occupied by non-farming families, commuters, and local business owners, and abandoned farm fields began to re-vegetate.

As discussed in section 2.1.5, the soil disturbances caused by agriculture resulted in soil homogeny (mixing) and depletion of key elements, such as carbon and nitrogen, which can last for decades or longer (Momsen 2007). In addition, late season harvests left agricultural soils exposed to harsh winter weather and subject to erosion. These soil impacts may have influenced current vegetation structure and composition. The dichotomy of vegetation patterns in the eastern (Wilderness Area) and western portions (Management Area) of the refuge reflect, in part, the differences in historic land use and land cover. The eastern portion of the present day refuge, while disturbed through logging, was not subject to the intensive soil and hydrologic alteration that resulted from agricultural practices. The western portion of the refuge has undergone soil disturbance from the clearing, ditching, and plowing associated with farming. As a result, the present day Wilderness Area vegetation patterns are consistent with the influence of post-glacial deposits that characterize the geologic history of the region. The pin-oak swamps and other vegetation communities of the western portion of the refuge more reflect post-colonization agricultural use (Momsen 2007).

The Northern Piedmont Plains contains approximately 82,780 acres (33,500 hectares or 129.3 square miles) of forest, including upland, wetland and riparian habitats (NJDEP 2008a). The largest patches of forested land occur in a scattered network of public natural lands, with the largest patch in Great Swamp NWR (NJDEP 2008a). The largest contiguous bottomland forested areas are located within the Wilderness Area of the refuge. These areas are dominated by red maple in the canopy. The Management Area of the refuge contains a mosaic of tracts of bottomland forest habitat, primarily in the southwestern and western portions of the refuge. The majority of upland forested areas are centrally-located on the refuge and are dominated by American beech and oak species. Small upland "islands" of hardwood forest, dominated by American beech and chestnut oak, are also scattered throughout bottomland forest habitats within the Wilderness Area.

Loss of forested land and forest fragmentation due to development are two primary reasons for the decline in many forest-dependent bird species. Fragmentation of forested areas by means of development isolates stands from the main forest complex, increasing the amount of edge habitat and decreasing the amount of forest interior habitat. Negative effects associated with forest habitat fragmentation are well documented for breeding birds. Most forest interior species will only nest within a forest "core" that is at least 295 feet (90 meters) from the nearest forest edge. In addition, the forest core must be a minimum of about 25 acres (10 ha) in size (Dawson *et al.* 1993). Large tracts of contiguous forested areas are necessary to support breeding populations of migratory songbirds (Robbins, *et al.* 1989; Robinson *et. al.,* 1997) as well as forest dwelling raptors (Bosakowski *et al.* 1992; Bosakowski, 1994).

Fragmented forests are characterized by high levels of edge-related nest predation, brood parasitism, or both and prove undesirable for many area-sensitive species. In addition, forest fragmentation can facilitate the spread of exotic invasive plant species that can dramatically change the habitat structure of the forest.

According to the 2008 NatureServ report, Great Swamp NWR contains approximately 4,550 acres of bottomland forest. The most contiguous bottomland forested areas are located within the Wilderness Area of the refuge (i.e., southeastern portion of refuge). These areas are dominated by red maple in the canopy. The Management Area of the refuge contains a mosaic of large tracts of bottomland forest habitat, primarily in the southwestern and western portions of the refuge. Based upon the 2008 NatureServ report, the refuge contains approximately 1,794 acres of upland hardwood forest. A majority of the upland forested areas are centrally-located on the refuge and are dominated by American beech and oak species. Small upland "islands" of hardwood forest, dominated by American beech and chestnut oak, are also scattered throughout bottomland forest habitats within the Wilderness Area.

Active management of forested areas in the Management Area consists primarily of invasive species control (i.e, Japanese barberry and Japanese stiltgrass) and selective thinning to encourage understory growth. Although management in the Wilderness Area is already limited to non-mechanical and non-motorized techniques due to legal constraints, very little management occurs in these areas since this area historically experienced less land alteration and as a result, has experienced minimal presence of invasive species

Forests of Great Swamp NWR are known to support several priority resources of concern, including Indiana bat, barred owl, and various forest dependent birds (i.e., wood thrush). The Indiana bat is a federally and State-listed endangered species; the NJWAP has been targeted for increase in Piedmont populations of this species. The refuge is documented as having maternal roost colonies for Indiana bat in New Jersey (Kitchell 2008). Maternal roosts are typically established in agricultural areas with fragmented forests. Roosting by Indiana bat occurs within the Management and Wilderness Areas of the refuge where an interspersion of forests, brushland, open water, and wet meadow exists (Kitchell 2008). Foraging occurs primarily in and around forested habitats that include pole-stage mixed-oak forest, floodplain forest, upland forest, and forested wetlands (Butchkoski and Hassinger 2002; Gardner et al. 1991; Humphrey et al. 1977; Murray and Kurta 2004; Romme et al. 2002, Sparks et al. 2005). Pregnant or lactating bats forage primarily within wooded or riparian corridors, streams, associated floodplain forests, and impounded bodies of water; however, they will sometimes use hedgerows, upland forest, early successional fields, and croplands (Kitchell 2008). Refer to section 2.6.1 for additional details on the habitat preferences and requirements of the Indiana bat.

The barred owl is a State–listed threatened species, which also has been targeted for increase in Piedmont populations in the NJWAP. Forests within Great Swamp NWR support a significant population of this species. Barred owls require large tracts of undisturbed forest dominated by mature and old growth stands and high canopy cover (Bosakowski et al. 1987; Bosakowski 1989). Barred owls prefer older stands but earlier stages of forest succession will be used if a suitable number of large diameter trees or snags is present (Allen 1987). In eastern North America, barred owls generally maintain established territories year-round with home ranging from 213 to 914 acres in size (Beans and Niles 2003). Although the barred owl is most often associated with densely forested woodlands, this species is not restricted to specific vegetative associations in their foraging activities. These owls have been documented foraging for amphibians traveling to and from vernal pools (Kenney and Burne 2002). Deciduous forests, especially riparian and

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lowland areas, are the most frequently recorded forest types for nesting throughout North America. A typical nest tree is tall, decadent, and has a suitable cavity or a nest site greater than 25 feet above the ground (Allen 1987). Barred owls have been known to use hawk nests when tree cavities are not available (Beans and Niles 2003). Owl sites were located a considerable distance (mean = 2,204 feet) from houses and other buildings (Bosakowski and Smith 1997), showing a significant avoidance of human disturbance and habitat alteration in northern New Jersey. This species demonstrates long-term site fidelity in areas that remained undisturbed (Bent 1937; Bosakowski et al. 1987).

The refuge supports various forest-interior breeding birds including wood thrush, eastern wood peewee, scarlet tanager, veery, and red-eyed vireo. The wood thrush is of the highest rank in BCR 28 and a high priority in BCR 29. Both PIF Physiographic Areas 9 and 10 designates this species as the highest (IA) priority. Wood thrush is listed as both a Bird of Conservation Concern and a Species of Regional Concern for the USFWS. Robbins (1979) estimated that a minimum area of 247 acres is required to support a viable breeding population of wood thrush. The forest patches required by this species for successful reproduction result in the protection of numerous other migratory and breeding forest interior birds at Great Swamp NWR.

The forest complex at Great swamp NWR is extremely important for large volumes of migratory songbirds, including but not limited to Cerulean warbler, Canada warbler, Prothonotary warbler, Louisiana waterthrush, veery, Cooper's hawk, red-headed woodpecker, Acadian flycatcher, and eastern screech owl.

Objective 3.1 Woodland Vernal Pool Habitat

Maintain and enhance 300 acres of vernal pool habitat (i.e., vernal pool and surrounding buffer) for blue-spotted salamander and other obligate vernal pool species, and where possible, maintain a 1,000-foot vegetated buffer around each vernal pool (NJDEP 2004). Buffers should consist of native vegetation and vernal pools should contain approximately 1 to 4 feet of isolated seasonal standing water with a 10 to 30 percent shrub component.

Rationale

The refuge contains approximately 35 acres of vernal pool habitat. Vernal pools are essential habitat for portions of the life cycles of many species, and are also the favored habitat for considerably more species, particularly amphibians, that use them for breeding and foraging in an area of reduced predation (Kenney and Burne 2002). Vernal pool habitats support many other priority species, including spotted turtles and wood turtles, and may occasionally be utilized by barred owls for foraging. Vernal pools are indispensable to biodiversity both locally and globally. In New Jersey, seven species are dependent on vernal pools (i.e., obligate vernal pool species), including the blue-spotted salamander and wood frog (NJDFW 2008). In New Jersey, threats to vernal pool habitat include development, which often results in filling and clearing of surrounding vegetation; change in hydrology due to irrigation wells; overuse of fertilizers and pesticides; and mosquito control efforts (biological, chemical, and hydrological changes). Roadways near vernal pool habitats also contribute to high mortality due to vehicular traffic during annual migrations by amphibian species. Protection, maintenance, and enhancement of vernal pools, as well as the surrounding vegetated buffer, is critical for vernal pool-dependent wildlife. The refuge's vernal pools are monitored annually in

early spring for amphibian presence and reproduction as part of an on-going USGS study. Habitat management of the vernal pools includes tree thinning and installation egg mass attachment sites, such as logs.

The blue-spotted salamander is a State listed endangered species. Additionally, this species is listed in the NJWAP; however, it is not identified for the Piedmont Region. The blue-spotted salamander breeds during late winter and early spring in woodland vernal pools, marshes, swamps, and drainage ditches. Blue-spotted salamander larvae develop for about 2 to 4 months in a vernal pool before metamorphosing into terrestrial juveniles. The terrestrial adult utilizes rotting logs and deep humus for cover around vernal pools and in forested wetlands, slightly above the water level (Kenney and Burne).

Vernal pool habitats support many other priority species, including spotted turtles and wood turtles, and may occasionally be utilized by barred owls for foraging. Additionally, the wood duck, a high priority species in BCR 29, may also utilize vernal pools as nesting habitat. The spotted turtle is a State-listed species of Special Concern and a goal for maintaining the population has been established in the Piedmont Region under the NJWAP. Research has demonstrated that vernal pools provide important foraging areas for spotted turtles (Colburn, 2004). Spotted turtles spend considerable amounts of times in vernal pools during early spring (March and April) feeding on amphibian eggs, invertebrates, and other sources of food. These turtles also utilize vernal pools for basking and breeding (Kenney and Burne).

The wood turtle is a State-listed Threatened species. Additionally, a goal for increasing the population has been set in the Piedmont Region under the NJWAP. The wood turtle is a riparian species and typically uses a mosaic of wetland and upland habitats in the vicinity of its stream habitat; however, this species often uses vernal pools located in the vicinity of streams during early spring to feed on amphibian eggs, larvae, and invertebrates (Kenney and Burne).

The barred owl is a State-listed Threatened species and a goal for increasing the population has been set in the Piedmont Region under the NJWAP. In Northern New Jersey, barred owls inhabit mature, mixed deciduous wetland or riparian forests and prefer flat, lowland terrain (Beans and Niles, 2003). Nocturnal owls have been documented foraging for amphibians traveling to and from vernal pools (Kenney and Burne).

Strategies

- Continue to protect all known vernal pools and maintain surrounding intact forest. Map locations of, and protect any new vernal pools located on the refuge. Evaluate newly identified vernal pools for presence of indicator species (i.e., fairy shrimp, wood frogs, and blue-spotted salamanders).

- Continue to conduct population surveys (i.e., egg mass counts of blue-spotted salamanders and wood frogs) at vernal pools to monitor trends in indicator species activity.

- Perodically inventory and monitor snags. Continue to allow dead trees and snags to persist (i.e., no cutting or removal), to provide additional microhabitats (e.g., natural cavities), for various wildlife species, including bats, woodpeckers, owls, and other wildlife species, as well as future cover and egg site attachment sites for amphibians.

- Continue to monitor, maintain, and restore vernal pool habitat, where practical. Document the extent that invasive plants are occurring in vernal pool habitat and carry out targeted control when necessary. Enhance condition of poor-quality vernal pools [i.e., add thin, long branches and twigs to provide amphibian egg laying sites, maintain large woody debris, brush piles, and rock piles in surrounding forest to provide moist protected cover for adult amphibians, and carry out habitat restoration activities (i.e., native shrub plantings and tree girdling to open the canopy, create snags, and increase percentage of shrub cover) as needed].

Objective 3.2 Riparian Corridors

Where practical, maintain a minimum of a 492 foot (150 meter) wide (Fischer 2000) buffer of riparian corridor along all of the streams on the refuge, including floodplain and swamp forest, dominated by native species, such as American sycamore, pin oak, American elm, and Southern arrowwood, to maintain connectivity of mature bottomland hardwood forest and riverine habitat; to protect the water quality of the Great Brook, Loantaka Brook, Black Brook, Primrose Brook and the Passaic River; to provide roosting and foraging habitat for Indiana bat; and to provide nesting habitat for barred owl, wood duck, wood turtle, and other species of conservation concern.

Rationale

Riparian corridors, including floodplain and swamp forest habitat types, support numerous forest dependent bird species, bat species, and freshwater fisheries. The Indiana bat, a State- and federally listed endangered species, utilizes riparian corridors at Great Swamp NWR for foraging and roosting (see Objective 3.3 for additional information and details on habitat use) (Kitchell 2008). The barred owl is a State-listed threatened species. Additionally, a goal has been established by the NJWAP to increase the barred owl population in the Piedmont region of New Jersey (see Objective 3.3). The State-threatened wood turtle utilizes the aquatic portions of the riparian corridor for foraging and reproduction. The wood turtle also utilizes submerged riparian root systems for brumation and are found in mid-successional forest dominated by oaks, red maple and black birch. Wood turtles have declined in many historic sites in New Jersey due to habitat loss and stream degradation (Beans and Niles, 2003). Wood turtles generally require undisturbed pollutant-free habitats, often at least 0.5 miles away from development (Beans and Niles, 2003). The wood duck has long been historically and successfully managed at Great Swamp NWR and is associated with the refuge purpose. Wood ducks are a cavity-nesting species that may nest in forests typically within 600 feet of slow moving streams or other standing water. The wood duck is a species listed as high priority in BCR 29 and the NJWAP seeks to maintain populations of this species within the Piedmont. Additional forest bird resources of concern that utilize riparian forest habitats at Great Swamp NWR for foraging and/or nesting include Louisiana waterthrush, red-headed woodpecker, hooded merganser, Cooper's hawk, rose-breasted grosbeak and yellow-throated vireo. The cerulean warbler and over a dozen other warbler species identified on the Great Swamp Resources of Concern list may also utilize the riparian habitats during migration.

In addition to preventing water quality degradation through nutrient, sediment and pollutant control, riparian corridors allow wildlife to move between habitat patches. The best corridors are those that are the widest possible and those that connect the largest patches of habitat. Forest interior and neotropical migrant birds, although able to disperse effectively, have been found to have a higher probability of using wider corridors (Keller, *et al*. 1993). Hodges and Krementz (1996) recommend that the minimum corridor width be no less than 330 feet (100 meters) in width.

The improvement, stabilization, protection and maintenance of riparian corridors will also benefit aquatic fauna, particularly freshwater fisheries and macroinvertebrate species. Riparian vegetation species provide an important food base for benthic organisms that break down fallen organic matter, making this material available to other aquatic organisms. Riparian vegetation shades stream corridors, which provides suitable trout habitat while supplying adequate root mass for bank stabilization. The native brook trout (*Salvelinus fontinalis*), a refuge resource of concern, depends on small, cold and clear streams. Brook trout cannot tolerate temperatures greater than 77.5 degrees Fahrenheit (25.3 degrees Celsius), with a maximum temperature for self-sustaining populations at about 66.2 degrees Fahrenheit (19 degrees Celsius) (Detar 2007). One resident fish species, commonly found in streams of the refuge, typically associated with brook trout is the blacknose dace (*Rhinichthys atratulus*) (Hiawatha National Forest Draft Environmental Impact Statement 2005). The protection and improvement of stream health and aquatic resources will contribute to biodiversity of the refuge.

These riparian corridor habitats of Great Swamp NWR may be interspersed with patches of shrub and emergent wetland, including the floodplain pool association (see Chapter 3 for a full description). The floodplain pool association is a narrow herbaceous community located between streams and the adjacent forested habitat. The floodplain pool association may be particularly important for a variety of aquatic amphibians and is identified as globally imperiled (Sneddon, 2008).

Strategies

- Continue to conduct invasive species management, as necessary.
- Continue to allow dead trees and snags to persist (i.e., no cutting or removal), which would provide additional microhabitats (e.g., natural cavities), for various wildlife species, including bats, woodpeckers, owls, and other wildlife species.
- Continue selective cutting using chainsaws or other techniques.
- Continue to maintain existing Atlantic white cedar plantings.
- Continue to maintain wood duck boxes and perform nest box checks.

Monitoring Elements:

- Inventory and monitor snags for wood ducks.
- Continue to conduct vegetation and wildlife surveys, such as Indiana bat surveys, to monitor trends, especially for species of conservation concern.
- Continue to cooperate with partners, students, and volunteers to conduct vegetation and wildlife surveys, such as bat emergence counts.

Objective 3.3 Bottomland Forest

For the life of the plan, maintain 3,700 acres of mature and late successional stages of bottomland forest consisting of a mix of native vegetation of pin oak, red maple, swamp white oak, shagbark hickory, black gum, American elm, sweet gum, and green ash in the canopy with understories of Southern arrowwood,

hornbeam, and sweet pepperbush at varying densities. Target high priority areas for removal of invasive plants, based upon level of threat and potential for re-colonization, and prevent the establishment of invasive species in unaffected areas to maintain biodiversity and ecosystem health. Bottomland forest patches should be large and contiguous (with other patches of both wetland and upland forest) to the greatest extent practicable. Patches in excess of 700 acres should be maintained at the refuge to provide ideal nesting habitat for barred owl, wood thrush and numerous other forest interior breeding species. Maintenance of mature bottomland forest, containing both dead and dying trees, will also provide roosting habitat for Indiana bat and other bat species.

Rationale

The Indiana bat is a federally and State-listed endangered species. Additionally, a goal for increasing this population was also set for the Piedmont Region under the NJWAP. Great Swamp NWR is documented as having one or more maternal roost colonies for Indiana bat in New Jersey (Kitchell 2008). Maternal roosts are typically established in agricultural areas with fragmented forests. Roosting by Indiana bat occurs within the Management and Wilderness areas of the refuge, where an interspersion of forests, shrubland, open water, and wet meadow exists (Kitchell 2008). Roost trees are found within a variety of forested habitats, including wetlands and riparian areas, and primarily include snags or nearly dead trees with peeling or exfoliating bark. Primary roost trees are of large diameter (greater than 22 inches dbh) in open areas with high exposure to sunlight, while alternate roosts are generally smaller in diameter and located within forest interior (Kitchell 2008). Foraging occurs primarily in and around forested habitats that include pole-stage mixed-oak forest, floodplain forest, upland forest, and forested wetlands (Butchkoski and Hassinger 2002, Gardner et al. 1991, Humphrey et al. 1977, Murray and Kurta 2004, Romme et al. 2002, Sparks et al. 2005). Pregnant or lactating bats forage primarily within wooded corridors, streams, associated floodplain forests and impounded bodies of water, but will sometimes use hedgerows, upland forest, early successional fields and along croplands (Kitchell 2008).

The barred owl is a State-listed threatened species, which has also been given a goal of increasing Piedmont populations in the NJWAP. Barred owls require large tracts of mature interspersed wetland and upland forest. In eastern North America, barred owls generally maintain established territories year-round, with home ranging from 213 to 914 acres (86 to 370 ha) in size (Beans and Niles, 2003). Forests within Great Swamp NWR support a significant population of this species.

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The wood thrush is of the highest rank in BCR 28 and is a high priority in BCR 29. Both PIF Physiographic Areas 9 and 10 designate this species as the highest (IA) priority. Wood thrush is listed as both a Bird of Conservation Concern and a Species of Regional Concern for the USFWS. Robbins (1979) estimated that a minimum area of 247 acres (100 ha) is required to support a viable breeding population of wood thrush. The protection of forest patches of sufficient size and connectivity results in the protection of numerous other migratory and breeding forest interior bird species at Great Swamp NWR, including but not limited to Cerulean warbler, Canada warbler, Prothonotary warbler, Louisiana waterthrush, veery, Cooper's hawk, red-headed woodpecker, Acadian flycatcher, and Eastern screech owl. Red-shouldered hawks are listed as endangered (breeding) in New Jersey and have

been recorded nesting in Great Swamp NWR, but were not chosen as a focal species due to the limitations on forest expansion. Additionally, the maintenance of large tracts of forested land for barred owl will benefit red-shouldered hawk.

In the early 1900s, the wood duck population was reduced to exceedingly low levels due to over harvesting. The Migratory Bird Treaty Act, harvest regulations, and management actions have allowed the wood duck population to increase dramatically. In the Northeast, wood duck populations have increased in response to recovering beaver populations, the use of artificial nesting boxes, and increasing amounts of mature cavity trees. Approximately 7,800 juveniles are produced annually in nest boxes at all Region 5 refuges combined, or 0.24 percent of the fall population of juvenile birds. Great Swamp NWR contains approximately 200 wood duck nest boxes that are primarily maintained and monitored by volunteers (USFWS 2006e). The overall contribution of the wood duck box program should be assessed to determine the refuge's contribution to the local population. Volunteer resources may be more valuable and beneficial in other management programs, such as invasive species detection and control. Although wood ducks are ranked a "high priority" in BCR 29, the refuge contains high quality snags and mature cavity trees which provides natural habitat for many cavity dwelling or snag-dependent species, including wood ducks, red-headed woodpeckers, screech owls, and bats. Continuation of the wood duck box program may no longer be necessary.

Threats to bottomland forest in New Jersey include habitat fragmentation; invasive species, especially Japanese stiltgrass; development and associated encroachment; change in hydrology (i.e., increase in flooding, siltation, erosion) due to development; browsing pressure by white-tailed deer; forest succession to a climax stage (impediment to regeneration); and parasites, disease, and infestations, such as gypsy moth, Dutch elm disease, bacterial leaf scorch, and chestnut blight.

Active management of forested areas in the Management Area consists primarily of invasive species control (i.e., Japanese barberry and Japanese wisteria) and selective thinning to encourage understory growth. Although management in the Wilderness Area is already limited to non-mechanical and non-motorized techniques, very little management occurs in these areas since this area historically experienced less land alteration and as a result has fewer occurrences of invasive species.

Strategies

- Continue to conduct invasive species management, as necessary.
- Continue to allow dead trees and snags to persist (i.e., no cutting or removal), which would provide additional microhabitats (e.g., natural cavities), for various wildlife species, including bats, woodpeckers, owls, and other wildlife species.
- Continue selective cutting using chainsaws or other techniques.
- Reconfigure vegetative communities to maximize patch size, reduce fragmentation, and optimize wildlife use and value.
- Increase monitoring and early detection of forest disease and pests, including sudden oak death syndrome and emerald ash borer.

- Where feasible and practical, use feathered edges to create softer transitions between forest and adjacent habitats.

- Evaluate the ecological value of the wood duck box program to determine its contribution to the local population.

  - Identify and remove boxes that are not generally productive, attract non-desirable species, are prone to dump nesting, or are subject to high predation.

  - Less valuable boxes that become old and dilapidated should not be replaced.

  - Combine box removal activities with public outreach effort, emphasizing the importance of high quality snags for cavity nesting species, including wood ducks, red-headed woodpecker, and bats.

  - Consider maintaining a select number of structures for the purpose of providing wildlife observation, photography, and interpretative opportunities.

Monitoring Elements:

- Continue to conduct vegetation and wildlife surveys, such as Indiana bat surveys, to monitor trends, especially for species of conservation concern.

- Continue to cooperate with partners, students, and volunteers to conduct vegetation and wildlife surveys, such as bat emergence counts.

Objective 3.4 Mature Upland Forest

Provide 1,700 acres of mature-late successional upland forest dominated by native species of oak, hickory and beech to benefit migratory breeding birds, including Eastern wood pewee, scarlet tanager and wood thrush. Focus forest management and restoration on parcels within 500 acre blocks of forest or more, if possible, with an emphasis on those parcels with minimal edge habitat, and maintain forests in close proximity to one another.

Rationale

The Eastern wood pewee is a high priority species in BCR 29, a moderate priority in BCR 28, and a high regional priority in PIF Physiographic Area 9. Additionally, a goal to increase the population of this species was set for the Piedmont Region under the NJWAP. The Eastern wood pewee is a generalist species that occupies primarily deciduous, evergreen, and mixed woodland types, but will also utilize open, park-like conditions on xeric sites with limited canopy cover and low shrub densities (Robbins and others, 1989; McCarty 1996). This species will also utilize small forest fragments; however, it may require a minimum amount of forest in the landscape (60 to 90 percent with optimal levels between 80 and 90 percent in 0.62 mile radius).

The scarlet tanager is a moderate priority in BCR 28, highest priority in PIF Physiographic Area 9, and high priority in PIF Physiographic Area 10. A goal to increase the population of this species was set for the Piedmont Region under the NJWAP. This species prefers mature forest, especially where oaks are common, but may occur in young successional woodlands. Scarlet tanagers prefer to nest in large trees with horizontal limbs and small branches (Mowbray, 1999; Stokes, 1983). Notably, as the amount of forest

in the surrounding landscape block decreases below 70 percent, the minimum area required by tanagers increases as the amount of forest in the landscape is reduced.

The wood thrush is of the highest rank in BCR 28 and is a high priority in BCR 29. Both PIF Physiographic Areas 9 and 10 designate this species as the highest (IA) priority. Refer to *Objective 3.3 – Bottomland Forest* above for additional details and habitat requirements.

Threats to upland forests in New Jersey include habitat fragmentation; invasive species, especially Japanese barberry and garlic mustard; urban sprawl, development and associated encroachment; browsing pressure by white-tailed deer and forest succession to a climax stage (impediment to regeneration); and parasites, disease, and infestations (i.e., gypsy moth, Dutch elm disease, bacterial leaf scorch, and chestnut blight).

Large tracts of contiguous forested areas are necessary to support breeding populations of migratory songbirds (Robbins et al. 1989; Robinson et al. 1997), as well as forest dwelling raptors (Bosakowski et al. 1992; Bosakowski 1994). Most forest interior species will only nest within a forest "core" that is at least 295 feet from the nearest forest edge. In addition, the forest core must be a minimum of about 25 acres in size (Dawson et al. 1993). Multiple regional plans stress the importance of developing larger contiguous or core mature forest patches within the regional landscape (Northern Piedmont Plains). Under this alternative, various forest interior species would directly benefit from the consolidation of forest habitat, including wood thrush, scarlet tanager, Acadian flycatcher, and a number of warblers (e.g., Canada warbler, cerulean warbler, black-and-white warbler, and Kentucky warbler, among others).

Loss of forested land and forest fragmentation due to development are two primary reasons for the decline in many forest-dependent bird species. Fragmentation of forested areas by means of development isolates stands from the main forest complex, increases the amount of edge habitat, and decreases the amount of forest interior habitat. Negative effects associated with forest habitat fragmentation are well documented for forest interior breeding birds (Whitcomb et al. 1981; Robinson et al. 1995). Fragmented forests are characterized by high levels of edge-related nest predation and brood parasitism, and prove undesirable for many area-sensitive species, including Arcadian flycatcher, Louisiana waterthrush, prothonotary warbler, wood thrush, veery, and scarlet tanager (Rich et al. 1994; Robinson et al. 1995). In addition, forest fragmentation can facilitate the spread of invasive plant species that can dramatically change the habitat structure of the forest. Under this alternative, we propose to consolidate habitats into larger patch sizes, which will reduce fragmentation and edge effects and associated ecological impacts.

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Feathered edges, also known as cut-back borders, may be used to create a softer ecotonal transition between mature forest and adjacent habitat types like grassland, scrub-shrub, or wetland. In general,

feathered edges are at least 50 feet wide with a rough, irregular edge composed of various young trees, shrubs, vines, and herbaceous plants (Arbuthnot 2008; USDA undated). Feathered edges can serve as important travel and dispersal corridors, and can reduce fragmentation effects (Arbuthnot 2008). Feathered edges provide important nesting, foraging, and escape cover for a variety of wildlife species. In addition, feathered edges improve flowering plants for pollinators and soft mast producing shrubs for wildlife food (Oehler et al. 2006; USDA undated).

Active management of forested areas in the Management Area consists primarily of invasive species control (i.e., Japanese barberry and Japanese wisteria) and selective thinning to encourage understory growth. Although management in the Wilderness Area is already limited to non-mechanical and non-motorized techniques, very little management occurs in these areas since this area historically experienced less land alteration and as a result has fewer occurrences of invasive species.

Strategies

- Continue to conduct invasive species management, as necessary.
- Continue to allow dead trees and snags to persist (i.e., no cutting or removal), which would provide additional microhabitats (e.g., natural cavities), for various wildlife species, including bats, woodpeckers, owls, and other wildlife species.
- Continue selective cutting using chainsaws or other techniques.

Monitoring Elements:

- Continue to conduct vegetation and wildlife surveys, such as Indiana bat surveys, to monitor trends, especially for species of conservation concern.
- Continue to cooperate with partners, students, and volunteers to conduct vegetation and wildlife surveys, such as bat emergence counts.

GOAL 4 Provide opportunities for visitors of all ages and abilities to enjoy wildlife-dependent recreation, appreciate the cultural and natural resources of Great Swamp National Wildlife Refuge, and increase their understanding and support of the refuge's mission.

Objective 4.1 (Hunting)

Similar to alternative A, objective 4.1; however, provide additional hunting opportunities to the public and promote awareness regarding the ecological benefits of hunting.

Rationale

Hunting is one of the six priority public uses to receive enhanced consideration on National Wildlife Refuges in accordance with the Refuge Improvement Act of 1997 and as such needs to be considered at each refuge. If deemed compatible, refuges have a proactive responsibility to provide safe, high-quality public hunting opportunities. Hunting is recognized in the Refuge System as a healthy, traditional outdoor past time, and is deeply rooted in our American heritage.

Hunting opportunities within Northern New Jersey and particularly in the vicinity of Great Swamp NWR are continually reduced by expanding land development and loss of hunting opportunity. As a result of the local reduction of available hunting lands, the demand for hunting on public lands has increased. During the USGS visitor survey, 24 percent of those surveyed identified hunting as an activity they have participated in at the refuge during the past 12 months. With this in mind, the refuge seeks to provide this quality experience to all interested participants, including groups that have limited hunting access or opportunity, such as youths and disabled individuals.

Under this alternative, the refuge would provide two separate and distinct white-tailed deer hunting seasons, including a fall archery (bow) season each October and a firearm season each November. Archery provides the refuge with an additional tool for deer management that does not disrupt current levels of access or reduce the refuge experience for non-hunting visitors. The refuge also proposes the addition of spring wild turkey (*Meleagris gallopavo silvestris*) hunt, which would include a one-day youth hunt at the end of April followed by a regular hunt during a one-week period in late May. Spring turkey hunting would be conducted within the framework of New Jersey State regulations, federal regulations in 50 CFR pertaining to the upland game hunting, and refuge-specific regulations. Season dates and bag limits would be managed to ensure that refuge hunts are compatible with the principles of sound wildlife management and otherwise in the public interest, and would be modified, as needed, on an annual basis. Allowing turkey hunting at the refuge will provide a new and sustainable wildlife-dependent recreational opportunity to the public without interference or additional limits on other wildlife-dependent uses of the refuge.

Fall archery hunting would be allowed on approximately 5,000 acres of the refuge, or about 65 percent of the total area (7,735 acres), which includes the Wilderness Area east of Long Hill Road and Management Area south of White Bridge Road, with exception of land designated as “Safety Zone” or “No Entry.” Firearm hunting would continue to be allowed on approximately 6,376 acres of the refuge, or about 82 percent of the total area, which includes the Wilderness and Management Areas, with exception of land designated as “Safety Zone” or “No Entry.” Similar to archery hunting, wild turkey hunting would be allowed on approximately 5,000 acres of the refuge or about 65 percent of the total area, which includes the Wilderness Area east of Long Hill Road and Management Area south of White Bridge Road with exception of land designated as “Safety Zone.”

The additional Great Swamp NWR hunting opportunities provided under the preferred alternative would expand wildlife-dependent recreational opportunities without reducing access or other non-hunting wildlife opportunities at the refuge. Hunting opportunities at the refuge would be designed to provide the widest range of opportunities with safe, high-quality hunting conditions. These conditions include reasonable harvest expectations, low hunter densities with few conflicts between hunters, relatively undisturbed wildlife, and limited disruption from or use of mechanized equipment.

As is done with the existing hunting program at the refuge, populations of hunted wildlife will be closely and regularly monitored. Parameters of the hunt, including seasons and limits, will be adjusted as needed to maintain healthy populations of hunted wildlife (see alternative A, Objective 4.1).

Strategies

In addition to Alternative A, Objective 4.1:

- Within 2 years, provide a fall archery hunt for white-tailed deer, which will precede the current shotgun and muzzleloader season. This hunt would occur within the Wilderness Area and on refuge lands south of White Bridge Road. The target goal is to maintain levels of deer at 18 to 20 per square mile.

- Within 2 years, open a spring wild turkey hunt for gobblers (males) in the Wilderness Area and areas south of White Bridge Road. The hunt would sustain low daily densities of hunters. There would be no fall hunt for wild turkey.

- Provide a one-day youth hunt for turkey during the spring season

- Collect data on the refuge's turkey population through regular winter and spring counts and by collecting data.

- Use data about the turkey population to set initial bag limits and revise over time as necessary.

- The additional hunts proposed would not result in changes to public access such as additional trail closures of the refuge to the non-hunting visitors.

- Coordinate with Somerset and Morris County EECs to synchronize hunting periods to maximize deer harvest and avoid use conflicts.

- Promote outreach and education programs to increase understanding of the impacts of overabundant deer and other species and the role hunting can play in wildlife management and outdoor recreation.

- Provide additional hunting opportunities for various sectors of the population including veterans and disabled individuals (days, access, hunting blinds, etc.).

Objective 4.2 (Fishing)
Same as alternative A, objective 4.2.

Objective 4.3 (Wildlife Observation, Photography and Public Access)
In addition to alternative A, objective 4.3, enhance or expand the variety of wildlife observation and photography opportunities and improve the quality of access while minimizing user conflicts and impacts to wildlife.

Rationale
Wildlife observation and nature photography represent two of the six priority public uses ("Big Six" public uses) identified in the National Wildlife Refuge System Improvement Act of 1997. The refuge offers many opportunities to view and photograph wildlife, plants, and habitats. The refuge permits the public to use several different modes of access to facilitate opportunities for wildlife observation and photography. The permitted modes of access have been determined to minimize user conflicts and impacts to the refuge's resources.

During the first CCP scoping period, individuals and members of various organizations expressed interest in expanding public access through the creation of new trails and parking areas; maintaining existing trails, boardwalks, and blinds; and improving and maintaining the WOC, access roads, and Pleasant Plains Road.

The FWS is constantly trying to achieve a balance between protecting wildlife and offering a quality visitor experience.

Under this alternative, we propose to extend existing trails, provide limited access to existing service roads, and create new trails; provide additional parking and pull-offs; expand the Wildlife Tour Route; and construct observation towers. Providing increased opportunities for the public on the refuge promotes visitor appreciation and support for refuge programs as well as habitat conservation efforts in the GSW and region.

Strategies

- Expand Wildlife Tour Route from Great Brook Bridge to the Visitor Center.
- Provide additional pull-offs or parking opportunities along the Wildlife Tour Route and White Bridge Road for additional wildlife observation and photography opportunities.
- Evaluate and determine ways to encourage visitors to explore the refuge beyond the Visitor Center, such as the Wilderness Area, WOC, Wildlife Tour Route, and the Headquarters.
- Create additional pollinator gardens within areas viewable to the public for pollinators to promote awareness of native plants and pollinators.
- Construct two observation towers for viewing and teaching opportunities of impoundments and moist soil units. Observation towers would be located near the display pond by the Headquarters and at the WOC.
- Construct additional trails at the Visitor Center for wildlife viewing and educational opportunities.
- Increase communication between individuals staffing the WOC and the Visitor Center during high visitation periods to better direct visitors, reduce overcrowding, and improve visitor's experiences.
- Increase maintenance of or renovate blinds at the WOC, when necessary, to improve visitors' experience.
- Increase connectivity of Wilderness Area trails to provide additional access opportunities to visitors.
- Coordinate with partners to provide refuge visitors with additional access opportunities (i.e., closed areas, after-hours tours, etc.) by taking advantage of existing programs, such as the Raptor Trust's Owl Prowl.
    - Consider jointly sponsoring events with partners.

Objective 4.4 (Non-Wildlife Recreational Opportunities)
Same as alternative A, objective 4.4.

Objective 4.5 (Environmental Education)

Moderately expand standard-based educational opportunities, programming, and materials for all educational levels; and increase opportunities for urban populations.

Rationale

Environmental education is identified in the National Wildlife Refuge System Improvement Act of 1997 as a priority public use ("Big Six" public use). Environmental education in the Refuge System incorporates on-site, off-site, and distance-learning materials, activities, programs, and products that address the audience's course of study, the mission of the Refuge System and the management purposes of the refuge. The goal of environmental education is to promote awareness of the basic ecological foundations for the interrelationships between human activities and natural systems. Through curriculum-based environmental education, both on- and off-refuge, refuge staff and partners hope to motivate students and other persons interested in learning the role of management in maintaining healthy ecosystems and conserving our fish and wildlife resources.

Under this alternative, the refuge would work to expand its Visitor Services staff to increase and improve environmental education programming. This would allow the refuge to reach more teachers and students each year and develop new multidisciplinary programs that meet State curricula standards. In addition, the Visitor Center hours of operation would also be expanded under this alternative. The Visitor Center is currently open four days a week, specifically Thursdays-Fridays (noon to 4 PM) and Saturdays-Sundays (10 AM to 4 PM). The Friends of Great Swamp Nature Shop, which is located in the Visitor Center and staffed solely by volunteers, is also open during these times.

William Lynch

The refuge would continue to encourage volunteers and partners to provide on- and off-site programs and environmental education materials. In addition, the refuge would create new and enhance existing partnerships with educational institutions, county education centers, and other organizations. The internship program would also be expanded by providing additional opportunities for students to gain a valuable learning experience and to help meet college employment program requirements.

Strategies

- Increase Visitor Services staff to four full-time employees.

- Increase environmental education opportunities by providing up to five programs per year at the refuge and three programs per year off the refuge.

- Within 3 years, provide at least 2 on-site environmental education opportunities for nearby urban communities, such as Morristown or Newark.
    - Provide programs that raise awareness of the Service mission and share how the conservation of natural resources is important to the local urban community.

  - Include a continuum of nature experiences for students and urban residents that moves from awareness to engagement.
  - Highlight the value of wildlife that lives in urban areas, and foster connections between wildlife and urban residents.

- Work with local urban communities, to secure grant funding in support of environmental education, including transportation and programming.

- Develop a special relationship with an urban school or class and host a series of on-site and off-site events over the course of a school year.

- Translate refuge brochures and website into Spanish.

- Work with partners like Boy/Girl Scouts, NJ Audubon, TNC, Passaic River Coalition, local colleges to promote visits by organized urban youth groups/clubs (birding club, AP biology class, scout troops, etc.).

- Rotate refuge display among urban schools and follow-up with an on or off-site visit.

- Expand partnership opportunities with county Environmental Education Centers and The Raptor Trust to increase educational opportunities and promote the Great Swamp NWR within the local community.

- Secure grants through National Fish and Wildlife Foundation and others to increase the number of programs offered.

- Work more closely with partner institutions to provide additional curricula-based classes and educational resources.

- Reach out to community colleges, colleges, and universities to promote refuge-based educational programs as part of their curriculum and employment experience requirements.

- Increase opportunities share interns with partners to provide a broader educational experience and to stimulate interest and motivation.

- Increase refuge internship program to accommodate six to eight interns per year, including biological, visitor services, and maintenance interns. Expand internship opportunities beyond the summer months.

- Develop one new multidisciplinary program every 2 years that meets State curricula standards and relates to current events and issues, such as global conservation, climate change, aquatic resources, biology, and pests and diseases.

Objective 4.6 (Environmental Interpretation)

Moderately expand environmental interpretation to incorporate more informal educational opportunities to reach a greater and more diverse audience, especially in the New Jersey-New York metropolitan area.

Rationale

Environmental interpretation is identified in the Improvement Act as a priority public use ("Big Six" public use). Interpretation is an educational activity aimed at revealing relationships, examining systems, and exploring how the natural world and human activities intertwine. One of its goals is to stimulate additional interest and positive action. Interpretation is both educational and recreational in nature. That is, participants voluntarily become involved in interpretive activities because they enjoy them, and in the process, they learn about the complex issues confronting fish and wildlife resource managers. Although audiovisual media, exhibits, demonstrations, and presentations are often advantageous and necessary components in interpretation, the program emphasizes first-hand experience with the environment.

As discussed above under Alternative B, Objective 4.5, additional staff would be requested under this alternative, which would allow the refuge to enhance its environmental interpretation program. Additionally, the operational hours of the Visitor Center would be expanded, which would provide visitors access to exhibits, displays, and audiovisual media that serve to educate the public about the refuge's resources. Expanded operational hours would also allow for additional opportunities and more flexible schedules for demonstrations, presentations, and other interpretative programs at the Center. Expanding the Visitor Center hours would allow the refuge to reach more visitors and promote increased usage during non-peak visitation periods.

Strategies

- Increase Visitor Services staff to four full-time employees.
- Expand the Visitor Center's operational hours to 7 days per week year round.
- Increase environmental interpretation opportunities by providing up to five programs per year at the refuge and three per year off the refuge.
- Promote the Visitor Center through a variety of media to increase awareness of the FWS mission, refuge purposes, and refuge resources.
- Use the USGS Visitor Survey and other sources to guide environmental interpretation based on public interest, current events, refuge or FWS priorities, and ongoing refuge management.
- Expand opportunities for first-hand wildlife connections that inspire, instill appreciation, and raise awareness. When possible, provide or sponsor opportunities with partners.
- Collaborate with partners to promote outreach in urban and minority communities.
- Provide temporary moveable interpretative signage to inform visitors on the purpose and benefit of management activities, such as rotational mowing and Hydro-Axing.
- Increase interpretative programs about climate change and its impact upon wildlife and vegetation communities.
- Use, promote, and provide interpretative programs about the benefits of green technology.

- Increase the use of technology, such as Q-R tags, on interpretive materials to provide visitors with additional information about the refuge's resources.

GOAL 5 Collaborate with the local community and partners to complement biological and visitor services programs on the refuge and surrounding landscape.

Objective 5.1 (Volunteers and Partnerships)

Same as alternative A, objective 5.1, but with the following additional strategies.

Rationale

Partnerships and volunteers are vital to refuge management by providing labor, knowledge, and enthusiasm for biological, public use, and maintenance programs beyond what could be provided by staff alone. Partners and volunteers also facilitate public outreach and provide many environmental interpretation and education programs. Under Alternative B, the existing volunteer program and partnerships would be expanded to encourage learning and study of the refuge, increase volunteer participation, and promote coordination between partners, volunteers, and the refuge.

Strategies

- Identify groups and individuals in the urban community with whom to partner to conserve more wildlife and accomplish conservation efforts previously unachievable.

- Promote awareness and coordination between volunteers, organizations, and refuge and increase volunteer participation (e.g., host biannual meetings).

- Partner with Morris and Somerset County tourism boards to promote eco-tourism at the refuge.

- Expand partnerships with educational institutions, such as Morris and Somerset County Community Colleges, Drew University, Fairleigh Dickinson University, College of Saint Elizabeth's, and Rutgers University, to promote formal educational uses and study of the refuge.

- Promote Heritage Trail, similar heritage resources, and "Crossroads of the American Revolution National Heritage Area."

- Within 2 years, establish partnerships with two local private companies to sponsor an intern or refuge event, or adopt a trail for maintenance.

Objective 5.2 (Public Outreach)

Expand outreach in such a way that increases visitation and usage without negatively impacting the diversity of wildlife, plants, or vegetation communities on the refuge.

Rationale

Expanding public outreach would improve recognition of and appreciation for the refuge, the Refuge System, and the FWS among neighbors, local leaders, conservation organizations, and elected officials, thereby generating support for conservation in the region. Outreach can take many forms, including off-site

exhibits and displays; news media relations; internet, intranet, and Listservers; partnerships; environmental education; memberships in professional and community organizations; and Congressional relations.

Because of its location in a highly urbanized and populated area, the refuge has the potential to reach out to millions of children and adults making Great Swamp NWR the ideal place to implement the Refuge System's new "Urban Refuges" initiative. New Jersey is the most densely populated state in the country with an estimated 1,195 people per square mile (US Census Bureau 2011a). New York City, the most populated city in the U.S. (8,175,133), is located approximately 35 highway miles from the refuge. Philadelphia, the fifth most populated city in U.S. (1,526,006), is located approximately 80 highway miles from the refuge (US Census Bureau 2011b). The top five most populated cities in New Jersey are located within 30 highway miles, including Newark, Jersey City, Paterson, Elizabeth, and Edison. The New Jersey-New York metropolitan area is very racially diverse and Hispanics or Latinos (of any race) are the dominant minority group in New Jersey, making up 17.7 percent of the State population (US Census Bureau 2011c). Public outreach will benefit communities in the greater New Jersey-New York metropolitan area by raising awareness, instilling appreciation, and educating individuals about the unique natural resources found on the refuge and about current environmental issues.

In recent years, the use of wireless communications and the internet have become primary methods of communication. The volume of wireless data traffic in the U.S. grew by 50 percent from the end of 2009 to June 2010. By 2015, it is estimated that 98 percent of U.S. mobile web traffic will come from smart phone users and the number of wireless internet users will increase from 84 million to nearly 160 million (CTIA 2011). The first cell phone "app" was launched in July 2008. Since then, more than 500,000 "apps" have become available from numerous providers (CTIA 2011). For example, an "app" entitled *myRefuge Maps* provides maps and information about bird watching, trails, and historic sites at participating National Wildlife Refuges, including Great Swamp NWR. Under this alternative, the refuge would embrace these types of communications as methods of public outreach. Use of the internet (i.e., refuge website), cell phone "apps", and social media websites (such as, but not limited to, Facebook, Twitter, Google+, YouTube) would allow the refuge to reach individuals in the local community, in the New Jersey-New York Metropolitan Area, and across the world.

Strategies

- Expand the use of web cams for viewing wildlife to reach a broader audience and instill interest.
- Re-establish the Youth Conservation Corps summer program as a tool for outreach and recruitment of urban and minority youths.
- Promote public awareness in neighboring communities and develop partnerships to address important environmental issues such as the spread of invasive plant species and the availability of native plant alternatives.
- Develop a "virtual refuge tour" to reach a broader audience on the internet with the goal of encouraging visitation.
- Improve design of and information contained on the refuge's website.
- Increase media and publicity by promoting the refuge in local and regional papers, such as the Chatham Patch.

- Reach out to minority groups and partner with organizations in the New Jersey-New York metropolitan area to raise awareness and appreciation.

- Develop cell phone applications ("apps") to provide tours and maps.

- Develop a "Watershed Wagon" or mobile visitor center similar to Silvio O. Conte NWR's "Watershed on Wheels" to reach out to communities and schools throughout the area.

- Create educational videos to reach a broader audience on the internet, such as "You Tube" videos.

Objective 5.3 (Climate Change)

Increase efforts to address global climate change through outreach, interpretation and education, refuge habitat planning and water management, partnerships, green technology, and maintenance.

Rationale

Worldwide scientific consensus tells us that our climate is changing and that these changes are already impacting our natural resources, as well as the people, communities, and the economies that depend on them. The observed changes in climate have been directly correlated to the increasing levels of carbon dioxide and other greenhouse gases in the atmosphere (USFWS et al. 2012). Signs of rapidly changing climate are unmistakably evident, including melting glaciers, more frequent and more intense heat waves and droughts, flowers blooming earlier, birds delaying their migrations, rising sea levels, and increases in global average air and ocean temperatures (USFWS et a.l 2012; IPCC 2007). Refer to section 2.1.7 for additional details and examples of climate change impacts.

In response to accelerating climate change, the FWS prepared a plan entitled "Rising to the Urgent Challenges of a Changing Climate: A Strategic Plan for Responding to Accelerating Climate Change in the 21st Century", which was finalized in September 2010 (USFWS 2010a). The primary purposes of the plan are to present a vision for accomplishing the FWS mission in the face of accelerating climate change, to provide direction for our organization and its employees, and to define our role within the context of the Department and the larger conservation community (USFWS 2010a). The plan calls for the FWS and its partners to face challenges, lay the foundation for science-based decision making in the future, and take actions now to ensure that our nation's fish and wildlife resources will thrive in the years to come.

In 2009, Congress urged the CEQ and the Department to develop a national, government-wide climate adaptation strategy to assist fish, wildlife, plants, and related ecological processes in becoming more resilient, adapting to, and surviving the impacts of climate change (USFWS et al. 2012). In a cooperative effort among federal, State, and Tribal governments, the FWS prepared a draft plan entitled "National Fish, Wildlife, and Plants Climate Adaptation Strategy," which was released for public review and comment in January 2012. The purpose and overarching goal of the plan is to provide a nationwide, unified approach, reflecting shared principles and science-based practices, to protect the nation's biodiversity, ecosystem functions, and sustainable human uses of fish, wildlife, and plants in a changing climate (USFWS et al. 2012). The plan provides a basis for sensible actions that can be taken now, in spite of uncertainty that exists about the specific impacts of climate change, and presents guidance about what actions are most likely to promote natural resource adaptation. In the context of climate change, adaptation is defined as an

"adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities" (USFWS et al. 2012).

In accordance with the Adaptive Management Implementation Policy [522 Department Manual (DM) 1], all Department bureaus and offices are encouraged to incorporate adaptive management strategies into their land and resource management decisions. Adaptive management is defined as "a process that promotes flexible decision making that can be adjusted in the face of uncertainties as outcomes from management actions and other events become more understood" (DOI 2008). Environmental assessments are necessary to determine resource status, promote learning, and evaluate progress toward achieving objectives whenever using adaptive management.

Climate change poses significant new challenges for refuge managers, natural resource professionals, legislators, and other decision makers. However, each year, more is being learned on how the climate will change, its impacts on our natural resources, and how future management and policy decisions will affect these impacts (USFWS et al. 2012). Although there is much uncertainty in terms of climate change, adaptive management is structured in way that new information can be incorporated into decision-making over time without delaying needed management actions. Adaptive management actions must be made using the best science-based information available while always striving to improve our knowledge and management capabilities.

According to the 2010 to 2011 USGS Visitor's Survey of Great Swamp NWR, approximately 80 percent of those surveyed indicated that future generations will benefit from addressing climate change impacts to fish, wildlife, and habitats in the present and that addressing these issues will improve their quality of life. While 62 percent of visitors surveyed felt that the catastrophic effects of climate change have not been overemphasized, 39 percent of visitors felt that there is too much scientific uncertainty to adequately understand the specific effects of climate change on fish, wildlife and habitats. These results indicate that visitors generally grasped the seriousness of and supported actions to address climate change impacts to ecological systems. More than half of visitors (51 percent) indicated that their experience would be enhanced if Great Swamp NWR provided information about how they could help address the effects of climate change on fish, wildlife, and their habitats. Alternative B strategies address the visiting public's general concern for the issue tempered with the need for a clearer understanding of impacts. In essence, under this alternative, Great Swamp NWR will continue to focus on the importance of the issue while collecting the best on-site and regional data available and will adapt educational and management strategies accordingly.

Strategies

In addition to alternative A, objective 5.3:

- Increase education and awareness programs about climate change.
- Monitor for climate change-related species impacts, disease, and vegetation shifts. If feasible, establish a "Citizen Science Program" to assist in the collection of data through citizen participation, while immersing the public into the scientific process.
- Use adaptive management and mitigation, if practical and necessary, to protect native plants, wildlife, and habitats, especially resources of conservation concern.

- Increase monitoring, early detection, and control of invasive species that may increase as a result of climate change.

- Stay informed, current, and educated on climate change and share such information with partners and the public.

Objective 5.4 (Wilderness Area)

In addition to alternative A, objective 5.4, expand the existing designated Wilderness to include an additional 170 acres of bottomland forest.

Rationale

Although a portion of the refuge is already designated as Wilderness Area, Refuge System planning policy requires that we conduct a wilderness review during the CCP process. A wilderness review is the process we follow to identify and recommend for Congressional designation Refuge System lands and waters that merit inclusion in the NWPS. The results of the wilderness review are included as appendix B. The results of the wilderness review determined that approximately 170 acres of bottomland forest, contiguous with the southwestern portion of the present day Wilderness Area, meet the eligibility criteria for a WSA, as defined by FWS wilderness policy (610 FW 4). See section 3.1.23 above for details regarding the wilderness review process and appendix B for the results of our wilderness review.

Strategies

In addition to strategies identified under alternative A, objective 5.4:

- As part of the wilderness review, recommend the addition of 170 acres to the existing Wilderness Area.

- Manage the recommended area as Wilderness until designated or released by Congress.

Objective 5.5 (Nuisance Wildlife Control)

Similar to alternative A, objective 5.5, but with the following additional strategies.

Rationale

The term nuisance wildlife is often associated with an animal that causes or has potential to cause damage to property, presents a threat to public health or safety, or causes an annoyance within, under, or upon a building. An animal that results in negative impacts to other wildlife species or their habitat may also be considered nuisance wildlife. Nuisance wildlife species can be native, non-native, or feral, and are often adapted to living in fragmented habitat and in close proximity to humans. Certain species are periodically problematic at the refuge, such as raccoons, Canada geese, beavers, and feral cats. Management or control of nuisance wildlife may be required to prevent impacts to other wildlife (i.e., predation, competition, and spread of disease) or habitat (i.e., undesired flooding or excessive herbivory).

People that intentionally or accidentally feed, provide shelter, or release rehabilitated, feral, or other wild animals onto or near the refuge can perpetuate ecological impacts associated with nuisance wildlife. Promoting awareness about the ecological effects of nuisance wildlife may help prevent or reduce the frequency of problematic wildlife that occur as a result of human actions.

Strategies

- Promote public awareness regarding the ecological impacts of nuisance wildlife.

Alternative C: Emphasis on Maximizing Natural Regeneration

Introduction

The overall management strategy of alternative C focuses on the recognition that refuge habitats and wildlife populations are not ecologically independent from the surrounding landscape and that by taking a long-term regional perspective, the refuge can best contribute to higher conservation priorities at greater scales. As a result, management direction is primarily derived from regional plans and directives including relevant BCR and PIF plans, and the NJWAP, which prioritizes forest and successional shrub habitats in the Northern Piedmont Plains region of the State. By allowing Great Swamp NWR plant communities to return to post-glacial, pre-colonial conditions to the maximum extent possible, alternative C best fits the FWS BIDEH policy (601 FW 3). This policy provides guidance on maintaining or restoring the BIDEH of the Refuge System (see chapter 1, section 1.3.2).

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Under this alternative, natural succession or regeneration will be allowed to occur to the maximum extent practical to best recreate the pre-colonial natural communities of the refuge (see Figure 3-5). Although a similar strategy is employed in alternative B, alternative C maximizes regeneration to include an additional 284 acres of various plant communities. When compared to alternative B, several additional areas of actively managed scrub-shrub habitats would be allowed to naturally succeed in the vicinity of refuge headquarters, along Pleasant Plains Road, and along White Bridge Road. Similar to alternative B, large patches of consolidated grasslands and managed brushlands will be maintained along Pleasant Plains Road, which will benefit refuge priority resources (e.g., American woodcock) while providing wildlife viewing opportunities to the public. Active management would continue in areas known to support priority refuge resources, including bog turtle, woodcock, and other species that rely on a particular stage of succession for all or part of its life cycle. Hedgerows and forest corridors within grassland patches would be removed.

Under this alternative, we would conduct a comprehensive analysis of the impoundments to determine the best option for habitat management for these lands. The review would include options for management including, allowing the impoundments to revert to natural conditions. In particular this evaluation would include how the lands fit into the larger landscape and which habitat management option would provide the best conservation benefits to regional and landscape level priority species and habitats.

More than the other alternatives, alternative C maximizes the refuge's role in forest carbon sequestration and provides other regional forest management benefits. The refuge will actively work within regional partnerships dedicated to addressing climate change, habitat loss, and water and air quality impacts.

In addition to its ecological significance, alternative C significantly reduces labor costs and the impacts associated with the periodic mechanical clearing required to maintain open habitats. Management of many

small, open grassland tracts, particularly in wetland environments, can be time consuming and monopolize staff resources that may be better used in other management practices.

USFWS/George Gentry

GOAL 1: Provide high quality diverse freshwater emergent wetlands with naturally varying hydric regimes, including wet meadows, freshwater emergent marsh, and open water wetland habitats dominated by native plants for migratory birds, endangered and threatened species and priority conservation species.

Objective 1.1 Tussock Sedge Wet Meadows

Within five years, maintain and restore a minimum of 75 acres of high quality, spring-fed, open wet meadow dominated by a mixture of native sedges, including tussock sedge, with a 10 to 30 percent scrub/shrub component and hydric regime suitable for bog turtle.

Rationale

See alternative B, objective 1.1.

Strategies

The strategies for this objective will be the same as those listed in alternative B, objective 1.1. However, they will be expanded to include an additional 35 acres, for a total of 75 acres, as depicted in map 3-5.

Objective 1.2 Emergent Marsh – Migrating Waterfowl

Each year, maintain a minimum of 250 acres of spring (March through April) and fall (October through November) waterfowl migration and staging habitat consisting of shallow flooded wetlands (less than or equal to 12 inches of water) with a mix of native emergent vegetation and open water habitat, dominated by arrow arum, cattail, bur-reed, woolgrass, bulrush, swamp rose mallow, buttonbush, millets, tussock sedge (*Carex stricta*), duckweed, sedges, muskgrass, spikerush, rice cutgrass, wild rice, and pickerelweed.

Rationale

See alternative B, objective 1.2. However, the number of acres of emergent marsh under this alternative would likely be reduced as existing emergent marsh is allowed to naturally succeed to breeding marshbird, successional wet meadow and brushland habitat types.

Strategies:

Same as alternative B, objective 1.2, but on a reduced scale as seen in map 3-5.

Objective 1.3 Emergent Marsh – Breeding Marshbirds

Each year, provide a minimum of 900 acres of habitat for breeding marshbirds, including American bittern, consisting of an average mix of 50 to 70 percent vegetation and 30 to 50 percent open water with water depths often less than 4 inches (10 cm). Breeding habitats for American bittern consist of shallow marshes dominated by cattails, bulrushes, wild rice, sedges, and arrow arum. Provide patches of nesting habitat ranging from 6.2 acres (2.5 hectares) to 27.2 acres (11 hectares) or larger, preferably within 98 feet (30 meters) of open water or aquatic bed vegetation habitat (USFWS 2001b). Larger patch sizes (greater than

27.2 acres) results in higher productivity (USFWS 2001b); therefore, emphasis will be placed on large patch sizes, wherever possible.

Rationale
See alternative B, objective 1.3.

Strategies
Same as alternative B, objective 1.3. However, additional acres of this habitat would be available as additional emergent marsh succeeds to the vegetation cover and water depths outlined in this objective.

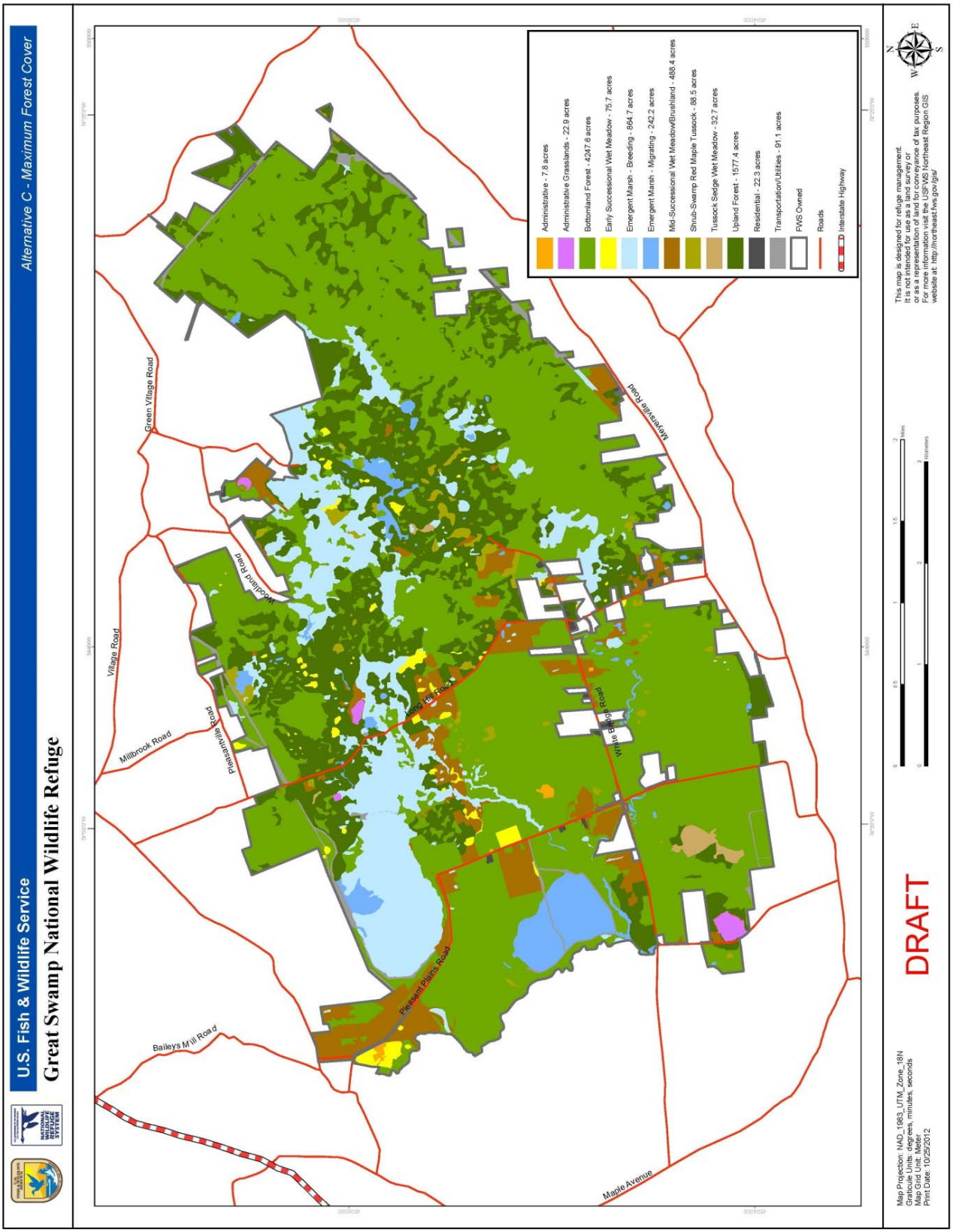
GOAL 2: Create and maintain an interspersion of brushland, grassland, and successional wet meadows comprised of native vegetation at various successional stages to enhance breeding and foraging habitat for priority species of conservation concern.

Discussion
The refuge contains approximately 840 acres of brushland habitats and 460 acres of early successional fields (Sneddon 2008). Brushland habitats are cut approximately every eight years to prevent it from succeeding toward immature forest habitat. Early successional fields are mowed (some annually and the others every 2 or 4 years) to prevent succession toward brushland habitat. The American woodcock, a key early successional management species, is a USFWS priority species that has responded well to the staggered rotational management at Great Swamp NWR. According to a USFWS Biological Review Report for Great Swamp NWR, the refuge's woodcock data (singing route surveys between 1985 and 2006) indicated relatively stable populations relative to declining statewide populations (USFWS 2006). Under the refuge's current Upland Management Plan (1988), a total of 477 acres were targeted specifically for woodcock management with four cover type needs (singing grounds, feeding, nesting, and roosting cover). Areas were identified to be cut on a staggered rotation to provide field, brush, and early successional stages. An additional 131 acres were targeted for brushland habitat to increase wildlife diversity (USFWS 2006).

In addition to American woodcock, management of these habitat types also benefit a suite of species at the refuge, including Eastern towhee, prairie warbler, yellow-breasted chat, blue-winged warbler, willow flycatcher, Northern harrier, Baltimore oriole and rose-breasted grosbeak. Wood turtles and Eastern box turtles also utilize the refuge's early successional habitats for foraging and basking.

Although some obligate grassland nesting bird species benefit from maintaining early successional fields, management objectives are not based on these species. Great Swamp NWR Biological Review (2005) stated that the size and habitat structure of the refuge's early successional fields are such that they will not attract significant numbers of grassland nesting birds. The latter typically require open habitats in excess of 100 acres that are free of hedgerows and other visual impediments.

Due to maintenance requirements for remediated landfills, the refuge's remediated landfills must be periodically mowed to keep the sites in a permanent state of early plant succession. This assures that the underlying substrate remains intact and also provides habitat for species that use early successional fields.



Map 3-5. Anticipated habitat types under alternative C.

Objective 2.1 Mid-Successional Wet Meadows / Brushland – Woodcock Nesting/Foraging and Blue-Winged Warbler Nesting

Provide 500 acres of mid-successional wet meadow habitat (shrubs up to 6 feet in height at cover densities of approximately 70 percent) dominated by native species containing a mixture of shrubs and herbaceous vegetation throughout the refuge to provide foraging and breeding habitat for brushland and wet meadow-dependent birds. For example, this habitat is utilized by American woodcock for nesting/brood cover and by blue-winged warblers for nesting habitat. American woodcock nesting cover is ideally located within 300 feet of the male's courtship habitat (USFWS 2001c). Courtship habitats should be greater than 2.9 acres (1.2 hectares) in size and consist of open fields, pastures or brushland/forest clearings (USFWS 2001c). Nesting territories of the blue-winged warbler should range from 24 to 123 acres (10 to 50 hectares) in size (USFWS 2001d).

Rationale

See alternative B, objective 2.1.

Strategies

Same as alternative B, objective 2.1.

Objective 2.2 Early Successional Wet Meadows – Northern Harrier Foraging and American Woodcock Foraging/Displaying

Provide 75 acres of early-successional field habitat dominated by native vegetation to provide wintering/foraging habitat for the Northern harrier and displaying/foraging habitat for American woodcock. Wet meadow habitat patches should be greater than 2.9 acres (1.2 hectares) in size to provide courtship habitat for American woodcock (USFWS 2001c) and greater than 2.47 acre (1 hectare) in size to provide foraging habitat for Northern harrier (USFWS 2001e). Additionally, 150 acres of these habitats should be maintained adjacent to riparian areas to support the refuge's wood turtle population.

Rationale

See alternative B, objective 2.2.

Strategies:

Same as alternative B, objective 2.2, but on a reduced scale as seen in map 3-5.

Objective 2.3 Shrub-Swamp and Red Maple-Tussock Sedge Wooded Marsh

Maintain 100 acres of seasonally or semi-permanently flooded tussock-sedge wooded marsh dominated by native species, including red maple saplings and tussock sedge, and lesser areas of shrub-swamp containing a variety of shrubs including alders, buttonbush, swamp rose, black willow, Southern arrowwood, highbush blueberry, sweet pepperbush, and dogwood species, with greater than 50 percent woody vegetation to provide important nesting and migratory habitat for passerines and other bird species. Wooded marsh habitats, particularly riparian shrub habitat areas, should be greater than 1.7 acre (0.7 ha) to support nesting willow flycatcher (Walkinshaw 1966).

Rationale

See alternative B, objective 2.3.

Strategies

Same as alternative B, objective 2.3, but on a reduced scale as seen in map 3-5.

GOAL 3: Maintain a mosaic of wetland and upland forest, consisting of native understory species of varying densities and structure, to maximize the potential utilization by priority resources of concern.

Discussion
See alternative B, goal 3.

USFWS/Eric Engbretson

Objective 3.1 Woodland Vernal Pool Habitat
Maintain and enhance 300 acres of vernal pool habitat (i.e., vernal pool and surrounding buffer) for blue-spotted salamander and other obligate vernal pool species, and where possible, maintain a 1000-foot vegetated buffer around each vernal pool (NJDEP 2004). Buffers should consist of native vegetation and vernal pools should contain approximately 1-4 feet of isolated seasonal standing water with a 10 to 30 percent shrub component.

Rationale
See alternative B, objective 3.1.

Strategies
Same as alternative B, objective 3.1.

Objective 3.2 Riparian Corridors
Where practical, maintain a minimum of a 492 feet (150 meter) wide (Fischer 2000) buffer of riparian corridor, including floodplain and swamp forest, dominated by native species, such as American sycamore, pin oak, American elm, and Southern arrowwood, to maintain connectivity of mature bottomland hardwood forest and riverine habitat; to protect the water quality of the Great Brook, Loantaka Brook, Black Brook, Primrose Brook and the Passaic River; to provide roosting and foraging habitat for Indiana bat; and to provide nesting habitat for barred owl, wood duck, wood turtle, and other species of conservation concern.

Rationale
See alternative B, objective 3.2.

Strategies
Same as alternative B, objective 3.2.

Objective 3.3 Bottomland Forest
Within 15 years of plan implementation, maintain 3,700 acres and restore approximately 600 acres of mature and late successional stages of bottomland forest consisting of a mix of native vegetation of pin oak, red maple, swamp white oak, shagbark hickory, black gum, American elm, sweet gum, and green ash in the canopy with understories of Southern arrowwood, hornbeam, and sweet pepperbush at varying densities. Target high priority areas for removal of invasive plants, based upon level of threat and potential for re-colonization, and prevent the establishment of invasive species in unaffected areas to maintain biodiversity and ecosystem health. Bottomland forest patches should be large and contiguous (with other

patches of both wetland and upland forest) to the greatest extent practicable. Patches in excess of 700 acres should be maintained at the refuge to provide ideal nesting habitat for barred owl, wood thrush and numerous other forest interior breeding species. Maintenance of mature bottomland forest, containing both dead and dying trees, will also provide roosting habitat for Indiana bat and other bat species.

Rationale
See alternative B, objective 3.3.

Strategies
Same as alternative B, objective 3.3, but with an additional 600 acres of restored forest, as seen in map 3-5.

Objective 3.4 Mature Upland Forest
Provide 1,600 acres of mature to late successional upland forest dominated by native species of oak, hickory and beech to benefit migratory breeding birds, including Eastern wood pewee, scarlet tanager and wood thrush. Focus forest management and restoration on parcels within 500-acre blocks of forest or more, if possible, with an emphasis on those parcels with minimal edge habitat, and maintain forests in close proximity to one another.

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Rationale
See alternative B, objective 3.4.

Strategies
Same as alternative B, objective 3.4, but with 100 fewer acres of mature upland forest than alternative B, as seen in map 3-5.

GOAL 4 Provide opportunities for visitors of all ages and abilities to enjoy wildlife-dependent recreation, appreciate the cultural and natural resources of Great Swamp National Wildlife Refuge, and increase their understanding and support of the refuge's mission.

Objective 4.1 (Hunting)
Same as alternative A, objective 4.1.

Objective 4.2 (Fishing)
Same as alternative A, objective 4.1.

Objective 4.3 (Wildlife Observation, Photography and Public Access)

Same as alternative A, objective 4.3, except eliminate less used or dead end trails in the Wilderness Area.

Rationale

The refuge currently provides approximately 8.5 miles of trails in the Wilderness Area. Under this alternative, select dead end or less used trails would be eliminated through natural succession. Elimination of these trails would reduce unnecessary fragmentation and the potential for inadvertent introduction of invasive species. In addition, there would be fewer occurrences of visitors getting lost on the less used trails, which become overgrown with vegetation.

Strategies

Within 10 years of CCP approval:

- Eliminate less used or dead end trails in wilderness area.

Objective 4.4 (Other Non-Wildlife Recreational Opportunities)

Same as alternative A, objective 4.4.

Objective 4.5 (Environmental Education)

Same as alternative A, objective 4.5.

Objective 4.6 (Environmental Interpretation)

Same as alternative A, objective 4.6.

GOAL 5: Collaborate with the local community and partners to complement biological and visitor services programs on the refuge and surrounding landscape.

Objective 5.1 (Volunteers and Partnerships)

Same as alternative B, objective 5.1:

Objective 5.2 (Public Outreach)

Similar to alternative B with more emphasis on forest habitats and related issues.

Rationale

In conjunction with the volunteer and partnership strategies employed under alternative B, objective 5.2, public outreach under this alternative would concentrate on the importance of forest resources and their contribution to regional ecology. The rationale of alternative C, objective 5.3 provides the climate related focus for public outreach under this alternative.

Strategies:

In addition to the strategies identified under alternative B and within 5 years of CCP approval:

- Develop programs that focus on the problem of forest fragmentation, the importance of forest dependent species, and the refuge's role in carbon sequestration as a climate change mitigation tool.

- Coordinate and work with adjacent parks and agencies containing forest habitats to create a coherent regional approach to providing information about managing and promoting the ecological role of mature forest.

Objective 5.3 (Climate Change)
Same as alternative B, objective 5.3.

Objective 5.4 (Wilderness Area)
Same as alternative B, objective 5.4.

Objective 5.5 (Nuisance Wildlife Control)
Same as alternative A, objective 5.5.

Alternative D: Focus on Expansion of Priority Public Uses

Introduction
Great Swamp NWR is uniquely located in one of the most urban and densely populated areas in the United States. As a result, the refuge is an ideal conduit to reaching a diverse public, segments of which may be under-served and have limited access to outdoor and wildlife-oriented opportunities. Its unique potential to reach urban populations is reflected in one of the refuge's original purposes as an "outdoor laboratory" for the "people of the heavily populated surrounding area" (see section 1.5). Great Swamp NWR is an ideal place to implement the Refuge System's new "Urban Refuges" initiative. With this in mind, alternative D prioritizes a multitude of methods for maximizing priority public uses while minimizing impacts to wildlife (see figure 3-6).

Under alternative D, the refuge would increase visitor and program participant numbers; maximize the demographic diversity of visitors and program participants; provide a greater variety of quality wildlife-oriented public and volunteer opportunities and programs; and increase outreach and publicity to promote conservation, the refuge, and the Refuge System purpose.

In addition to programmatic changes, this alternative emphasizes, to a greater extent than alternative B, the expansion of infrastructure, including the creation of new trails, observation towers, and parking lots, and the installation of new signage in ways to better attract and retain visitors. As with all alternatives, changes in infrastructure would still be performed in conjunction with careful monitoring and with full consideration of the needs of wildlife resources (see introduction of chapter 3). Trails systems throughout the refuge would be better connected by trail additions and certain management roads would be open to public access. Additional areas would be evaluated for future trail opportunities.

Other differences between alternative D and the preferred alternative relate to differences in the allocation of resources, such as the priorities for staffing, increased marketing efforts, and changes and increases to the volunteer program.

Biological objectives, including the configuration, proportions, and acreages of varying habitats within the Management Area of the refuge, are generally the same as to those proposed under the preferred alternative B. Under alternative D, however, there is more emphasis placed on managing for open habitats popular for wildlife observation, particularly open water and grasslands. The most notable management

difference under alternative D is the proposed maintenance (vegetation suppression) of open water habitat within impoundments located west of Pleasant Plains Road. Open water habitats are popular among refuge visitors seeking waterbird observation opportunities. Under this alternative, grassland configuration (consolidation), size, and proportions remain the same as alternative B as both habitat and public use goals are met through the improvement of grassland habitat patches on the refuge.

This alternative further emphasizes the use of emerging technologies and aggressively expands partnerships for conservation initiatives, such as global climate change. Under this alternative, promotion of the refuge and Refuge System are given additional emphasis.

Alternative D incorporates all priority public uses of the refuge to the greatest extent practicable. Most notably, fishing opportunities, which are not authorized under any other alternative, would be provided in select areas of the refuge. The refuge's hunting program would be expanded as described under alternative B.

This alternative relies heavily on data collected from the USGS Visitor Survey (Sexton et al. 2012), as well as comments received during the public CCP scoping process, to provide manageable objectives that address the concerns and desires of refuge visitors and volunteers.

GOAL 1 Provide high quality diverse freshwater emergent wetlands with naturally varying hydric regimes, including wet meadows, freshwater emergent marsh, and open water wetland habitats dominated by native plants for migratory birds, endangered and threatened species and priority conservation species.

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Objective 1.1 (Non-forested Wetlands and Open Water)
Same as alternative A, objective 1.1.

Objective 1.2 (Impoundments)
Given the existing limits of the impoundments, within 10 years, increase percent open water habitat for all of the impoundments to provide resting, breeding, staging, and foraging habitat for migrating waterfowl and to provide additional public viewing opportunities. These areas would be configured to maximize wildlife observation and environmental interpretation opportunities

Rationale
The conservation of North American waterfowl, particularly the restoration of associated wetland habitats, has been a major focus of the FWS for decades (USFWS 1993). A primary purpose of the refuge is to provide foraging, resting and staging habitat for migratory waterfowl (see chapter 1, section 1.5).

The original NAWMP was signed by the United States and Canada in 1986 and by Mexico in 1994. The plan was created in response to substantial declines in waterfowl populations observed during the mid-1980s (ACJV 2005). As it was realized that a collaborative effort is the most effective way to provide waterfowl habitat conservation, those involved with the NAWMP created regional joint ventures that allow partners to pool resources to meet common goals (ACJV 2005). The ACJV Waterfowl Implementation Plan, which applies to the Atlantic flyway in which the refuge lies, resulted from these newfound partnerships. The plan describes a 15-year strategy to restore and sustain waterfowl populations by protecting, restoring and enhancing waterfowl habitat. Among their initial considerations was the protection of 50,000 acres of black duck migration and wintering habitat in the region (ACJV 2005). This consideration eventually became incorporated into a broad objective of protecting 945,000 acres, restoring 35,633 acres and enhancing 121,740 acres of waterfowl habitat (ACJV 2005).

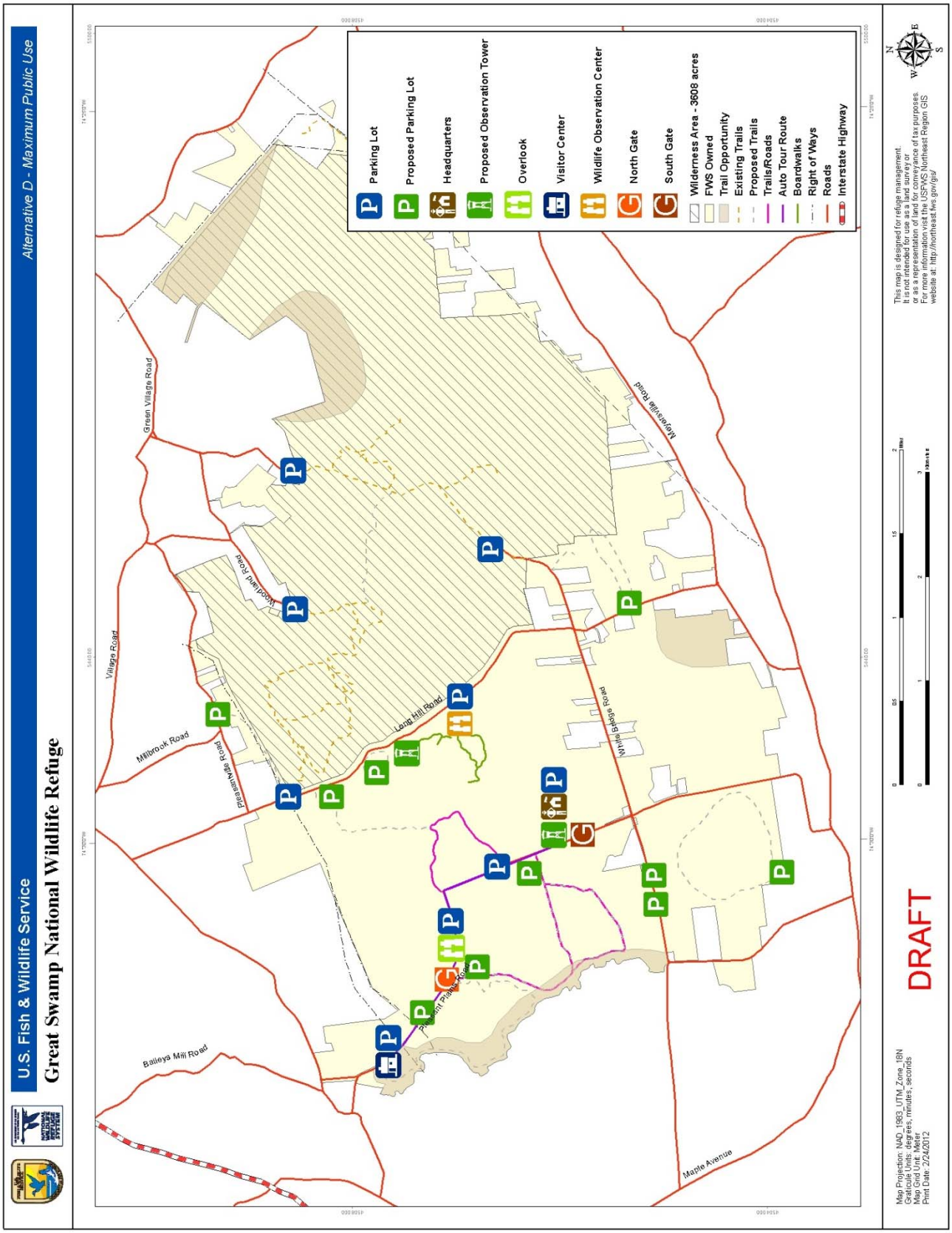
Great Swamp NWR supports a variety of waterfowl during some phase of their annual life cycle. The American black duck, which is a common migrant and occasional breeder at Great Swamp NWR, is among the highest priority in BCR 28 and is a medium priority in BCR 29. As mentioned above, this species is a major conservation focus of the ACJV. Other waterfowl species that utilize the refuge for foraging or resting during migration include mallard, green-winged teal, American wigeon, Northern pintail, gadwall, Northern shoveler, blue-winged teal, and bufflehead. The most common waterfowl nesting on the refuge are wood duck, mallard, Canada goose, and the occasional hooded merganser, a State-Special Concern species.

During the first CCP scoping period, the public expressed concerns regarding the preservation of open water habitats. Several comments specifically addressed sedimentation and vegetation succession issues within impoundments and an increasing inability to observe waterfowl and other wildlife in these areas. This objective addresses the public's concern about the loss of waterfowl viewing opportunities by both managing habitat and increasing open water access. It should be stressed that suitable habitat for waterfowl consists of a mix of open water and emergent vegetation; therefore, management efforts that propose to improve waterfowl viewing for the public must be carefully implemented and considered to prevent adverse impacts to the refuge's waterfowl. This objective acknowledges the refuge's responsibility to preserve waterfowl habitat under the ACJV, and as part of Great Swamp NWR's original purpose (see chapter 1, section 1.3.2).

Strategies

Within 10 years of CCP approval:

- Expand open water habitat to promote waterfowl use and viewing, primarily by manipulating water levels in existing impoundments as opposed to dredging out sediment and root masses, which would be more expensive, time-consuming, and disruptive to wildlife.



Map 3-6. Proposed public use facilities under alternative D.

- Control vegetation and potentially raise water levels in all impoundments to create additional open water.

- In conjunction with two proposed observation towers (see alternative B, objective 4.3), provide additional signage or improvements to existing signage at accessible emergent wetland habitats to raise awareness on waterfowl, waterbirds, marshbirds, and herptiles, and open water habitats in general.

- Expand public access to view currently off-limits open water sites by allowing seasonal non-vehicular access along certain service roads in the Management Area (see alternative D, objective 4.3).

GOAL 2 Create and maintain an interspersion of scrub-shrub, grasslands, and successional wet meadows comprised of native vegetation at various successional strategies to enhance breeding and foraging for priority species

Objective 2.1 (Grasslands)
Same as alternative A, objective 2.1, except increase signage emphasizing pollinators and grassland bird species.

Strategies
Same as alternative A, objective 2.1, except increase signage emphasizing pollinators and grassland bird species.

Objective 2.2 (Scrub-Shrub/Brushland)
Same as alternative A, objective 2.2.

GOAL 3 Maintain a mosaic of wetland and upland forest, consisting of native understory species of varying densities and structure, to maximize the potential utilization by priority resources of concern.

Objective 3.1 (Forest)
Same as alternative A, objective 3.1.

GOAL 4 Provide opportunities for visitors of all ages and abilities to enjoy wildlife-dependent recreation, appreciate the cultural and natural resources of Great Swamp National Wildlife Refuge, and increase their understanding and support of the refuge's mission.

Objective 4.1 (Hunting)
Same as alternative B, objective 4.1.

Objective 4.2 (Fishing)
Provide opportunities for safe, high quality fishing experiences on the refuge.

Rationale

Alternative D is the only alternative that considers opening the refuge to fishing. The Refuge Improvement Act identifies fishing as a priority public use within the Refuge System and as such, the activity should receive elevated consideration as goals and objectives are created. Sport fishing is a traditional and accepted form of wildlife-dependent recreation within the Refuge System. As a result, Great Swamp NWR has carefully considered ways that a warm water fishery could be provided on the refuge that would be compatible with refuge purposes. Provided it is conducted in accordance with State and refuge regulations, recreational fishing will provide a new wildlife-dependent opportunity to the visiting public with minimal impact to sensitive wildlife resources. This alternative employs several strategies, including changes to existing resource use, new access, expanding partnerships, increasing monitoring on potential wildlife impacts, and promoting responsible fishing through education. Fishing access to the Wilderness Area was initially considered but ultimately dismissed due to safety and access issues. Evidence of unauthorized fishing has been observed at the refuge. By providing and publicizing safe, legal, and ecologically responsible opportunities for fishing coupled with enhanced enforcement, we will seek to reduce or eliminate unauthorized fishing on the refuge.

Fishing presents an opportunity to reach a larger and more diverse audience. If promoted properly, a refuge fishing program will be an effective tool for reaching children from locally urban or disadvantaged environments that have limited access to fishing resources.

The refuge is in a unique position to provide high quality environmental education through this program by combining knowledgeable staff and volunteers with easily accessible fishing opportunities. Enhancing the existing borrow pond behind Refuge Headquarters would create a safe, accessible, and controlled environment for fishing with limited impact to sensitive wildlife. This additional resource will be of particular value in attracting school, clubs, or Scout groups and will also serve as a catalyst for new weekend or family events.

Fish surveys conducted at the refuge (see chapter 2, section 2.6.6) demonstrate that our open waters do support a small number of larger warm water predatory species considered popular game fish in New Jersey. These include chain pickerel, largemouth bass, black crappie, carp, catfish, and yellow perch.

Strategies

Within 5 years of CCP approval:

- Consider expanding and enhancing the existing borrow pond near headquarters for fishing opportunities. The pond would be stocked with hearty native warm water species, such as yellow perch, chain pickerel, pumpkinseed and red-breasted sunfish.

- Open select areas of the refuge to fishing to attract visitors of various demographic backgrounds. In addition to evaluating the feasibility of an on-site fishing pond at the Refuge Headquarters, we would evaluate the ponds off of Pleasant Plains Road for potential to be opened to fishing. A trail for fishing access would also be considered at the confluence of Black Brook and the Passaic River near White Bridge Road.

- Evaluate the impacts of fishing on the refuge (e.g., aquatic invasives, bait fish, wildlife disturbance, and litter). Any proposed action at the refuge involving the introduction of fishing will be carefully

monitored to minimize impacts at the refuge. Changes to access hours or locations, or other practices would be mandated if specific impacts are observed as a result of the change in the fishing policy.

- Development of the above mentioned fishing opportunities would be conducted in partnership and consultation with the New Jersey Division of Fish and Wildlife. All State fishing laws regarding licenses and bag limits would apply to the refuge. The refuge would utilize the Division's expertise in promoting fishing.

- Increase refuge enforcement to prevent fishing in unauthorized areas and to ensure responsible and legal fishing practices in authorized areas.

Objective 4.3 (Wildlife Observation, Photography and Public Access)

Maximize wildlife observation, photography opportunities, and trail access to the greatest extent practicable to increase visitation and appreciation of the refuge and the Refuge System in ways compatible with wildlife protection.

Rationale

Wildlife observation and photography are identified by the FWS as priority public uses at Great Swamp NWR. The importance of wildlife observation and photography as an activity at Great Swamp is reflected in the data collected during recent visitor surveys.

The USGS Visitor Survey (Sexton et al. 2012) identified wildlife observation (64 percent), including bird watching (62 percent), as the most common use by visitors of the refuge during the course of a year. Hiking (57 percent) and photography (36 percent) were the next most common uses identified during the survey. The visitor survey also indicates that access to activities (such as hiking, bird watching, wildlife and observation opportunities), access to observation structures, and photography opportunities are considered "very important" to their refuge experience. The importance of wildlife observation is also reflected in the numerous comments received from the survey that reference positive wildlife observation or nature observation experiences.

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During the first CCP scoping period, several comments requested that the refuge provide additional observation opportunities in the vicinity of the Visitor Center. Approximately 60 percent of the visitors to the refuge utilize the Visitor Center during their visits. With the clear importance of wildlife observation among refuge visitors, this objective seeks to provide the greatest amount of access for observation and photography opportunities without creating additional negative wildlife impacts.

In order to create a more complete and unique visitor experience at Great Swamp NWR that will attract and retain visitors, this objective utilizes a combination of improved infrastructure and staffing, increased access, and expanded programs.

The strategies of this objective are designed to make visitors aware of the full range of access and resources at the refuge by proposing basic technological improvements at the Visitor Center. The refuge seeks to create new wildlife experiences by providing unique viewing perspectives and access to habitats that currently have limited public viewing options.

In addition, this objective includes the evaluation of a Visitor Center pond that would provide a unique opportunity for teaching aquatic ecology through instructor or volunteer guided observation in an accessible and controlled setting.

By providing controlled seasonal pedestrian public access to impoundments along existing service roads, Great Swamp NWR will provide new opportunities for the public to observe wildlife without the cost or environmental impacts of new trail creation. Observation of open water and waterfowl in particular has been identified as "important" to some visitors during the first CCP scoping period. In addition, pedestrian access to service roads is occasionally requested by the public and trespass along service roads is a matter of law enforcement concern.

By connecting the Blue and Orange trail systems within the Wilderness Area, all current trails and trailheads would be connected thereby allowing individuals to more easily access this secluded portion of the refuge . Driving among trailheads would be reduced and hiking opportunities would be expanded to include the full 8.5 miles of the trail system. The addition of new trails and use of existing management roads would allow adventurous visitors to travel on foot through multiple habitat types between the Visitor Center and the Wilderness Area at certain times of the year.

Strategies

In addition to the strategies identified under alternative B:

- Expand and enhance the interactive touch-screen maps of the refuge and neighboring areas at the Visitor Center. The maps will facilitate the visitor's ability to access the refuge's public resources and highlight unique opportunities offered by nearby partners, such as the Morristown National Historical Park, Morris and Somerset County Environmental Education Centers, and The Raptor Trust.

- Construct a pond near the Visitor Center for additional wildlife observation and educational opportunities.

- Staff and/or the Friends of Great Swamp NWR will develop and host wildlife photography programs or tours.

- Evaluate the need for and potential impacts of increasing parking opportunities at the WOC. Overall under this alternative, 5 to 10 new parking areas would be established. Additions include parking areas established under alternative B, plus additional parking areas primarily along major roads within the refuge (see Alternative D: Maximum Public Use Figure).

- Evaluate other potential improvements or expansions to the WOC, including renovations and maintenance of WOC restrooms, wildlife blinds, and boardwalks.

- Expand the existing refuge foot trail system to a maximum of 21.2 miles to maximize access without significantly impacting wildlife or habitats. In addition to the foot trails proposed under alternative B (see alternative B, objective 4.3), alternative D seeks to add additional trails to provide public access to previously inaccessible management ponds, marsh habitats and wet meadows, and new portions of the Wilderness Area.

- Evaluate additional areas for future trail opportunities. These include four areas along the border of the refuge including an area near the Passaic River, two within the Wilderness Area, and one area south of White Bridge Road (see map 3-6).

- Provide limited seasonal pedestrian access to service roads around Pools 3A and 3B west of Pleasant Plains Road. These areas would be closed to the public during migration or other time periods where wildlife may be sensitive to disturbance. Seasonal access restrictions would be well posted and enforced.

Objective 4.4 (Non-Wildlife Recreational Opportunities)

Maximize non-wildlife dependent recreational uses to the greatest extent practicable to increase visitation and refuge appreciation while minimizing impacts to wildlife.

Rationale

These activities, though not directly related to wildlife, are low-impact opportunities that may draw visitors, provide new and unique public access experiences, and ultimately promote appreciation of the refuge, its wildlife, and the Refuge System. Once determined to be compatible and appropriate, these activities would be carefully implemented and evaluated to minimize impacts to refuge resources.

Within the 2010-2011 USGS Visitor Survey, canoeing and kayaking opportunities were requested. In addition, although biking is currently permitted on Pleasant Plains Road and other township roads that traverse the refuge, a bike path was also requested. Biking is not permitted in the Wilderness Area. Amongst those surveyed, a majority of visitors rated water trail opportunities for kayak or canoe as “somewhat” or “very important” with relatively neutral satisfaction (Sexton et al. 2012). Interest in these activities was also identified during the first CCP scoping period in the form of public comment. Within the refuge, kayaking and canoeing is permitted on Great Brook up to the bridge. Kayaking and canoeing is permitted within the Passaic River and Black Brook. The refuge has no jurisdiction to prevent kayaking or canoeing from occurring on these rivers. As with fishing, allowing this activity with restrictions may minimize unauthorized canoeing or kayaking.

A number of comments in the USGS Visitor Survey expressed interest in accommodations for biking. While some visitors expressed interest in specific trails for biking, many simply expressed concerns about biker and auto conflicts and safety.

Strategies
Within 5 years of CCP approval:

- Consider constructing a paved bike trail along the gravel section of Pleasant Plains Road.

Objective 4.5 (Environmental Education)
Provide the maximum number of standard-based educational opportunities through a variety of methods in collaboration with partners and volunteers.

Rationale
Over 80,000 students are enrolled in the public schools of Morris County alone (County of Morris, 2010). As a result of its position as a rich environmental resource within a heavily populated setting, the refuge has the unique opportunity to provide effective field and classroom standards-based educational opportunities to both educators and schoolchildren.

Through educational programs the refuge will provide excellent science teaching opportunities to a variety of students of varying ages and backgrounds. The refuge staff are well qualified to provide supportive services to teachers and students who are required to meet specific science oriented objectives in the New Jersey Core Curriculum Standards (2009). Science topics include earth science and a basic understanding of the nature and impacts of climate change, as well as basic ecological concepts including species interactions, species population studies, and human impacts on ecosystems.

In addition to providing expertise on State-mandated subject matter to local schools, developing a consistent classroom presence among regional schools is a highly efficient way to maximize promotion of the refuge and the Refuge System. By providing standards-based education to schools, we create an excellent vehicle to secure grant funding from scientific and educational organizations that will in turn maintain and expand educational opportunities to students and teachers.

Strategies
In addition to the strategies described under alternative B, perform the following strategies.

Within 5 years of CCP approval:

- Increase staff involvement in Standards-based educational programs to eight per year.
- Expand and/or reconfigure the "Swamp-in-a-Box" program.
- Refuge staff and volunteers will provide five environmental education programs at schools.
- Consider "America's Great Outdoors" (AGO) program, "No Child Left Inside," and possibly the environmental literacy plan to help schools meet these State-mandated criteria.
- Consider hosting formal district or State-approved continuing education programs or certifications for teachers at the refuge.

Objective 4.6 (Environmental Interpretation)

Expand environmental interpretation to the greatest extent practicable, including increased staff time and resources.

Rationale

Same as alternative B, objective 4.6.

Strategies

In addition to the strategies described under alternative B, perform the following strategies:

Within 5 years of CCP approval:

- Promote awareness on the differences between refuges, State, county, and municipal facilities.
- Each year, host or attend five Career Days at local schools to promote wildlife, conservation, and natural resource professions.
- Use traveling exhibits on and off the refuge to provide information about and encourage visitation to the refuge.

GOAL 5 Collaborate with the local community and partners to complement biological and visitor services programs on the refuge and surrounding landscape.

Objective 5.1 (Volunteers and Partnerships)

Same as alternative B, objective 5.1, but with the following additional strategies.

Rationale

By utilizing the various strengths of our local partners, such as the cultural resources and knowledge of the Morristown National Historical Park or the avian programs and resources of The Raptor Trust, the refuge can provide a wider variety of educational and cultural opportunities to its visitors. The refuge will in turn provide wildlife-oriented opportunities to visitors of these partner facilities that may have previously not visited or utilized the refuge.

In addition, by working with various partners such as assisted living facilities or various interest groups, opportunities are created to promote conservation, the refuge, and the Refuge system with new demographic groups. This is of particular importance in educating the public on regional and global conservation issues, such as water quality, watershed management, and global climate change.

By partnering with the Friends of Great Swamp NWR to expand the organization, we can both provide new volunteer opportunities to existing members and expand the variety of management and public use opportunities proposed under this alternative without incurring prohibitive costs or drains on resources. Additional volunteer effort will specifically allow Great Swamp NWR to increase Visitor Center hours, provide more interpretation at the WOC, and increase the number of interpretive tours hosted at the refuge.

Strategies:
Within 5 years of CCP approval:

- Use a variety of methods including partnerships with schools or senior organizations, new technologies such as social media networks, and the aggressive expansion of the Friends program to increase volunteer hours to facilitate the development of new programs.

- Consider expanding partnerships with assisted living facilities to promote environmental education and interpretation in adults over 55.

- Increase partnerships to include organizations watershed-wide and regionally, especially urban and minority partners.

- Partner with various interest groups, such as cultural resource groups, school biology clubs, Scout troops, or the private sector to promote refuge use.

Objective 5.2 (Public Outreach)
Maximize public outreach to promote the refuge and refuge purposes.

Rationale
Same as alternative B, objective 5.2.

Strategies
In addition to the strategies described under alternatives A and B, perform the following strategies:

Within 5 years of CCP approval:

- Increase staff involvement and presence in public outreach events to five programs per year.

- Produce five press releases per year.

- Conduct three TV or radio interviews per year.

- Produce three podcasts per year.

- Increase use of social media by creating Facebook and Twitter accounts.

Objective 5.3 (Climate Change)
Increase efforts to address global climate change through research, partnerships, and monitoring.

Rationale
By partnering with volunteers to collect information on the timing of plant and animal phenology (budding, fruiting and leafing of various tree species; bird migration, nesting, fledging; etc.) citizen scientists will be engaged in the process of collecting vital ecological data and can make a significant contribution to our understanding of climate change phenomena. For additional information see alternative B, objective 5.3.

Strategies

Within 5 years of CCP approval:

- Develop partnerships with scientists and scientific organizations to participate climate change research on the refuge and disseminate information on climate change to the public.
- Apply for grants to conduct long-term climate change monitoring.
- Participate in Project Budburst which will allow the public to directly participate in the scientific process in a meaningful way by collecting and sharing climate change data.
- Use the Wilderness Area as a natural control and compare it to more intensively managed areas on the refuge and beyond.

Objective 5.4 (Wilderness Area)

Same as alternative B, objective 5.4.

Objective 5.5 (Nuisance Wildlife Control)

Same as alternative B, objective 5.5.

Table 3-2. Comparison of alternatives

Alternative	A: Current Management	B: Enhance Biological Diversity and Public Use Opportunities (Preferred)	C: Emphasis on Maximizing Natural Regeneration	D: Focus on Expansion of Priority Public Uses
Objective 1.1: Non-Forested Wetlands and Open Water	1,000 acres	N/A	N/A	Same as A
Objective 1.1: Tussock Sedge Wet Meadow	N/A	Restore 40 acres	Restore 75 acres	N/A
Objective 1.2: Impoundments	485 acres	Evaluate impoundment management for highest habitat benefits	Evaluate impoundment management for highest habitat benefits	In addition to A: Determine methods for providing additional open water for wildlife viewing
Objective 1.2: Emergent Marsh – Migration	N/A	Maintain 1,000 acres	Maintain 250 acres	N/A
Objective 1.3: Emergent Marsh – Breeding	N/A	Maintain 700 acres	Maintain 900 acres	N/A
Objective 2.1: Grasslands	375 acres	N/A	N/A	Same as A
Objective 2.1: Mid-successional wet meadows/ brushland	N/A	Maintain 500 acres	Same as B	N/A
Objective 2.2: Scrub-shrub	315 acres	N/A	N/A	Same as A
Objective 2.2: Early successional wet meadows	N/A	Maintain 460 acres	Maintain 75 acres	N/A
Objective 2.3: Shrub-swamp and Red-maple tussock sedge wooded marsh	N/A	Maintain 800 acres	Maintain 100 acres	N/A
Objective 3.1: Forest	6,000 - 6,500 acres	N/A	N/A	Same as A
Objective 3.1: Vernal pools	N/A	Protect 35 acres	Protect and enhance 300 acres	N/A

Alternative	A: Current Management	B: Enhance Biological Diversity and Public Use Opportunities (Preferred)	C: Emphasis on Maximizing Natural Regeneration	D: Focus on Expansion of Priority Public Uses
Objective 3.2: Riparian corridor	N/A	Maintain and restore 500 foot buffer along all streams	Same as B	N/A
Objective 3.3: Bottomland forest	N/A	Maintain 3,700 acres	In addition to B: restore 600 acres	N/A
Objective 3.4: Upland forest	N/A	Maintain 1,700 acres	Maintain 1,600 acres	N/A
Objective 4.1: Hunting	Current 5-day firearms season	In addition to current deer season, provide turkey hunting and archery deer hunting	Same as A	Same as B
Objective 4.2: Fishing	No fishing allowed on refuge	Same as A	Same as A	Provide fishing opportunities
Objective 4.3: Wildlife observation, photography, and public access	1.5 miles of boardwalk and 3 observation blinds at WOC. Wildlife tour route. 8.5 miles of Wilderness Area trails. South Gate open during daylight hours. North Gate open during visitor center hours	In addition to A: expand wildlife tour route north to the visitor center. Provide additional pull offs and parking opportunities along the tour route and White Bridge Road. Construct 2 additional observation towers overlooking the impoundments and moist soil unit.	Same as A, except: Eliminate dead end trails in the Wilderness Area.	In addition to B: Establish 5-10 additional parking areas. Expand foot trails to include existing management roads.

Alternative	A: Current Management	B: Enhance Biological Diversity and Public Use Opportunities (Preferred)	C: Emphasis on Maximizing Natural Regeneration	D: Focus on Expansion of Priority Public Uses
Objective 4.4: Non-wildlife dependent recreation	Jogging, bicycling, horseback riding, and leashed dogs allowed on Pleasant Plains Road. Virtual geocaching allowed. Cross-country skiing and snowshoeing allowed.	Same as A	Same as A	In addition to A: Evaluate potential bike trail along Pleasant Plains Road.
Objective 4.5: Environmental education	Continue existing environmental education programs (25 in 2011). Continue to provide "Swamp-in-a-box".	In addition to A: Provide an additional 2 opportunities per year for regional urban schools. Every 2 years, develop a new multidisciplinary program that meets State standards.	Same as A	In addition to B: Provide 3 additional opportunities per year for regional urban schools.
Objective 4.6: Environmental interpretation	Continue existing interpretive programs Kiosks and interpretive displays. Self-guided wildlife tour route	In addition to A: Expand visitor center operation to 7 days a week. Provide an additional 5 interpretation programs per year on-site and 3 per year off-site.	Same as A	In addition to B: Use traveling exhibits to expand interpretation opportunities beyond the refuge.

Alternative	A: Current Management	B: Enhance Biological Diversity and Public Use Opportunities (Preferred)	C: Emphasis on Maximizing Natural Regeneration	D: Focus on Expansion of Priority Public Uses
Objective 5.1: Volunteers and partnerships	Maintain existing partnerships: Friends of Great Swamp Great Swamp Watershed Association Raptor Trust, Morris and Somerset County Environmental Education Centers, NJDEP, and others	In addition to A: Expand partnerships to include Morris and Somerset county tourism boards. Develop partnerships with local educational institutions.	Same as B	In addition to B: Expand partnership to include the local senior population. Partner with local private sector companies.
Objective 5.2: Public outreach	Web site, outreach events as available.	Same as A	In addition to A: Develop programs that focus on forest fragmentation issues.	In addition to B: Increase staff presence at public outreach events. Conduct 3 TV or radio interviews per year. Produce 3 podcasts per year.
Objective 5.3: Climate change	Continue use of green technology.	Increase efforts through outreach, interpretation, partnerships, additional green technology, and maintenance.	Same as B	In addition to B: Develop partnerships with science organizations to participate in climate change research on the refuge. Participate in Project Cloudburst. Use the Wilderness area as a natural control for experiments in the local area.

Alternative	A: Current Management	B: Enhance Biological Diversity and Public Use Opportunities (Preferred)	C: Emphasis on Maximizing Natural Regeneration	D: Focus on Expansion of Priority Public Uses
Objective 5.4: Wilderness area	Monitor and maintain wilderness character of the Wilderness Area.	In addition to A: recommend designation of an additional 170 acres of Wilderness.	Same as B	Same as B
Objective 5.5: Nuisance wildlife control	Control and/or eradicate nuisance wildlife, such as raccoons, mute swans, non-native turtles, feral cats, beaver, and resident Canada geese.	In addition to A: Promote public awareness of the ecological impacts of nuisance wildlife.	Same as A	Same as B

Chapter 4

Navjot Singh

Environmental Consequences

- Introduction
- Impacts on Air Quality
- Impacts on Soils
- Impacts on Hydrology and Water Quality
- Impacts on Vegetation
- Impacts on Federally Listed and Recently Delisted Species
- Impacts on Landbirds
- Impacts on Open Water and Wetland Bird Species
- Impacts on Fisheries
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- Impacts on Amphibians and Reptiles
- Impacts on Invertebrates
- Impacts on Public Use and Access
- Impacts on Cultural and Historic Resources
- Impacts on the Socioeconomic Environment
- Cumulative Impacts

4.0 Introduction

This chapter describes the environmental consequences we expect from implementing Great Swamp NWR management alternatives presented in chapter 3. Where detailed information is available, we present a scientific and analytic comparison between alternatives and their anticipated consequences, which we describe as "impacts" or "effects." In the absence of detailed information, we make comparisons based on our professional judgment and experience.

We focus our discussion on the beneficial and adverse impacts associated with the goals and key issues identified in chapter 1, "Purpose of, and Need for, Action." Direct, indirect, short-term, beneficial, and adverse effects likely to occur over the 15-year life span of the plan are discussed. Beyond the 15-year planning horizon, we give a more speculative description of the direct, indirect, and cumulative effects. The chapter identifies cumulative impacts, any irreversible and irretrievable commitment of resources and the relationship between short-term uses of the environment and its long-term productivity. At the end of this chapter, table 4.2 summarizes the effects predicted for each alternative and allows for a side-by-side comparison.

4.0.1 Regional, Historical, and Watershed Context

As required by CEQ and FWS regulations implementing NEPA, we assessed the importance of the effects of the alternatives presented in this draft CCP/EA based on their context and intensity. The context of the impacts ranges from site-specific to broader regional and eco-regional scales (table 4.1). Although refuge lands comprise a small percentage of these larger regional area contexts, all alternatives were developed to contribute towards conservation goals in these larger contexts.

As discussed in section 2.1.3, the refuge is located within the GSW, which is situated within the southern portion of the Upper Passaic River Watershed (figures 2-1 and 2-5). The GSW refers to a collection of adjoining subwatersheds that feed the hydrology of Great Swamp, which encompasses approximately 55 square miles (35,200 acres). The GSW is bound by a ridge of the Appalachian Mountains to the northwest, the third Watchung Mountain to the south, and the Loantaka Moraine to the northeast (Parrish and Walmsley 1997). Black Brook, Great Brook, Loantaka Brook, and Primrose Brook flow through the refuge, generally in an east to west direction, before draining to the Passaic River, located along the western refuge boundary. The Passaic River forms the western refuge boundary.

Table 4.1: Regional Context for Impacts Analyses at Great Swamp National Wildlife Refuge

Resource	Context
Air Quality	The New York-New Jersey Metropolitan Area
Water Quality	Waters that pass through or are contained by the Great Swamp National Wildlife Refuge and the reaches of rivers immediately downstream

Table 4.1: Regional Context for Impacts Analyses at Great Swamp National Wildlife Refuge	
Resource	Context
Soils	Area within the refuge boundary
Vegetation	Area within the refuge boundary
Species	Immediate impacts to migratory species while on refuge and consideration of greater populations that refuge specific individuals are a part of
Socioeconomics	Morris and Somerset Counties
Recreation	Morris and Somerset Counties

Across a more localized landscape scale, the refuge protects a variety of resources and provides a unique opportunity for education and outreach in the New York-New Jersey Metropolitan Area. Connecting children and families with nature is a high priority national program of the FWS. The suburban to urban context of the refuge provides excellent opportunities for such environmental education and conservation outreach.

Approximately 150,000 to 160,000 visitors from around the region, the country, and other countries visit the refuge each year. Because of its location within the most highly developed and densely populated area in the country, the refuge has the potential to reach out to millions of children and adults making Great Swamp NWR the ideal place to implement the Refuge System's new "Urban Refuges" initiative. Great Swamp NWR is in a position where it can foster greater understanding of natural systems, species of conservation concern, the value of the Refuge System, and the FWS mission in conserving and protecting those resources. Each of the management alternatives is consistent with state, regional, ecosystem, and watershed conservation plans identified in chapter 1. At varying levels, each of the alternatives would make positive contributions to these larger landscape-scale conservation endeavors.

Significant land use changes since European colonization have impacted the surrounding area, as well as the refuge itself, including clearing for farmland, repeated attempts at draining and stream alteration, highway construction, landfills, and residential, commercial and industrial development. As implied in the refuge vision statement, the refuge is an island of wildlife habitat in a heavily suburbanized landscape. The heavily suburbanized environment and historical disturbance of primarily wetlands of the refuge and surrounding area also present many challenges ranging from minimizing visitor impacts to minimizing or mitigating wildlife impacts due to impaired regional water and air quality, habitat fragmentation, invasive species, and other conditions associated with urban environments.

The refuge's ability to directly and beneficially impact the regional environment is somewhat limited given the extent of surrounding land uses and the large human population, but the refuge participates in regional efforts for land conservation, protection of wildlife corridors, air and water quality improvements, and early

detection and management of regional invasive species. Given this urban context, the analysis of impacts mainly focuses on how FWS actions at the refuge might affect the physical and biological environment, socioeconomics, historical, and cultural resources, as well as wildlife-dependent public uses. Where possible and information is available, we also provide discussions of how management actions would impact regional resources.

4.0.2 Evaluation of Environmental Impacts and Time Frames

In accordance with CEQ and FWS regulations implementing NEPA, we assess the importance of the effects of the alternatives based on their context and intensity. The scale of their context ranges from site-specific to local, landscape, or regional. Although the area of the refuge is only a small percent of the context in its ecosystem or region, we developed all of our management alternatives to contribute to the many conservation goals in those larger contexts. For each alternative, we based our evaluation of the intensity of the effects on the following factors:

- Expected degree or percent of change in the resource from current conditions.
- Frequency and duration of the effect during the 15-year planning horizon.
- Sensitivity of the resource to such an effect or its natural resiliency to recover from such an effect.
- Potential for implementing effective preventive or mitigating measures to lessen the effect.

Significance also encompasses the magnitude of change or of an impact. It is not a value judgment, as some impacts can be beneficial for one species and adverse for another, or have a positive impact on visitor use but a negative impact on migratory birds. The following table defines this aspect of significance by giving more detailed information about the magnitude or level of intensity for each of the impacts topics which will be discussed in more detail in this chapter.

Table 4-2: Impact Significance Criteria Threshold Definitions

Impact Topic	Significance Criteria
Socioeconomic	Effects to socioeconomic elements would be considered significant if: • Management actions would result in readily apparent changes to economic conditions. While there may be some apparent changes in social or economic conditions in nearby communities, if such effects are localized, they are considered not to be significant. Significant social or economic effects encompass measurable changes in social or economic conditions at the regional level.
Cultural and Historic Resources	Effects to cultural and historic resources would be considered significant if: • Management actions would have a substantial, noticeable, and permanent effect on a site or group of sites. The action would

Impact Topic	Significance Criteria
	severely change one or more characteristics that qualify the site(s) for inclusion in the National Register, diminishing the integrity of the site(s) to such an extent that it would no longer be eligible for listing in the National Register. For purposes of Section 106, the determination of effect would be an *adverse effect.*
Air Quality	Effects to air quality would be considered significant if: • Implementation of a proposed refuge action would result in: emissions equal to or in excess of the standards set in local implementation plans for the Clean Air Act; large areas of soil becoming routinely exposed and subject to wind erosion; or sensitive receptors being exposed to substantial pollutant concentrations, including air toxics such as diesel particulates. Significant indirect effects to air quality would occur if a proposed refuge action results in frequent heavy congestion on adjacent roadways. Significant cumulative effects would occur if the "*de minimis*" (minimum) thresholds developed by the EPA for proposed Federal actions in a nonattainment area are exceeded.
Soils	Effects to soils would be considered significant if: • Management actions would result in the permanent loss or alteration of geologic features or soils in relatively large areas, such as 1,000 acres, or there would be a strong likelihood for erosion or mass movement of large quantities of soil, sediment, or rock as a result of the action. Mitigation measures to offset adverse effects would be necessary, extensive, and their success could not be guaranteed. • Management actions would preserve or restore geologic features, geologic processes, or soil resources in relatively large areas, such as 1,000 acres.
Water Quality and Hydrology	Effects to water quality and hydrology would be considered significant if: • Actions would result in substantial increased flooding on- or off-site, accelerating flooding, or further deviation from historical hydrological patterns above reasonably anticipated levels due to climate change, or a substantial reduction in the local groundwater table. • Actions would violate any water quality standards or waste discharge requirements, substantially increase sedimentation, introduce persistent contaminants (nonpoint source pollution) into the watershed, or otherwise substantially degrade water quality.

Impact Topic	Significance Criteria
	Water quality impacts could include increased loads of sediment, debris, chemical, or toxic substances, or pathogenic organisms. The impact could be easily visible to visitors. • Restoration projects and best management practices would measurably improve water quality in most tributaries in the refuge, and overall effect would be clearly detectable.
Vegetation	Effects to vegetation would be considered significant if: • An action would result in a substantial change in the amount or quality of available habitat for a wildlife species (for wintering waterfowl, other migratory birds, or native resident wildlife, a substantial reduction in habitat resulting in a significant adverse impact would be defined as a reduction of 30 percent or more of the available acreage or 50 percent of the quality of habitat for these species within the refuge; a significant beneficial impact would be defined as a 30 percent or greater increase in the quantity or 50 percent increase in the quality of habitat for wintering waterfowl, other migratory birds, or native resident wildlife). • A substantial portion of native habitat would be removed or otherwise modified as to accommodate a proposed action. The impacts would be substantial and highly noticeable and could result in widespread change. This could include changes in the abundance, distribution, or composition of a local vegetation community or regional plant population to the extent that it would be likely to be replaced by a different vegetation community. Significant ecological processes would be altered, and changes would be expected. • A refuge action causes mortality of greater than 30 percent of a regional or State population of a species. • Management actions would restore or preserve vegetation or unfragmented forest blocks throughout much of the refuge. • Management actions to remove invasive vegetation are not considered significant even if the result substantially decreases the abundance of the invasive species, if the result is the restoration or increase in quantity or distribution of native vegetation.
Threatened and Endangered Species	Effects to threatened and endangered species would be considered significant if: • An action would result in a substantial adverse effect, either directly or through habitat modifications, on any Federal

Impact Topic	Significance Criteria
	threatened, endangered, candidate, or special concern wildlife or fish species. Also included would be species listed threatened or endangered by NJDEP. • Management actions could result in a noticeable change to a population or individuals of a listed or protected species or designated critical habitat. The change would be substantial and highly noticeable and would most likely result in a *likely to adversely affect* opinion from the FWS. • Management actions would measurably increase a population or numbers of individuals of a listed or protected species or enhance designated critical habitat.
Terrestrial Wildlife, Waterfowl, Shorebirds, Secretive Marsh and Waterbirds, Mammals, Reptiles and Amphibians, and Invertebrates	Effects to species would be considered significant if: • An action would result in a substantial change in the amount or quality of available habitat for a wildlife species (for wintering waterfowl, other migratory birds, or native resident wildlife, a substantial reduction in habitat resulting in a significant adverse impact would be defined as a reduction of 30 percent or more of the available acreage or 50 percent of the quality of habitat for these species within the refuge; a significant beneficial impact would be defined as a 30 percent or greater increase in the quantity or 50 percent increase in the quality of habitat for wintering waterfowl, other migratory birds, or native resident wildlife). • A substantial portion of native habitat would be removed or otherwise modified to accommodate a proposed action. • A refuge action causes mortality of greater than 30 percent of a regional or State population of a species. • Management actions would restore or preserve aquatic wildlife populations in large portions (1,000 acres) of the refuge. This could include changes in the abundance, distribution, or composition of local terrestrial wildlife populations.
Fisheries	Effects to fisheries would be considered significant if: • An action would substantially change the availability of habitat for fish. • An action would result in an obvious detectable effect to aquatic wildlife populations at the regional level. Extensive mitigation would be needed to offset any adverse effects, and their success would not be guaranteed. • An action would restore, improve, or preserve aquatic wildlife populations in large portions (i.e., 1,000 acres) of the refuge. This

Impact Topic	Significance Criteria
	could include changes in the abundance, distribution, or composition of local aquatic wildlife populations.
Public Use and Access	Effects to public use and access would be considered significant if: • A proposed action resulted in substantial displacement of a wildlife-dependent public use (>25 percent of existing activities or opportunities moved to a different area or terminated at the refuge); • Substantial reduction in the quality of the wildlife-dependent experience (crowding increasing by more than 50 percent or substantial anticipated losses of wildlife or habitat supporting the experience). • Proposed actions resulted in substantial increase in opportunity for or quality of a wildlife-dependent public use (>25 percent increase over existing opportunity or quality of experience). • Management actions would result in impacts that would be readily apparent and would likely be perceived as highly positive by visitors because they would obviously enhance the visitor experience by making access to most refuge resources and experiences very easy.

Some impacts are not considered major or significant, and are described as either negligible, minor, or intermediate. The magnitude of such changes is defined as follows:

Scope, scale, and intensity can be defined on a range from negligible to major.

- Negligible: Management actions would result in impacts that would not be detectable or if detected would be considered slight, localized, and short term. .

- Minor: Management actions would result in impacts that would be detectable, but localized, small, and of little consequence to a population, wildlife or plant community, public use and access opportunity, visitor experience, or cultural resource. Mitigation, if needed to offset negative effects, would be easily implemented and likely to be successful.

- Intermediate: Management actions would result in impacts that would be readily detectable and localized with consequences to a population, wildlife or plant community, public use and access opportunity, visitor experience, or cultural resource. Mitigation measures would be needed to offset negative effects and could be extensive, moderately complicated to implement, and probably successful.

- Major: Management actions would result in impacts that would be obvious and would result in substantial consequences to a local area or regional population, wildlife or plant community, public use and access opportunity, visitor experience, or cultural resource. Extensive mitigating measures may be needed to offset negative effects and would be large-scale, very complicated to implement, and may

not have any guarantee of success. In some instances, major effects would include the irretrievable loss of the resource.

In addition to the magnitude of impact (negligible, minor, moderate, or major) the impacts of the management action on some of the environmental attributes are also, at times, described as beneficial or adverse. Generally, an impact will be described as 'beneficial' if it results in a condition that improves the biological health, population size of native or naturally occurring species, or the robustness or sustainability of that characteristic. However, many times value judgments cannot be given for ecological change. A change in habitat that is beneficial for certain species of waterfowl may be adverse for others with different habitat preferences. Factors which reduce the population of a predator may be adverse for the predator and positive for the prey. Therefore, sometimes our impact assessments do not describe impacts as either positive or negative, or describe them specifically in term of what the impact applies to. The duration of identified effects and their consequences varies, from those occurring only once for a brief period in the 15-year period of this plan—for example, the effects of construction for expanding existing facilities—to those occurring more frequently during the year, like mowing. The environmental consequences analysis provided in this chapter will also furnish the level of detail necessary to assess the compatibility of all proposed uses.

Time scales are defined as either short-term or long-term.

- Short-term or temporary: An effect that generally would last less than a season or year.
- Long-term: A change in a resource or its condition that would last longer than a single season or year.

4.0.3 Management Actions Not Analyzed in Detail

The following list of management activities is included in the analysis in this document even though they are both trivial in effect and common to all alternatives. If any of these items were independently proposed they would qualify for categorical exclusion under applicable regulations:

- Operations and maintenance of existing infrastructure and facilities (unless major renovation is involved).
- Issuance of new or revised management plans when only minor changes are planned.
- Law enforcement activities.
- Environmental education and interpretative programs (unless major construction is involved, or a significant increase in visitation is expected).
- Research, resource inventories, and other resource information collection activities.
- Routine, recurring management activities and improvements, including managing invasive plants.
- Small construction projects (for example, fences, berms, small stream and wetland restoration projects, trail maintenance, interpretative kiosks, and development of access for routine management purposes).
- Minor vegetation plantings.

- Reintroducing native plants and animals.
- Minor changes in amounts or types of public use.

In addition, some of the actions that are described would fall under the "extraordinary circumstances" exceptions in 43 CFR 46.215. Further, some of the management actions described in chapter 3 are not categorically excluded from NEPA, such as emergency responses to a major disease outbreak. Where either of these conditions applies, we have conducted further NEPA analysis and included it in the following section. Where possible and information is available, we provide discussions of how the below management actions could beneficially or adversely impact refuge resources:

- Increasing management and restoration of open, spring-fed wetlands for the purpose of benefiting the bog turtle under alternatives B, C and D.
- Consolidating habitats to create large, contiguous patches and to reduce fragmentation under alternatives B, C, and D.
- Eliminating hedgerows to reduce fragmentation under alternatives B, C, and D.
- Allowing natural succession of select areas of actively managed grassland and brushland habitats to forest under alternatives B and D.
- Allowing natural succession of select areas of actively managed grassland and brushland habitat, as well as open water habitat associated with Pools 3A and 3B, to maximize natural regeneration to forest or other late successional stage, while maintaining large contiguous patches of actively managed grasslands and brushlands under alternative C. Open water habitat within Pools 3A and 3B would be reduced by performing draw-downs and removing boards from water control structures.
- Increasing open water habitat within the existing impoundments to provide additional wildlife viewing opportunities under alternative D.
- Constructing a pond near the Visitor Center for wildlife observation and environmental education opportunities under alternative D.
- Using prescribed burning to manage grasslands and brushlands under alternatives B, C, and D.
- Expanding the Visitor Center's operational hours under alternatives B, C, and D.
- Creating additional trails along the Passaic River, within the "Black Brook Acquisition Area" (south of White Bridge Road) and at the WOC, and constructing wildlife observation viewing towers at the WOC and along Pleasant Plains Road under alternatives B and D.
- Creating additional trails east of Long Hill Road (south of Pleasantville Road and south of White Bridge Road) and west of Long Hill Road connecting to an existing management road; creating a Wilderness Area connector trail; permitting seasonal use of existing management roads by public on foot; and evaluating additional trail opportunities under alternative D.

- Expanding outreach, interpretation, and education programs to increase refuge visitation and to promote awareness about the refuge, its purposes, and the Refuge System under alternatives B, C, and D.
- Constructing additional pull-offs and parking opportunities under alternative B, and to a greater extent, alternative D.
- Expanding auto tour route from the Great Brook Bridge to the new Visitors Center under alternative B.
- Adjusting the hunt program by providing additional opportunities for disabled individuals, permitting fall archery season for deer hunting, and opening spring turkey hunting under alternatives B and D.
- Keeping the refuge open to the public during the spring turkey hunting season under alternatives B and D.
- Providing limited opportunities for fishing on the refuge under alternative D.

4.0.4 Adaptive Management Actions Common to All Resources

Adaptive management strategies are proposed for all management actions to mitigate uncertainties in information upon which the proposed activities are based. We propose continued and expanded monitoring, surveying, and inventorying of resources to ensure that we have sufficient scientific data, or have consulted with sufficient subject matter experts, to support our proposed activities affecting refuge resources. Where baseline data is lacking, we have proposed additional inventories. We propose continuing ongoing research and monitoring, including, but not limited to, bat emergence surveys, to help inform proposed management actions. We propose strengthening and expanding partnerships with agencies, universities, and other designated parties to help conduct these activities to address uncertainties and improve management practices (see chapter 3).

All of the alternatives include a renewed focus on gathering baseline information on refuge resources and monitoring resources to evaluate the potential impacts of climate change. The potential impacts of monitoring, surveying, and inventorying resources to the physical and biological environment are controlled and mitigated by SUPs that specify the research activities, locations, frequency of activities and limitations, such as seasonal or temporal timing restrictions to mitigate potential impacts. Generally, these activities have short-term and localized adverse impacts to physical and biological resources.

4.0.5 Organization of Chapter 4

We have organized this chapter by major resource headings so that each section describes the impacts of all management activities proposed under each of the four alternatives that would likely have an effect on a given resource, such as an impact on water quality or on waterfowl. We begin with the physical environment (air, water, soils, etc.), then the biological and ecological resources (habitats and wildlife), and finally the socioeconomic, cultural, and historic environment. Under each heading, we discuss the resource context and the types of benefits and adverse impacts of management actions that we evaluated. We then discuss the benefits and adverse effects that would occur regardless of which alternative is selected and the benefits and adverse impacts of each of the CCP alternatives.

4.1 Impacts on Air Quality

Chapter 2, "Existing Environment," discusses the status of air quality around the refuge. Given the heavily suburbanized nature of the surrounding area, the analysis of air quality impacts considered only how FWS actions at the refuge might affect air pollutants, visibility, and climate change, focusing on the potential for localized air quality impacts or improvement.

We evaluated the potential benefits of our actions that would protect or improve air quality:

- Managing and restoring forests and wetlands to enhance carbon sequestration and reduce greenhouse gases.
- Decreasing emissions by consolidating actively managed habitats into large, contiguous patches and allowing natural regeneration of small, isolated, or difficult to manage patches, which will reduce heavy equipment use and associated emissions.
- Continuing and expanding energy efficiency practices to reduce the refuge's contribution to emissions.
- Managing and restoring forests to enhance carbon sequestration and reduce greenhouse gases.

We evaluated the potential for the proposed actions to cause increased emissions and adverse effects on air quality:

- Emissions from increases in visitors from vehicles and facilities.
- Increasing Visitor Center hours.
- Maintaining the existing impoundments and potential impacts from emissions of methane from the impounded area.
- Use of prescribed burns.

4.1.1 Impacts on Air Quality That Would Not Vary by Alternative

Due to the refuge's location within the greater New York-New Jersey Metropolitan Area, we believe that the impacts of refuge management on regional air quality would be negligible, but slightly positive overall, and would not vary significantly under any of the alternatives. Refuge land management, regardless of alternative, would be expected to have a net positive effect on air quality.

Benefits

Our management activities are not anticipated to adversely affect regional air quality. None of the alternatives would violate EPA standards and all alternatives would comply with the Clean Air Act. There would be no major stationary or mobile sources of air pollutants at the refuge created under any of the refuge management alternatives. On the contrary, the FWS limits public uses of the refuge to compatible wildlife-oriented activities, and land ownership and protection curtails human sources of emissions from vehicles and infrastructure by preventing development and consequent impacts to air quality.

Maintaining natural vegetation on approximately 98 percent (includes impoundments; excludes administrative, residential, transportation/utilities, and open water) of the refuge and promoting the growth of woody vegetation on previously managed fields would provide various benefits to air quality. Trees have been shown to reduce the concentration of the five air pollutants identified in the EPA's 1990 NAAQS (40 CFR part 50), including ozone, sulfur dioxide, nitrogen dioxide, carbon monoxide, and particulate matter less than 10 and 2.5 microns in diameter, primarily through direct uptake and adhesion to stems and leaves (Escobedo et al. 2007).

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As discussed in chapter 3 (see alternative C, objective 5.3), forests can store carbon in a process known as carbon sequestration in which atmospheric CO_2 is taken up by plants through photosynthesis and incorporated as carbon into the biomass (trunks, branches, foliage, and roots). Some carbon makes its way into soils when vegetation, litter, and roots decay. In forests, carbon can be sequestered over decades or even centuries until mature ecosystems reach carbon saturation. Carbon can return to the atmosphere as CO_2 when soils are disturbed or when biomass decays and burns (EPA 2010). Forests in the Northeast can sequester from 12 to 20 percent of current annual emissions from the region (Perschel et al. 2007). Approximately 6.8 billion tons of carbon is stored in the Northeast's forests. On average, forestland holds about 75 tons of carbon per acre, of which 38 percent is alive aboveground carbon, 8 percent is alive belowground carbon, 6 percent is in dead wood, 10 percent in litter, and 38 percent is in soil organic material (Perschel et al. 2007).

Managing and restoring forests would benefit air quality in a number of ways. Long-term benefits of restoration are healthier native plant communities that would perform more ecological services, support a greater number and diversity of wildlife year-round, and sustain or improve carbon sequestration capacity. Wetlands and forests both act as carbon sinks by incorporating decaying vegetation into sediment and trees, respectively. Wetlands can also produce methane, a greenhouse gas, but overall there is a net long-term benefit to air quality. Management activities in these habitats, such as removing and controlling invasive plants that suppress regeneration, will contribute to improvements in habitat quality and carbon sequestration capacity. These activities would occur no matter which alternative is selected, but the degree to which we practice them would vary, and thus, their impacts. Because of the urbanized nature of the region and the close proximity of heavily travelled roadways, we do not expect our management actions to result in measurably improved regional air quality, but they would contribute to improving local air quality.

As discussed in section 3.2 (alternative A, introduction and objective 5.3), the refuge will continue to use, expand, and promote the benefits of green technology. Use of green technology will make the refuge more energy efficient, thereby reducing the refuge's carbon footprint and providing long-term cost savings.

Refuge greening includes:

- the refuge headquarters administrative building oil furnace and air conditioning were replaced with a heat pump, that has an electric back up system (2012)
- all interior lights were replaced with efficient lighting using sensors and timers (2012)
- the electrical system was designed to add roof solar panels (expected installation in 2013 or 2014)
- Visitor Center roof solar panel design was completed (expected installation by 2014)
- the refuge plans to convert Visitor Center furnaces from oil to natural gas (2014)
- plans to replace maintenance shop oil furnace with heat pump
- 25 percent of station vehicles are hybrids and more to be added when replacements occur (currently)
- an electric powered "Gator" UTV is used on refuge (currently)
- bio-diesel is used in refuge equipment and eco-friendly anti-freeze is used when manufacturer specifications permit (currently)
- recycling of paper, cardboard, metal, plastic, glass, electronic equipment, used oil, automotive batteries
- scrap metal is recycled (currently)
- hazardous materials are properly disposed (currently)
- purchase products made from recycled materials [e.g. paper products (copy paper, cups, towels), plastic (deck lumber, park benches)] (currently)
- approximately 1.0 mile elevated swamp boardwalk trail has been constructed with recycled material (currently)
- plan to replace asbestos shingle roofing on buildings with more durable and recyclable metal roofing when replacement occurs (unknown timing).

Adverse Impacts

The most likely sources of adverse impacts to air quality from the refuge would come from exhaust fumes produced by heavy equipment and emissions from increases in visitor vehicle traffic and increased energy consumption needed for extended facility hours. In FY 2012, an estimated 168,000 individuals visited the refuge. Approximately 91 percent of these visitors arrived using a private vehicle (USGS 2011). Assuming an average of three visitors per vehicle, an estimated 50,960 private vehicles are currently entering the refuge annually. Approximately 79 percent of refuge visitors live within a 50-mile radius of the refuge (USGS 2011). The increased numbers of visitors would be very small relative to the amount of daily traffic in the area on local roads and interstate 287; therefore the overall impacts to air quality would be negligible.

Under each alternative, the refuge would continue to use IPM methods to control invasive plants, pests, and diseases. IPM is a science-based, sustainable approach to pest management that uses a wide variety of tools including biological, mechanical, cultural, and chemical methods to achieve desired outcomes in ways that minimize health, environmental, and economic risks (569 FW 1). In certain instances, chemical control is the safest and most effective treatment option. When chemical control is warranted, the refuge typically applies general use pesticides on the “Field Station Approval List” as higher-risk pesticides are generally not necessary and require either Regional Office or Headquarters approval. We must request approval, through a Pesticide Use Proposal (PUP), for all chemical control applications on the refuge. The PUP process includes section 7 consultation for endangered species. The Refuge Manager, Regional IPM Coordinator, and National IPM Coordinator have the authority to approve pesticides and their application procedures. In addition to FWS policies, all pesticide usage must also comply with applicable Federal

(FIFRA) and state regulations. Aquatically-labeled products are used in wetland areas to protect water quality. In recent years, only glyphosate and triclopyr ester herbicides have been used.

The volatilization rate (ability to vaporize) of glyphosate is nearly non-existent (Schuette 1998). Studies indicate a high potential for volatilization of triclopyr (NPS 2010). Triclopyr dissipates quickly in the environment, however, with a mean time to 50 percent dissipation of 1.5 days and 9 days to 90 percent dissipation (Thompson et al. 1994). Aerial drift of mists of these chemicals during application has the potential to cause negative impacts to non-target plants (Schuette 1998); however the methods discussed below ensure that negative impacts from drift would be very localized, short-term and negligible to the vegetation community.

When using pesticides on the refuge, we observe best management practices (BMP) and application methods that minimize drift and non-target mortality, such as cut stem, “snip and drip,” basal bark, or low-volume foliar applications with backpacks. BMPs are effective, practical, structural, or nonstructural methods that minimize or prevent the movement of sediment, nutrients, pesticides and other pollutants from land to air or water. Examples of BMPs for pesticide application include proper calibration of application equipment, following all label restrictions including the timing of applications, and creating pesticide-free buffers around environmentally sensitive areas. Pesticides used on the refuge are typically applied by hand within a few feet of ground level and only when wind speed at application level is below the drift threshold. When applied in this way, there is little to no impact on air quality. Using the BMPs mentioned, drift and other non-target impacts have been negligible. Furthermore, proper selection of herbicides and application methods has eliminated the need for repeat treatments thereby reducing the quantity and cost of herbicide usage and the potential for cumulative effects.

Because air quality in the region is generally “good” (refer to section 2.1.8), we do not expect our management to result in measurably improved air quality; however, our management efforts should contribute to the existing satisfactory conditions. Most noticeable improvements to air quality would be localized in nature.

4.1.2 Impacts on Air Quality under Alternative A (Current Management)

Benefits

Benefits to air quality are the same as those discussed in *Impacts on Air Quality That Would Not Vary by Alternative*.

Adverse Impacts

Adverse impacts to air quality would be the same as those discussed in section 4.1.1, *Impacts on Air Quality That Would Not Vary by Alternative*.

4.1.3 Impacts on Air Quality under Alternative B (FWS-Preferred Alternative)

Benefits

Under alternative B there would be continuing benefits to air quality from maintaining the natural vegetation on the majority of refuge lands. Natural vegetation serves to filter air pollutants, and maintaining refuge lands precludes development and the introduction of attendant sources of pollutant emissions. Alternative B would provide some additional long-term benefits to the air quality by allowing 169 acres of currently managed grassland and scrub-shrub fields to succeed by natural regeneration. This alternative also

proposes to increase monitoring and removal of invasive plants in all habitat types. The management actions proposed under alternative B would contribute to improvements in habitat quality and carbon sequestration capacity.

In this alternative, we would reduce the amount of grassland and brushland management and consolidate these habitats into fewer, but larger, contiguous tracts and decrease the amount of cover that is subjected to mechanical treatment. We expect the consolidation of management units will reduce the use of heavy equipment for mechanical treatments by 5 to 10 percent annually leading to corresponding reductions in fuel consumption and exhaust emissions. This would provide negligible long-term impacts.

Adverse Impacts

Based upon our proposed increase in outreach efforts to communities in the region and proposed additional Visitor Center hours, we expect a 2 percent average increase in visitation per year over the life of the plan. Given the suburban to urban area surrounding the refuge, anticipated increase in visitation and the associated emissions from travel to and from the refuge is expected to have negligible impacts on air quality.

The refuge's Visitor Center is currently open Thursday and Friday from noon until 4 p.m. and Saturday and Sunday from 10 a.m. until 4 p.m. The refuge proposes to increase operational days to 7 days per week year round. Monday through Wednesday have traditionally not been high public use days, however, and we expect opening on these additional days will result in a slight increase in visitation of between 1 to 2 percent on average per year over the life of the plan. This change in operational hours will result in a minor increase in energy consumption and the refuge's carbon footprint; however, given the urban context of the region, the expansion of operational hours is expected to have negligible impacts on air quality. In addition, an increase in energy use may be offset by the continued and expanded use of green technology.

Under this alternative, there would be temporary, short-term impacts to air quality from equipment exhaust and particulates from soil disturbance associated with the habitat restoration and reconfiguration efforts. These are temporary in nature and would most likely be offset by reduced grassland and brushland acreage maintained by mowing or cutting.

Under alternative B, we propose to introduce prescribed burning for habitat management, when and where appropriate and compatible. Prescribed burning is a cost-effective and ecologically sound tool for forest, range, and wetland management, and is often used to reduce the potential for destructive wildfires, which maintains long-term air quality. Prescribed fires removes logging residues, controls insects and disease, improves wildlife habitat and forage production, increases water yield, maintains natural succession of plant communities, and reduces the need for pesticides. Prescribed burning may be implemented in conjunction with mowing to maintain smaller scale grasslands. Under this alternative, a maximum of 200 acres of grassland with some shrub component would be burned on a rotation of every 2 to 5 years within the refuge.

The major air pollutant of concern resulting from prescribed burning is smoke, which consists of a complex mixture of carbon, tars, liquids, and various gases. The other major pollutants from wildland burning are particulate matter (dust, ash, and unburned fuel), carbon monoxide, and volatile organic compounds, including methane. Particulate matter can reduce visibility or cause negative effects on the health of people with respiratory illnesses.

For prescribed burns on grassland in the Northeast, emission rate estimates of particulate matter (PM) are 10 grams per kilogram (g/kg) burned and 75 g/kg for CO (USEPA 1996). Nitrogen oxides are emitted at rates from one to four g/kg, depending on combustion temperatures. Emissions of sulfur oxides are negligible (USEPA 1996). These pollutant emission levels are generally less than levels expected in prescribed burns of woody vegetation habitats of the northeast (USEPA 1996).

As part of this prescribed burn, a burn plan that follows USEPA standards (1998) would be in place; the plan will evaluate emissions and potential air quality impacts in detail. These emissions would be projected for the life of the plan. Because there is no record of any historic burns in recent history, the plan would not consider past emissions or impacts from fire. The emission predictions would incorporate pre-burn fuel loading by acreage, vegetation type and consumption and all other relevant factors. The plan would also set appropriate conditions for burns (moisture levels, wind speed and direction); identify sensitive receptors within the refuge region (which would include local residences and other populated areas); evaluate short term impacts and management of smoke; and incorporate ambient air monitoring plans and air station location data (when appropriate); and address all other relevant environmental and geographical factors.

In addition to being a cost-effective and ecologically sound tool for forest, grassland, and wetland management, prescribed burning is often used to reduce the potential for destructive wildfires, which actually maintains long-term air quality. The relative small scale and type of vegetation proposed to be burned combined with careful management and planning will result in a prescribed burn that will not significantly adversely affect regional air quality. The prescribed burn we propose will not violate EPA standards, and would comply with the Clean Air Act. The USDA has determined that this type of low intensity prescribed burning would release inconsequential amounts of gases (USDA 1989).

4.1.4 Impacts on Air Quality under Alternative C

The benefits and adverse impacts of alternative C would be similar to those discussed under *Impacts on Air Quality under Alternative B* in section 4.1.3 with the exception of minor increases in carbon sequestration expected based on net forested or woody vegetation habitat increases within the refuge. All differences among alternatives in air quality due to atmospheric carbon storage would be negligible in the regional or global context.

Benefits

This alternative would provide some additional very minor or negligible long-term benefits to air quality by allowing approximately 323 acres of currently managed grasslands and scrub-shrub to succeed to forest via natural regeneration. In addition, pools 3A and 3B, encompassing approximately 129 acres, would also be allowed to succeed to naturally-occurring marsh or shrub swamp plant communities.

Current information regarding carbon storage and methane production potential of wetlands is highly uncertain and varies based on wetland location and type (Bridgham et al. 2007; USEPA 2010b). We would; however, expect some additional minor long-term net benefit to air quality based on some increased carbon sequestration capacity in our expanded forest and shrub communities. As discussed in chapter 3, objective 5.3; forests in the Northeast can sequester from 12 to 20 percent of current annual emissions from the region (Perschel et al. 2007). Each acre of forestland sequesters about 75 tons of carbon in above (woody vegetation) and below ground (organic soil) storage, and dead wood (Perschel et al. 2007).

We are uncertain if the refuge impoundments act as a net source, or sink, for greenhouse gasses in the atmosphere. If these impoundments do act as a source, restoration of forests could reduce emissions of methane, a powerful greenhouse gas. Regardless, given the relatively small size of refuge impoundments regionally and globally, it is not expected to be a significant source of methane and differences would be short-term, localized, and negligible.

4.1.5 Impacts on Air Quality under Alternative D

Benefits and adverse impacts to air quality of alternative D would be similar to those discussed in section 4.1.3, *Impacts on Air Quality under Alternative B,* except this alternative seeks to increase visitation and program participation. An increase in visitation may elevate associated emissions from travel to, from, and within the refuge; however, given the urban context of the refuge, this increase is expected to have negligible impacts on air quality.

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Benefits

Under this alternative, marketing efforts or increased outreach or programming would generally target the local (NYC metropolitan) population. The majority (currently 79 percent) of refuge visitors will continue to travel from the same 50 mile radius (see section 4.2.1). As a result, we would not expect additional adverse air quality impacts due to increased visitor traveling distances.

Adverse Impacts

Based on 2012 private vehicle numbers (see section 4.2.1), the 2 percent increase in visitation expected under alternative B equates to an estimated increase of 1,139 to1,480 private vehicles entering the refuge each year. If annual visitation increases under alternative D were to double to 4 percent, the result would be an estimated increase of 2,278 to 2,960 private vehicles per year for the duration of this CCP. Under each of these scenarios, the traffic generated by the increased numbers of visitors would be very small relative to the amount of daily traffic in the area on local roads and interstate 287. As a result, the overall impacts to regional air quality from private vehicles would remain negligible under this alternative.

There are variables that may further negate adverse impacts to air quality resulting from increased refuge visitation. Improvements to vehicle fuel efficiency and emissions may offset some of the air impact associated with the visitation increase. Under alternative D, increased outreach efforts by the refuge to promote green technologies, use of public transportation, fuel efficiency, and carbon storage, may further help to mitigate air quality impacts resulting from visitation.

Any adverse regional air quality impacts directly related to construction activities from equipment or vehicles would be negligible. The short duration of construction activities (including observation tower

construction and visitor center improvements) and the limited amount of planned construction relative to the surrounding region would make these impacts undetectable on a regional scale. Some short-term, localized impacts may result from construction vehicle use. These can be mitigated through a number of measures including increased use of green technologies and strict adherence to BMPs during construction.

4.2 Impacts on Soils

Chapter 2, "Existing Environment," discusses the geologic history of the Piedmont Province and the soils of the refuge. Soils are the structural matrix and nutrient source for plant productivity and must be protected to sustain the variety of upland and wetland habitats that would meet refuge habitat and species management goals.

We evaluated the potential benefits of our proposed actions that would conserve, restore, and improve soils:

- Limiting sources of sediment by maintaining forest and other vegetative cover thereby preventing erosion.
- Allowing natural regeneration of select grassland and brushland fields, which reduces soil disturbance caused by mowing activities, to maintain carbon sequestration in soils.
- Using prescribed burning as a management tool, which will increase soil fertility and site productivity.

We evaluated the potential for the actions proposed to cause adverse effects on soils:

- Disturbing soils during non-regular refuge maintenance activities, which promote the spread of invasive plant species.
- Impacting soils by pesticide application, mowing, and invasive plant management.
- Disturbing soils during construction projects, including trails and parking lots.
- Increasing visitation and expanding the six priority public uses.

4.2.1 Impacts on Soils That Would Not Vary by Alternative

Based on the land use history, existing conditions, and current management of the refuge, we believe that the impacts of refuge management on soil structure and productivity would be negligible and would not vary significantly under any of the alternatives. The refuge's soils consist of heavy clays and are, therefore, not greatly susceptible to soil compaction. We predict that refuge land management, regardless of which alternative is selected, would be expected to have a net positive effect on soil quality. The following management actions would benefit or impact soils under all alternatives dependent on the scale, frequency, and duration of these activities and the sensitivity of the soils to erosion and compaction.

Benefits

Promoting intact forest cover and restoring forests and natural hydrology would benefit soil quality and help restore soil structure and improve the biological productivity of soil. By restoring the natural vegetation and hydrology, we encourage the natural physical, chemical, biological weathering and other soil-formation processes. Overall, the protection, maintenance, and restoration of habitats on the refuge are expected to benefit soils. Restoration projects would consider natural landform and transitional zones with project designs in order to replicate transitional soil characteristics, soil stability, and hydrology.

Increasing public awareness of soil erosion and the ways people can reduce soil erosion would continue to be part of environmental education and interpretation programs, including the benefits of conservation landscaping.

Adverse Impacts

Under each alternative, we propose to continue to manage select grassland and brushland fields through rotational mowing and cutting, although the acreage and location of managed fields would vary under each alternative. Rotational mowing and cutting could result in soil compaction though the refuge uses low ground pressure equipment whenever possible to minimize such impacts. Timing of these management actions are also considered to minimize any adverse impacts, e.g. fields are mowed in the fall when ground conditions tend to be dry and firm (after nesting season, most herptiles are absent, fall blossoms have past and pollinators absent); brush and forest mowing is scheduled in winter when vegetation is dormant and ground likely to be frozen.

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Currently, the refuge maintains approximately 7.5 miles of gravel roads, including 1.3 miles of Pleasant Plains Road and 6.9 miles of management roads, and 1.1 mile paved section of Pleasant Plains Road to facilitate refuge management activities and recreational access for visitors (by foot, bicycle, vehicle, or special access for visitors with disabilities). Several municipal and county paved roads also traverse the refuge. Although the gravel roads are pervious to precipitation, they do cause the compaction of soils and the loss of vegetation. Gravel access roads are generally located around the impoundments or provide access to administrative grasslands (i.e., remediated landfills). Maintenance of access roads, grading to minimize storm water erosion, and repairing soil erosion are done on an as needed basis. No new roads are proposed under any alternative.

We also maintain approximately 8.5 miles of primitive trails in the Wilderness Area. Trail maintenance in the Wilderness Area is limited to non-mechanical and non-motorized techniques. Bicycles are prohibited in Wilderness Area by law as a form of mechanical transportation. Horseback riding, though not banned by law, would continue to be prohibited due to the disproportionate damage caused by horses to the soft, wet soils underlying wilderness trails.

Public use impacts to soil, including those associated with short, relatively high participation events like the deer hunt or World Series of Birding, have not been observed on the refuge. However, trampling and the resultant loss of porosity, aeration and nutrient availability through soil compaction are commonly associated with high levels of public use (Roovers et al. 2004, Bell 2002). We regularly monitor trails and

roads and have not observed any major impact areas resulting from wildlife observation, photography, environmental education, or interpretive uses. Public use trails, wildlife observation areas, parking areas, and other high use areas are designed and maintained to minimize impacts on soils. We monitor parking and other concentration areas and have not observed excessive soil impacts. Maintenance of access roads, trails, and other facilities could cause negligible short-term, localized soil compaction and erosion. These activities would occur to some degree no matter which alternative is selected. We would continue to use BMPs to minimize any potential adverse impacts.

As discussed above under section 4.1, *Impacts to Air Quality*, herbicidal applications could also be a potential source of impacts to soil; however, we follow the PUP process and use the BMPs described in the Air Quality section to select pesticides that have less mobility or persistence in soils and generally use only highly-targeted direct application methods. The typical half-life of glyphosate in soil considered to be approximately 47 days (Vencill 2002); however, the half-life may range from 2 to 197 days (Giesey et al 2000) depending on climate conditions. The chemical absorbs tightly to soil and is generally considered immobile in soils. It primarily degrades by microbial action in the soil (Roberts 1998). Glyphosate degrades into two weak acids of low toxicity, Aminomethylphosphonic acid and glyoxlic acid, both of which ultimately degrade into carbon dioxide (Roberts 1998). Regarding, triclopyr, numerous studies have shown that it dissipates rapidly in the environment (Thompson et al. 1994; Berisford et al. 2006; Johnson et al. 1995; Petty et al. 2001). Based on their relative immobility and rapid degradation in soil, as well as their limited and careful application at the refuge, it is expected that adverse impacts to soil would be negligible, short-term and localized.

Under each alternative, the refuge may construct a new Headquarters facility, Visitor Center additions, and associated parking which would cause negligible short-term, localized disturbance to soil. These activities would occur to some degree no matter which alternative is selected. During the construction of these structures and associated parking lots, some upper layers of soils would be disturbed and compacted. BMPs and sediment and soil erosion controls will be implemented to minimize the release of sediments and soil erosion into environmentally sensitive areas, such as wetlands and waterbodies. Such practices would include the scheduling of construction to avoid periods with high erosion potential; preservation of natural features, slopes, and vegetation to the greatest extent possible; use of silt fencing, sediment traps, geotextile mats, or mulch; and prompt stabilization with native vegetation. Staff and contractors would be trained in the use of these BMPs.

4.2.2 Impacts on Soils under Alternative A (Current Management)

Benefits and adverse impacts on soils under alternative A would be the same as those described under section 4.2.1, *Impacts on Soils That Would Not Vary By Alternative.*

4.2.3 Impacts on Soils under Alternative B (FWS-Preferred Alternative)

Benefits

Alternative B would potentially improve soils by allowing natural regeneration to occur on approximately 169 acres of grasslands and brushlands, which are currently managed by rotational mowing and cutting. The areas allowed to succeed would no longer be subjected to soil compaction from heavy equipment. Succession to forest would potentially and improve soil conditions by restoring organic layers and biota that were previously impacted by farming or other disturbances.

As discussed in chapter 3, forests can play an important role in mitigating climate change by naturally removing carbon out of the atmosphere, a process known as carbon sequestration (Perschel et al. 2007). Carbon sequestration or storage occurs in forests and soils primarily through photosynthesis in which atmospheric CO_2 is taken up through tiny openings in leaves and incorporated as carbon into the plant's biomass (trunks, branches, foliage, and roots). Carbon can return to the atmosphere as CO_2 when soils are disturbed or when biomass decays and burns (USEPA 2010a). On average, each acre of forestland sequesters about 75 tons of carbon per acre of which 38 percent is in soil organic material (Perschel et al. 2007). Promoting natural regeneration (increase in forest cover) and reducing soil disturbance will therefore promote carbon sequestration on the refuge.

Soils will also be improved in areas where prescribed burning is used as a management tool. Although the relationship between fire and soil nutrients is complex, some generalizations can be made. Fires typically result in a reduction of fuel and the amount of organic soil nutrients present (nutrient pool), increase soil nutrient turnover rates, and redistribute nutrients through the soil profile. Post-fire soil nutrient dynamics and site productivity is most often determined by the intensity of the fire. High intensity fires typically decrease nutrient pools and site productivity more than low intensity fires. Low intensity fires can actually increase site productivity, as well as soil fertility (Forest Encyclopedia Network 2008). In order to perform a prescribed burn, specific weather and site conditions are required to control the extent and intensity of the fire, manage smoke, and maintain the burn within "prescription." Prescribed burns are generally low intensity fires that attempt to minimize the chance of an uncontrolled, high intensity wildfire in the future and are conducted to improve wildlife habitat, vegetation structure, and soil fertility.

Adverse Impacts

Disturbance of soils will occur during the reconfiguration of habitat patches (specifically, cutting of vegetation to regress to earlier successional stages) and the removal of hedgerows. Disturbance to soils during these activities would be minimal and temporary in nature. The use of BMPs, including soil erosion controls would be implemented to minimize the release of sediment into environmentally sensitive areas, such as wetlands and waterbodies.

Alternative B also proposes construction of additional facilities, including two observation towers, parking lots and pull-offs, additional trails, and other small improvements. During the construction of these structures, trails, and parking lots, some upper layers of soil would be disturbed and compacted. BMPs and soil erosion/sediment control plans will be implemented to minimize or prevent soil erosion and sediments entering wetlands and waterbodies. Such practices would include the scheduling of construction to avoid periods with high erosion potential; preservation of natural features, slopes, and vegetation to the greatest extent possible; use of silt fencing, sediment traps, geotextile mats, or mulch; and prompt stabilization with native vegetation. Staff and contractors would be trained in the use of these BMPs.

Activities associated with providing increased hunting opportunities have the potential to adversely impact refuge soils. Soils can become compacted and eroded as a result of continued foot traffic, and soils associated with wetland habitats have been rated as either high or very high in their potential for compaction (Bell 2002). However, impacts on soils from hunters will be minimal. The use of ATVs, which can cause soil erosion, is not permitted. The increased foot traffic prior to entering off-road hunting sites should not significantly impact soils because the trails in the Wilderness Area were constructed in areas that are not subject to high levels of erosion, and the boardwalks and gravel roads in the Management Area provide low impact travel routes. Additionally, impacts from off-trail foot traffic by hunters also are expected to be minimal due to the low number of hunters allowed on the refuge and the short duration of the hunts.

Hunters tend to disperse themselves and due to the nature of hunting on the refuge, once dispersed, most hunters remain stationary in a portable tree stand or on the ground. Hunters going off-trail often follow existing deer trails, but in areas where new vegetation is trampled, effects likely will be temporary. The soils throughout the refuge (predominantly poorly drained silt loam, stratified lacustrine sand, silt, and clay) by nature allow vegetation such as grasses, legumes, wild herbaceous plants, hardwoods and coniferous trees to recover rather quickly (NRCS 1976). Additionally, the archery hunt will occur during the dormant season; in general, impacts to soils are greater during the growing season than the dormant period due to the greater soil moisture content at that time of year.

4.2.4 Impacts on Soils under Alternative C

Benefits
The benefits of alternative C would be similar to those described in section 4.2.3, *Impacts on Soils under Alternative B*. However, this alternative emphasizes maximizing natural regeneration; therefore, the biological function of soils may improve as a result of succession and restored hydrology. Succession to forest would potentially restore historic soil profiles that were previously farmed, removed or filled.

Adverse Impacts
The adverse impacts of alternative C would be the same as those described in section 4.2.3, *Impacts on Soils under Alternative B*.

4.2.5 Impacts on Soils under Alternative D

Benefits
The benefits of alternative D on soils would be similar to those described under *Impacts on Soils under Alternative B.*

Adverse Impacts
The adverse impacts of alternative D would be similar to those described under section 4.2.3, *Impacts on Soils under Alternative B*; however, this alternative proposes the construction of additional facilities, including parking lots and additional trails. During the construction of these facilities, some upper layers of soils would be disturbed and compacted. BMPs and soil erosion/sediment control plans will be implemented to minimize or prevent soil erosion and sediments entering wetlands and water bodies.

4.3 Impacts on Hydrology and Water Quality

The alternatives we propose will have a neutral or net benefit to hydrology including water quantity and quality. No alternative we propose will negatively impact the hydrological benefits of the refuge's diverse vegetation communities. These communities act as riparian buffers that slow velocity of water entering the swamp, regulate surface water temperatures, increase dissolved oxygen (DO) levels, and filter contaminants. There are no activities that would measurably disrupt groundwater discharge or recharge or lead to a net increase in runoff on the refuge property. All alternatives include proper management and mitigation of potential hydrological impacts, such as strict control of herbicide use and minimization of impervious surfaces.

Hydrology of Great Swamp has been altered over the years through repeated attempts of ditching, draining, and stream alteration. In the 1960s, after the refuge was established, refuge staff began plugging

some of the previously constructed drainage ditches to restore previously drained wetlands. Also, several low dikes with water control structures were constructed to restore and enhance wetland habitats. Five major impoundments, encompassing a total of approximately 480 acres, were constructed in the 1970s and early 1980s in order to improve wetland wildlife habitat and influence plant composition and abundance. In the past, water levels in these impoundments were actively manipulated to create short- and long-term hydrological fluctuations (i.e., flooding and drought cycles). Water levels are currently maintained and only drawn down periodically (every 7 years) to mimic a natural drought cycle, which results in significant germination of annual plants and high seed production.

Water quality and quantity entering the refuge has been impacted by development and land use changes throughout much of the GSW. For the past 30 years, Great Swamp NWR has been involved in regional efforts to improve water quality with surrounding municipalities (see section 2.1.4, Water Quality and Quantity).

We evaluated the potential benefits on hydrology and water quality as a result of potential management actions under each of the alternatives:

- Restoration, expansion and maintenance of spring-fed emergent wetlands for bog turtle.
- Consolidation and maintenance of forests, scrub-shrub, grasslands, open water, and wetlands.
- Improving aquatic wildlife habitat for priority species by restoring natural hydrologic conditions in some impoundments.
- Controlling invasive species infestations.
- Increasing public awareness through the expansion of environmental interpretation and wildlife-dependent recreation.
- Increasing visitor and public awareness through continued and expanded partnerships, environmental education, and interpretation to benefit water quality and hydrology.

We evaluated the potential for the proposed actions to cause adverse effects on hydrology and water quality:

- Impacts to water quality due to increases in visitation.
- Impacts to water quality from the six priority public uses, including the addition of fishing and expansion of other uses.
- Impacts from the expansion of open water in impoundments via raising water levels to improve wildlife viewing opportunities.
- Impacts from introduction of non-wildlife-dependent activities, such as kayaking and canoeing.
- Impacts on water quality from the construction and management of public use facilities, including observation towers, buildings and trail expansion.

- Impacts due to changes in the management of impoundments.
- Impacts resulting from invasive plant species control, including the use of pesticides.
- Larger scale routine management activities, such as rotational mowing of fields, and facilities maintenance.

4.3.1 Impacts on Hydrology and Water Quality That Would Not Vary by Alternative

The hydrology of Great Swamp NWR is complex due to the convergence of five major surface waters (Passaic River, Black Brook, Great Brook, Primrose Brook, and Loantaka Brook) and multiple groundwater inputs that feed the refuge and the surrounding area. The refuge is situated in the lower receiving end of its 55 square mile watershed. All of one and parts of nine other municipalities in Morris and Somerset Counties make up the watershed. Much of the Great Swamp NWR hydrology is fed by offsite influences over which the refuge has limited control.

The impacts of nonpoint sources from surrounding development are reflected by the moderate impairment ratings of associated streams within the vicinity of Great Swamp NWR. Much of the impact of these streams is related to suspended solids, depleted DO depletion, presence of *E. coli*, and temperature issues (see chapter 2, section 2.1.4, AMNET monitoring and 303d lists). The refuge has worked closely with the surrounding communities and conservation partners for more than two decades to preserve the ecological integrity of the refuge and its watershed; however, the refuge is still very much subject to issues of water quality and quantity due to land use changes within the watershed.

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Benefits

Much of the Great Swamp NWR's vegetated landscape provides a riparian buffer along the complex of streams that pass through the refuge. The refuge's expansive forests, scrub-shrub, and emergent wetlands and riparian buffers slow velocity of water entering the swamp via stream systems and sheet flow occurs when streams overflow. As discussed in chapter 3, wetlands, in general, are critical natural resources because they perform a variety of important functions, including improvement of water quality through nutrient cycling, prevention of shoreline erosion, flood attenuation, and groundwater recharge, among various other functions (Balzano et al. 2002). The refuge's native aquatic and wetland vegetation helps mitigate the impacts of temperature, DO, total suspended solids (TSS), and *E. coli* by providing a filter of vegetation. Riparian buffers and wetlands trap and hold suspended solids and increase DO levels in refuge waters. A lack of consolidation of grassland and scrub-shrub habitats under alternative A may result in less soil and vegetation disturbances associated with hedgerow removal and other management activities and therefore, less hydrological impacts in the short term.

The refuge's vegetation communities help maintain lower water temperatures by providing shade and filtering contaminants and sediment from the waterbodies that pass through it. The refuge's role in this capacity is particularly important given its urban regional setting. Great Swamp NWR contains more than 5,000 acres of bottomland forest, which provides the greatest ecological benefit to the region in the form of shallow groundwater recharge, water quality, flood control and storage, nutrient and pollutant uptake, and soil stabilization. There is little, if any, groundwater recharge to deep aquifers due to the predominate thick clay layers present at the refuge; however, groundwater recharge to shallow aquifers does occur. Riparian forest also helps prevents bank erosion and increases the water's capacity to retain DO.

Refuge impoundments provide a variety of habitats suitable for feeding, nesting, brooding, and resting habitats for migratory birds and resident wildlife. Periodic drawdowns will continue to be performed to mimic a natural drought cycle and allow replenishment of vegetation and foraging opportunities for wildlife, such as migratory waterfowl, shorebirds, wading birds, and turtles. The five impoundments are connected through a series of low-level dikes and water control structures for varying the water levels. Vegetation, including oak spp., buttonbush, smartweed, cattail, bulrush, arrow arum, and pickerel weed is interspersed throughout the impoundments and provides excellent waterfowl habitat, especially for wood ducks. In the past, summer partial drawdowns were carried out on all five impoundments. For example, for Pool 1, the purpose of one of the drawdowns was to increase vegetative diversity and abundance through the rejuvenation of buttonbush, live timber, and emergent aquatics; in Pools 2, 3A, and 3B, drawdowns were to initiated to rejuvenate live timber and accelerate the partial drawdown of Pool 1; and in Middle Brook, drawdowns were initiated to enhance the growth of smartweed. In general, periodic drawdowns provide maximum feeding potential for migratory waterfowl in the spring and fall; lower water levels encourage growth of preferred waterfowl food, while normal operating levels provide suitable feeding areas for spring and fall migrating waterfowl. Additionally, drawdowns create quality breeding and brood habitat for waterfowl by enhancing the growth of emergent aquatics, which provide both food and cover.

Many of the existing outreach, education and interpretive programs and partnerships that are in place focus on watershed and water quality improvement. Great Swamp NWR and its watershed partners have been instrumental in promoting local ordinances which helped preserve the ecological integrity of the refuge and its watershed (see chapter 2, section 2.1.4 for details). These established partnerships and programs will continue in varying degrees under all alternatives.

Monitoring, maintenance, and restoration of spring-fed emergent wetlands for bog turtle will help improve water quality and hydrologic stability. The continued identification and management of invasive species at the refuge is also important as they pose a direct threat to refuge habitats, wildlife populations, and ecological functions. Invasive plant infestations, such as *Phragmites australis* for example, can quickly transform healthy, biodiverse communities into monotypic stands with reduced value for wildlife (Auclair et al. 1973; Hansen et al. 1998; Benoit and Askins 1999). Invasive aquatic plant infestations can negatively impact aquatic ecosystems by reducing DO levels (Caraco et al. 2006), altering water temperature, and reducing light availability (Angeloni et al. 2006). Some invasive species, when left uncontrolled, can rapidly change the hydrology of wetlands. For example, purple loosestrife is capable of altering hydrological and biochemical processes in wetlands, and may result in increased sedimentation and alteration of flow within wetlands (Lythrum salicaria Working Group, 2004).

Adverse Impacts

Although this will vary under alternatives, all alternatives include the continued mowing and cutting of managed patches. The maintenance of these habitats, particularly wet habitats, will result in some short-term, localized, and minor impacts to soils and water from the use of machines in soft, wet substrates for the purposes of cutting vegetation. Reduced impacts to these wet managed areas would occur under alternatives B, C, and D, since these alternatives propose to reconfigure and consolidate managed habitats. Small, difficult to manage units, especially wetter fields, would be eliminated from this management program.

Although reestablishing natural hydrology in Pools 3A and 3B is considered under alternative C, fully restoring the natural hydrology of the refuge is not achievable within the management areas. As soil was permanently altered by agricultural land practices, including ditching and tilling, so was hydrology of the refuge. Works Progress Administration projects in the 1930s resulted in the creation of deep drainage ditches within Black Brook to control flooding for agricultural purposes, which were ultimately unsuccessful. In the 1960s and 1970s, refuge staff plugged many ditches to restore the previously drained wetlands and constructed several impoundments with water control structures to manipulate shallow water levels and aquatic vegetation. Native vegetation growth may be suppressed by the use of water control structures that keep wetland areas inundated for prolonged periods of time. Physically removing water control structures would aid in restoring the natural hydrology in Pools 3A and 3B, but growth of historic native vegetation may still be suppressed from past land management activities. Thus, these areas may require additional habitat modifications for full restoration

Several historic sources of contamination prior to the establishment of Great Swamp NWR, including Rolling Knolls landfill, several asbestos dump areas and a former Harding Township landfill, have impacted local water quality (see chapter 2, section 2.1.4). All of these contaminated areas have been remediated, are considered “stable” due to depth of contamination, or are in some stage of remedial action or investigation. These sites will continue to be maintained and monitored in the future in accordance with O&M Plans that include quarterly inspections and annual monitoring of groundwater, surface water and sediment. These plans require that failure of the remedy to be protective, as indicated by physical problems with the landfill cap or analytical results that exceed the appropriate screening criteria, be immediately addressed. In the case of Rolling Knolls landfill, the site will be remediated and an O&M plan implemented by the responsible parties under the oversight of EPA, pursuant to CERCLA requirements. Therefore, it is expected that these sites will not affect water quality in the future if all O&M plans are followed. Remediation of all contaminated sites includes establishment and maintenance of a native grassland vegetative cover.

The development of new facilities may have temporary impacts on water quality due to the disturbance of soils during construction; however, we would implement BMPs to minimize impacts to adjacent habitats and waterways. Certain facilities, such as observation towers and new trails, are not proposed under alternative A. As a result, we would expect slightly less short-term impacts associated with facility construction and less long term impacts associated with expanded public access under this alternative. Any increase in visitation may also have impact on water quality through the increased use trails and vehicles on refuge roads. The most intense direct impacts to water quality could occur from construction of new facilities, maintenance of access roads and trails, and other maintenance activities (e.g., mowing of grasslands, brush and forested areas and pesticide application for invasive species control), which would cause negligible short-term, localized sedimentation or spills that could impact water quality. These

activities would occur to some degree no matter which alternative is selected. These impacts would be minimized by using BMPs. In general, variations in the amount of public use would result in negligible differences in impacts to water quality, especially in the context of the highly developed watershed.

Road maintenance activities, such as gravel spreading and the limited use of de-icing agents, have a relatively minor impact on water quality. The refuge limits the use of de-icing agents for public safety purposes only at locations that experience high visitation. De-icers are only used in parking lots at the refuge headquarters and the Visitor Center, on pedestrian walkways in those areas, and along the paved stretches of Pleasant Plains Road within the refuge. Environmentally friendly calcium magnesium acetate (CMA) is utilized whenever possible and in all environmentally sensitive areas. CMA is used to minimize runoff contaminants and possible environmental impacts. Standard rock salt is used in larger, less environmentally sensitive areas due to the high cost of CMA.

Under all alternatives, standard maintenance, including the mowing of managed grasslands and cutting of brushlands, would have some minor and seasonal impacts associated with the use of machinery and soil disturbance.

Though much of its effects are not fully understood at this time, the refuge will need to consider hydrologic impacts associated with climate change. Climate change could result in destabilized hydrologic cycles, including periods of flood and drought caused by changes in weather patterns or increased temperatures or precipitation (see chapter 2, section 2.1.7). More frequent and severe flooding could lead to increased erosion and sedimentation in waterbodies. All of the alternatives will monitor and develop strategies for mitigating climate change impacts on open water and refuge hydrology.

As discussed above under section 4.1, *Impacts to Air Quality*, herbicidal applications could also be a potential source of impacts to water quality; however, we follow the PUP process and use the BMPs described in the Air Quality section to select pesticides that have less mobility or persistence in water and generally use only highly-targeted direct application methods. The use of pesticides to control invasive species would have a negligible impact on water quality under all alternatives. Managing invasive plant species at current levels has not included widespread application of pesticides adjacent to or directly in hydrologic resources. Currently, glyphosate and triclopyr are the primary active ingredients used by the refuge to treat invasive plants. Both glyphosate and triclopyr are systemic herbicides that operate only on enzymes located in certain plant tissues within roots or vascular system structures. Glyphosate is a herbicide commonly used in crop production and as a management tool for invasive species. It quickly degrades making it biologically unavailable. The chemical has been found to persist in soils for approximately 47 days (Vincill 2002); however the half-life may range from 2 to 197 days (Giesey et al 2000) depending on climate conditions. Glyphosate has a low toxicity to wild birds and studies have shown bioaccumulation factor in birds was as low as 1/10,000 (USFS 1984). Glyphosate is nearly non-toxic to fish and mammals, which generally excrete the chemical in an unchanged form (USEPA 1987). Glyphosate does have a high solubility rate in water (Schuette 1998). However, the potential for glyphosate to accumulate in the tissues of aquatic invertebrates or other aquatic organisms is considered low (PIP 1984). Triclopyr is not labelled for aquatic applications and is toxic to fish at high concentrations. Residues are not persistent (Berisford et al. 2006), however, and dissipate rapidly in the environment (Johnson et al. 1995; Woodburn et al. 1993; Petty et al. 2001; Kreutzweiser et al. 1995). As a result of application restrictions and low persistence, the potential for contamination of surface and groundwater is minor. Berisford et al. (2006) found that triclopyr had the lowest potential to move into groundwater of five common herbicides tested. Woodburn et al. (1993) found no accumulation of triclopyr in sediment, no bioconcentration in fish,

and no decline in water quality. Kreutzweiser et al. (1998) found no significant mortality of detritivorous aquatic insects at typical environmental concentrations. Petty (2001) found no adverse effects on water quality or on the non-target biotic community following triclopyr applications.

We would minimize potential adverse effects to aquatic organisms by properly training all personnel performing pesticide application, applying all pesticides according to label instructions, state, and Federal laws, and FWS policy, and only using pesticides approved for aquatic use in and around waters and wetlands. Through its careful and limited application, the refuge would ensure that use of glyphosate remains well under the EPA enforceable contaminant level (MCL) of 0.7 mg/L or 700 ppb.

4.3.2 Impacts on Hydrology and Water Quality under Alternative A (Current Management)

The adverse impacts of alternative A would be the same as those described under section 4.3.1, *Impacts on Hydrology and Water Quality That Would Not Vary by Alternative.*

4.3.3 Impacts on Hydrology and Water Quality under Alternative B (FWS-Preferred Alternative)

Benefits

Within 5 years, the impoundments would be evaluated to determine the ecological costs and benefits of maintaining, enhancing, or altering succession in each of these impoundments. Depending on the findings of these evaluations and the future management of these areas, hydrology and vegetation composition within these impoundments may change. Adverse impacts and benefits to impoundments may eventually be similar to alternative A or alternative C, depending upon results of the impoundment study and conclusions. The study results will enable us to minimize negative impacts to ecological communities under the chosen management scenario.

The consolidation of habitats, including the conversion of brushland and grassland fragments to later successional stages, will have a modest benefit on water quality by maximizing absorption levels in the forested areas. As previously mentioned, the consolidation of habitats will result in less seasonal disturbance associated with maintaining small fragments of grassland or brushland fields, particularly those that are difficult to manage due to wet or inundated conditions.

The expansion of educational and interpretive programs would provide additional emphasis on regional issues, including water quality and watershed protections. As it has in the past, a sustained outreach program focusing on the issue of water quality and quantity, particularly in the context of climate change, may improve practices and ordinances within the surrounding communities. Maintaining and expanding this network of partnerships and communication may have the greatest positive impact on improving refuge water quality under this alternative.

Alternative B seeks to aggressively expand refuge efforts to manage for and promote understanding of climate change. The refuge would monitor changes in hydrological cycles and when necessary, follow the approach outlined in the FWS Strategic Plan (USFWS 2010a). This plan utilizes the approach of adaptation, mitigation and engagement (see chapter 2, section 2.1.7). The adaptive management approach allows the refuge to utilize management strategies that reduce hydrological impacts as they are observed or anticipated.

Adverse Impacts

As previously mentioned, any increases in program participation and visitation may result in increases in vehicle use and foot traffic near water bodies; therefore, these increases in public uses may result in negligible impacts to water quality due to increased sediment load from trail erosion, litter, or chemicals from leaking cars and exhaust. Public outreach and education on littering and importance of proper waste disposal will help reduce impacts associated with increased visitation. In addition, increased hunting under this alternative would be expected to have negligible impacts on water quality as these activities would not result in substantial increases of foot traffic or vehicle use.

In general, the refuge minimizes adverse effects on water resources in a variety of ways. Trails are placed in areas that are not subject to high levels of erosion or adjacent to sensitive areas, to minimize erosion and adverse impacts to hydrology and water quality. Additionally the refuge has constructed boardwalks on some of the heavily visited areas to prevent impacts to hydrology. Further, the Wildlife Observation Center and wilderness trail parking lots are graveled and are therefore more porous than impervious surfaces such as asphalt or concrete. This allows precipitation to absorb into the ground, preventing storm runnoff into the brooks and streams. The refuge also does not permit the public to drive off designated roads or to use ATVs, which can cause depressions in the soil and divert water from original drainage patterns.

Activities associated with increased hunting have the potential to adversely impact refuge water resources. For example, because hunters are not restricted to using only trails designed for other public use activities, they may travel through areas that are susceptible to erosion and subsequent sedimentation. In such areas, concentrated off-trail foot traffic can affect the hydrology of an area by removing vegetation, compacting the soil, and causing water to channel and pool. Long-term, this can result in some drainages becoming dry while others accelerating erosion by being forced to carry more water. However, impacts of additional hunters on the hydrology and water quality should be negligible. Hunter numbers will be limited and hunters will be dispersed across the refuge, which will reduce repeated erosive actions of soils. Additionally, the soils may be frozen during the fall hunting seasons, further reducing the potential for erosion and downstream sedimentation.

This alternative also proposes the construction of additional trails and new wildlife viewing facilities, such as observation towers. The use of BMPs, including soil erosion controls, would be implemented to minimize the release of sediment into environmentally sensitive areas, such as wetlands and waterbodies. Post-construction, the long-term effects to hydrology and water quality are anticipated to be minimal. We would monitor and periodically inspect roads, trails and facilities for evidence of erosion. If any public use causes evident and unacceptable adverse impacts, the refuge would limit or discontinue the use. Additional environmental education and interpretation programs will raise public awareness on water quality issues, as well as support for wildlife protection and habitat conservation.

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This alternative considers the use of livestock to manage for woody growth and invasive species in the emergent and shrub wetland habitats of bog turtles to mimic the natural function of native ruminants. There are potential hydrological impacts associated with the use of livestock in wetlands, including nutrient input from fecal matter, overgrazing, trampling of vegetation, and soil destabilization within the vicinity of rivulets or other waters.

The introduction of manure and subsequent agricultural runoff into these systems may denude native vegetation and promote the development of invasive species (Tesauro and Ehrenfeld 2007); however this is observed when livestock are utilized at very high densities and not for the primary purpose of habitat management (Tesauro 2013). It has been observed that formerly heavily pastured sites that have been left fallow over many seasons may develop dense mats of invasive vegetation. It therefore becomes essential to utilize only low densities of livestock that mimic natural grazing conditions to control woody and invasive vegetation on sites (Tesauro and Ehrenfeld 2007; Tesauro 2013).

There is also the potential of direct impacts to bog turtles or eggs from trampling. Injuries or deaths to bog turtles as a result of livestock trampling on pastured sites have been observed; however, these observations are extremely uncommon. Variables such as density and type of livestock and substrate type and depth play a role in these impacts (Tesauro 2013).

Careful long term planning that determines the correct type and density of livestock would be required to avoid major, long-term impacts to the vegetation community and potential direct negative impacts to bog turtles. Keeping livestock at estimated levels of one or two animals per acre may be required (Tesauro 2013) to result in net positive long-term impact to bog turtle populations.

4.3.4 Impacts on Hydrology and Water Quality under Alternative C

Benefits

Benefits to water quality are similar to those discussed under section 4.3.3, *Impacts on Hydrology and Water Quality under Alternative B (FWS-Preferred Alternative).*

While partnerships to protect watershed conditions would be expected under all alternatives, alternative C has greatest focus on partnerships that expand unifying ordinances and legislation to protect the GSW.

When compared to alternative B, there are slight increases in acreages of natural regeneration for grasslands and brushlands to later successional stages. This difference would potentially result in a slight improvement to water quality due to the increase of woody vegetation and decrease in rotational mowing or cutting activities. However, these improvements to water quality would be minimal and localized in the context of the entire GSW.

Adverse Impacts

Adverse impacts under alternative C are similar to those discussed under section 4.3.3, *Impacts on Hydrology and Water Quality under Alternative B (FWS-Preferred Alternative).*

4.3.5 Impacts on Hydrology and Water Quality under Alternative D

Benefits

Impacts to hydrology and water quality under alternative D are similar to those discussed in section 4.3.3, alternative B. Alternative D will provide the maximum number of environmental education and interpretation programs, which will raise public awareness and support for wildlife protection and habitat conservation. Any increase in outreach to the local communities under alternative D may have a greater benefit for improving water quality on the refuge.

Adverse Impacts

Alternative D would have a greater impact to hydrology than other proposed alternatives, primarily due to the expansion of open water habitat and increased visitation. Open water could be expanded in these habitats by elevating water levels as opposed to dredging sediment or removing vegetation, which would cause significant disturbance to the underlying sediment.

An increase in water level elevations would lead to a dieback of aquatic and wetland vegetation, which would likely change hydrological patterns and potentially increase the potential for flooding. These changes could have intermediate, long-term impacts to some of the refuge's local vegetation communities that are adjacent to these open water habitats. As mentioned in section 4.4.1, lower water levels allow for the increased vegetative diversity and abundance. Tussock sedge and other *Carex* spp. , rushes ,grasses , and forbs such as smartweeds, are all examples of early wetland successional species that may be impacted by water level increase as these impoundment edge communities are increasingly flooded. Other woody species such as buttonbush may also be impacted by increased water levels that are not periodically drawn down (see section 4.4.1). We would expect that the adverse impacts of open water expansion adjacent or successional wetland communities to be long-term and intermediate in nature. Overall these impacts on the vegetation community on a refuge wide or regional population level would be negligible as these communities are common throughout the refuge relative to losses that would be experienced under this alternative.

Conversely, without open water manipulation, open water communities which are popular with refuge visitors and utilized by waterfowl will be lost over time as aquatic vegetation such as pickerel weed, arrow arum and many marsh species succeed on these open water areas.

Any changes in open water would need to be closely monitored to ensure hydrological changes do not impact sensitive wildlife species or their habitats.

Alternative D anticipates the greatest increase in refuge visitation over the next 15 years. This alternative emphasizes, to a greater extent than alternative B, the expansion of infrastructure, including the creation of new trails, observation towers, and parking lots. The potential for hydrologic impacts due to increased visitation (described under section 4.4.1, *Impacts that Would Not Vary by Alternative*) would be slightly higher than other alternatives. In addition, seasonal pedestrian access would be provided on existing service roads around Pools 3A and 3B; however, these areas would be closed to the public during migration and other time periods when wildlife may be sensitive to disturbance. If any public use or new infrastructure results in evident and unacceptable adverse impacts to water quality due to erosion or pollution, the refuge would rotate the activities to secondary sites, curtail, or discontinue the use altogether.

The introduction of fishing at the refuge may result in some water quality impacts near open water including bank erosion from foot traffic and increased amounts of litter or waste. Lead weights may be discouraged or not permitted to be used; however it is likely that lead and other waste, such as excess fishing line, lures, and miscellaneous litter, would increase within fishing access areas.

There is also greater potential for the introduction of exotic species to the refuge from other locations and sources. There are multiple examples of invasive species being transferred throughout Northeastern aquatic ecosystems by fishing and other aquatic activities. A few of the many prominent examples include the diatom known as "rock snot" (*Didymosphenia geminata*), invertebrates such as *Dreissena* spp. mussels and Asian clam (*Corbicula fluminea*), and vascular plants such as Eurasian watermilfoil (*Myriophyllum spicatum*). These organisms, including their eggs or seeds, larvae, etc. may be transferred through bait, bait bucket water, on wading boots or other equipment (NANSP 2013). Introduction of one or more invasive species could result in a long-term, major adverse impact to refuge aquatic systems. This may include a degradation of habitat and direct loss or displacement of native populations of aquatic species.

Because of limited access and other more popular freshwater fishing options within the region, it is expected that fishing would be a relatively minor and very localized activity at the refuge. In addition, much of the streams associated with the refuge are heavily utilized by anglers and canoers at nearby off-site locations. It would be expected that allowing fishing at the refuge would result in a relatively minor increase in the probability of invasive species introductions in the watershed. Other non-wildlife dependent uses, such as the introduction of canoeing and kayaking, also increases impacts to water quality through bank erosion and increased potential for invasive species introductions.

The probability of invasive species introduction may be reduced through the inclusion of informational signage at refuge fishing locations. Signage would instruct anglers on ways to decontaminate boots and other equipment before utilizing a waterbody. Other measures including restrictions on certain baits, felt boots, or other potential vectors for invasive species may also be considered.

Under this alternative, we would consider the creation of an observation pond near the Visitor Center, which would result in temporary impacts associated with soil disturbance and machine use during construction. To minimize permanent hydrological impacts to wetlands and groundwater associated with its construction, we would carefully consider and evaluate the location of the pond to avoid unnecessary impacts. Impacts to wetlands and transition areas (i.e. buffers) would be avoided to the greatest extent possible.

In addition, we would consider the creation of a paved bike trail along a gravel section of Pleasant Plains Road; however, this would result in an increase in impervious surface (i.e., increased sheet flow or stormwater runoff).

4.4 Impacts on Vegetation

As discussed in chapter 2, refuge lands include a variety of habitat types, including bottomland, upland, riparian, and floodplain forests; naturally-occurring scrub-shrub wetlands and actively managed brushlands; non-forested wetlands; open water; and managed grasslands. The Management Area of the refuge had undergone intense post-colonial agricultural disturbances that impacted vegetation patterns to the present day (Momsen 2007). The dichotomy of vegetation patterns in the eastern (i.e., Wilderness Area) and

western portions (i.e., Management Area) of the refuge reflect the differences in historic land use and land cover. The eastern portion of the present day refuge, while disturbed through logging, was not subject to the intensive soil and hydrologic alteration from farming practices though extensive ditching for flood and mosquito control was conducted in the 1930s and 1940s. As a result, the present day Wilderness Area vegetation patterns are consistent with the influence of post-glacial deposits that characterize the geologic history of the region. The pin-oak swamps and other vegetation communities of the western portion of the refuge reflect post-colonization agricultural use (Momsen 2007). Some habitats are the result of alteration, such as impoundments. Despite these alterations, many of these impacted habitats have the potential to be restored through various management actions, natural succession, and specific projects. Some habitats support rare plant communities or species of concern.

We evaluated the following benefits to vegetation as a result of potential management actions under each of the alternatives:

- Conserving and protecting refuge lands to prevent future development, thereby limiting impacts on vegetation and losses of ecosystem integrity.
- Protecting, conserving, and monitoring habitats that contain rare or endangered plants, unique habitats, and habitats that support species of special concern.
- Conversion or restoration of certain impoundments, brushlands, and grassland areas of the refuge to forest or a later stage of vegetation succession.
- Maintaining wildlife habitat and supporting wildlife in some impoundments by restoring certain impoundments to natural marsh and scrub-shrub wetlands or by maintaining static water levels in other impoundments.
- Controlling invasive species, pests, and diseases that impact vegetation on the refuge and monitoring for those that are known to be present in the region.
- Supporting regional restoration projects and scientific studies that improve habitat management, knowledge of species of concern, or provide learning opportunities for students.
- Increasing public awareness and developing partnerships to address important environmental issues, such as the spread of invasive plant species and the availability of native plant alternatives.
- Emphasizing the use of native species wherever plantings or vegetation restoration are conducted, striving for species and structural diversity, and considering for overwinter survival or future native plant recruitment objectives.

We evaluated the potential for the proposed actions to cause adverse effects on vegetation and losses of ecosystem integrity:

- Direct or indirect actions causing soil, hydrology, and water quality impacts that could adversely impact vegetation, and habitat productivity and integrity.
- Managing and restoring bottomland, upland, riparian, and floodplain forest communities.

- Invasive species control.
- Larger scale routine management activities, such as mowing fields and maintaining or controlling water levels in impoundments, and less regular activities, such as prescribed burning.
- Constructing, updating, expanding, or managing public use facilities, wildlife viewing infrastructure, trails and parking lots, and administrative offices.
- Increasing visitation and expanding the six priority public uses.

4.4.1 Impacts on Vegetation That Would Not Vary by Alternative

We expect that refuge land management, regardless of alternative, would have a net positive effect on vegetation abundance, diversity, and quality.

Benefits

Under all alternatives, the refuge would continue to protect areas of bottomland, upland, floodplain, and riparian forest, non-forested wetlands, grasslands, and brushlands. Habitats supporting rare wildlife or plant species would also be maintained and restored, when necessary. For example, we would continue to maintain and control invasive species within spring-fed emergent wetlands for bog turtle and woodland vernal pools for blue-spotted salamander. We would continue to protect existing lands adjacent to rivers and stream segments within refuge boundaries that influence aquatic life and vegetation. Overall, the protection, maintenance, and restoration of habitats are expected to benefit vegetation.

Under all alternatives we would continue to employ early detection and rapid response (EDRR) techniques, in collaboration with other conservation partners, to prevent the establishment of newly emerging invasive plants. We would continue to reduce the footprint of habitats degraded by stand-replacing, near-monocultures of non-native plant species, such as common reed and reed canary grass. For example, beginning in 1995, one-half million *Galerucella* beetles were released, resulting in a significant reduction in purple loosestrife by 2005. Invasive species control efforts would continue under all alternatives. These efforts are expected to result in a net benefit to native vegetation across all habitat types on the refuge.

Public use can benefit vegetation through our education and interpretive actions proposed under all alternatives. By educating visitors on the importance and identification of native vegetation and intact plant communities, we help individuals to recognize the prevalence of invasive species and the benefits of native species. We would also continue to encourage nearby nurseries to sell and promote native alternatives to common non-native landscaping plants. Under all alternatives, we would continue to encourage volunteer-based efforts to help control invasive species and restore native plant communities.

The refuge would also continue to support deer hunting under all alternatives. Deer hunting benefits a variety of vegetative communities by keeping deer populations within the carrying capacity of the habitat, thus reducing excessive damage to vegetation caused by over-browsing and maintaining understory habitat for other species (Rawinsky 2008).

Adverse Impacts

Maintaining and protecting a diversity of high quality vegetation habitats are consistent themes within the refuge's goals and are common to all of the alternatives. However, creating large, contiguous patches of

managed vegetative communities, particularly managed brushlands and grassland fields, are consistent themes among alternatives B, C, and D to varying degrees. Reconfiguration of habitats, including cutting, burning, or removal of vegetation to create an earlier stage of succession, would result in short term, localized, minor impacts to vegetation. The impacted areas would regenerate and develop into the desired habiat conditions with a year or two of treatment. Temporary and/or permanent loss of vegetation would also occur during construction or repair of facilities, roads, or other infrastructure; however, the refuge would promote revegetation of disturbed areas with native species typical of this part of northern New Jersey.

Short-term adverse effects from public use activities consist of the deterioration of plant material, whereas long-term effects of trampling include direct and indirect effects on vegetation and soils like diminishing soil porosity, aeration and nutrient availability through soil compaction (Roovers et al. 2004). Compaction of soils thus limits the ability of plants, particularly rare and sensitive species, to re-vegetate affected areas (Hammitt and Cole 1998). Where adverse impacts to vegetation are observed, the refuge will take necessary measures, such as remediation and trail closures, to restore plant communities.

We anticipate that allowing use on designated routes will cause some vegetation loss. Foot travel may increase root exposure and trampling effects; however, we anticipate that under current and projected use the incidence of these problems will be minor. Routes for pedestrian travel consist of existing trails and boardwalks that have been used for many years. Designated routes do not have any known occurrences of rare plant species on their surface or soils subject to compaction that will be impacted by this use. Users leaving designated trails could have impacts to adjacent vegetation. Trails will be monitored, problem areas will be identified, and appropriate restoration and protection efforts will be made.

Highly traveled trails such as the ones at the Wildlife Observation Center have had boardwalks built to lessen the impacts on vegetation and wildlife disturbance. This allows visitors to quietly walk through these areas with minimal disturbance to the surrounding wildlife. Boardwalks have also been observed to be used as cover by some of the common species of turtles, fox, frogs, snakes and salamanders present in this area.

Direct adverse impacts on vegetation may occur as a result of hunting activities. Short-term, trampling of vegetation by hunters will occur to some degree throughout the refuge during the firearm and bow deer hunting season. Additionally, vegetation in designated grass hunter parking lots temporarily will be compressed from vehicles. Plant species vary in their resistance to trampling, which can lead to changes in plant communities over time. In general, plant diversity has been shown to increase with slight use and to decrease as use intensifies (Liddle 1997). Regardless, the overall physical effects of deer hunting on refuge plant communities are expected to be minimal and short-term. The number of hunters (maximum 450 permits) and duration of the hunt (5 days) are limited by the refuge. Additionally, use of all-terrain vehicles (ATVs), off-road vehicle travel, permanent tree stands and blinds, camping, and fires, which are most likely to damage vegetation, are prohibited. Hunter trampling of vegetation is likely to be further minimized as a result of the high acreage to hunter ratio (one hunter per 32 acres for deer, less dense for turkey) and the time of year most hunting occurs (dormant season). Finally, potential impacts to vegetation from an overabundant deer population far outweigh the limited impacts on vegetation that could occur from trampling by deer hunters. In fact, positive, indirect effects on the vegetation (i.e., increased ecological diversity) will result from continued management of the refuge's white-tailed deer population.

The most intense direct impacts to vegetation would occur from construction of new facilities, maintenance of access roads and trails, and other maintenance activities (e.g., mowing, mechanical grassland and brushland treatments, pesticide application for invasive species control), which would cause negligible short-term, localized disturbance to vegetation. These activities would occur to some degree no matter which alternative is selected. These impacts would be minimized by using the BMPs described under Section 4.3.1, *Impacts on Hydrology and Water Quality.*

4.4.2 Impacts on Vegetation under Alternative A (Current Management)

Impacts from refuge management under alternative A would be the same as those described under section 4.4.1, *Impacts on Vegetation That Would Not Vary by Alternative*.

4.4.3 Impacts on Vegetation under Alternative B (FWS-Preferred Alternative)

Benefits

As described under section 4.4.1, *Impacts on Vegetation That Would Not Vary by Alternative,* alternative B would reconfigure and maintain habitats to create large (greater than 50 acres), contiguous patches to promote wildlife use, increase connectivity, decrease fragmentation, and increase maintenance efficiency and reduce associated costs. This would shift the plant community structure and species composition within affected units over time. Within 5 years, open water habitat would also be evaluated to determine the ecological costs and benefits of maintaining, enhancing, or altering succession in each of the impoundments. Depending on the findings of these evaluations and future management of these areas, vegetation structure and composition within the impoundments may change.

Managed brushlands and grasslands would be enhanced to improve vegetative structure and species composition. The quality of brushlands and grasslands would be improved by evaluating and implementing ways to manage the flora, such as prescribed burning, grazing, or plantings, to maximize their native ecological diversity and productivity. Smaller brushland and grassland field areas that do not currently support obligate grassland bird species or other priority species, such as American woodcock, would be allowed to undergo natural succession. Based upon their limited patch size and location, allowing natural forest succession within these disjunct units would improve adjacent core forest health.

Prescribed burns will occur on a maximum of 200 acres of grassland under this alternative. Prescribed burns have multiple benefits to vegetation communities and their associated wildlife. Benefits to vegetation include increases water yield, maintenance of natural succession of plant communities, suppression of invasive species, and reduction of the need for pesticides. Prescribed fire increases the production of seed in legumes and grasses in frequently burned areas. Grassland fires cause early green up of warm season grasses, improved seed-germination, and greater production of grasses and forbs. It also increases the production of berries, drupes, and pomes for 2 to 4 years after burning (Lyon et al. 2000).

The actions proposed under this alternative will allow the refuge to make the most significant ecological contribution possible at the local and landscape levels within the GSW, Northern Piedmont Region, and the Refuge System.

Adverse Impacts

Adverse impacts on vegetation would be similar to those described under 4.4.1, *Impacts on Vegetation That Would Not Vary by Alternative,* however, there would be minor, temporary impacts on vegetation due

to the removal of hedgerows within existing grassland and brushland fields that create predator perches, fragment management units, and reduce the availability of suitable nesting areas for grassland birds. In addition, this alternative would expand the successful management practices that have been developed for the bog turtle on the refuge and elsewhere. This includes the maintenance of herbaceous dominant, spring-fed wetlands through control of woody plant succession and invasive species. This would result in direct impacts to woody vegetation; however, there would be an overall benefit to the federally threatened bog turtle, as well as other reptiles and amphibians that utilize these areas.

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The regular prescribed burns proposed under this alternative would reduce the amount of successional woody vegetation growth (brushland or secondary forest) in some grassland areas. Areas proposed to be managed with fire would be limited to approximately 200 acres of grassland that is largely currently managed with rotational mowing. As a result, the addition of prescribed burning would not by itself substantially change the ratios of grassland to forested and brushland communities within the refuge.

While it is likely that certain exotic species of shrubs such as Autumn olive may be suppressed through burning, other native shrub species such as *Cornus* spp. dogwoods, and tree seedlings such as *Quercus* spp. oaks and red maple may be regularly suppressed by regular burns.

Although grassland communities are particularly resilient to burning (Knapp et al 2009), we would expect very short-term, negligible adverse impacts to herbaceous species to occur from burning through direct injury or mortality. Burns during vulnerable phonological periods (e.g early growing season) increases the chance of woody or herbaceous species mortality (Knapp et al 2009). However, if properly implemented, the long-term net benefits (stated in 4.4.5 under benefits) to native herbaceous communities would far outweigh the short-term impacts of direct mortality or injury.

The inclusion of a prescribed burn on existing grassland habitats has the ability to shift the dominance ratios and composition of herbaceous vegetation. The frequency, intensity and the timing of burns can play a significant role in manipulating composition. For example, late winter or early spring burns may more effectively kill or suppress actively growing cool-season grasses over dormant warm season grasses. As a result of this timing, managers may shift a community from a cold-season to a warm-season dominant community (Knapp et al 2009; Howe 1994). With this in mind, any prescribed burn program will undergo careful evaluation prior to implementation to avoid long-term or major adverse impacts to refuge grassland communities. This would include a careful ecological analysis of communities to be burned and evaluation of specific desired goals and potential impacts. All of this information would be included in a fire management plan for the refuge burns. The plan will incorporate appropriate methods and practices from the FWS Fire Management Handbook (USFWS 2013), Guidance for Implementation of Federal Wildland Fire Management Policy (FEC 2009), Interagency Standards for Fire and Fire Aviation (NIFC 2013), and other appropriate guidance.

Under this and all alternatives, the potential for introduction of invasive species through public use of the refuge is a constant concern. People, vehicles, and dogs can be vectors for invasive plants when seeds or

other propagules are accidentally, or deliberately, introduced into the refuge. Once established, invasive species can out-compete native plants, thereby altering habitats and indirectly impacting wildlife. The threat of invasive plant establishment is an issue requiring continual monitoring and, when necessary, treatment. Staff and dedicated volunteers will continue to work to eradicate invasive species through an increasingly proactive EDRR strategy and educate the visiting public.

Alternative B proposes construction of additional facilities, which includes two wildlife observation towers, parking lots, and new trails. During the construction of these structures and trails, some areas of vegetation would be disturbed. Most, if not all, small project construction would be located where vegetation is already degraded, so a minor permanent loss of vegetated cover would result in a negligible impact. All temporary impacts would be restored and planted with native vegetation typical of northern New Jersey and the refuge. BMPs would be used to prevent unnecessary impacts to adjacent habitats and waterways.

Activities associated with providing increased hunting opportunities have the potential to adversely impact refuge soils.

4.4.4 Impacts on Vegetation under Alternative C

Benefits

The benefits of alternative C are similar to those discussed under section 4.4.3, alternative B, except we would further emphasize converting brushlands and grassland habitat to forested habitat or other late successional stages over the life of the plan. This would shift the plant community structure and species composition over time to more mature successional stages.

A benefit under this alternative would be the increase in forest acreage. The increased acreage will aid in forest resiliency and redundancy, factors important in weathering the effects of future climate change anticipated for this area, such as increased storm events, increased temperatures, more or less rainfall, new diseases and pests, and new invasive plant species. Additional forest acreage would also increase “core” forest habitat, which would directly benefit various forest interior bird species.

Under this alternative, we would consider the use of deer exclusion devices to promote succession and forest regeneration. This would also provide opportunities to study and document browsing impacts by deer.

Another benefit to this alternative is the reduced mowing and cutting associated with grassland and brushland habitat maintenance.

Adverse Impacts

The adverse impacts of alternative C are similar to those discussed under section 4.4.3 in alternative B. This would include impacts resulting from prescribed fire and other standard management activities (see discussion in section 4.4.3). One exception would be the minor, temporary, adverse effects on vegetation associated with impoundment restoration due to changes resulting from the removal of boards from water control structures. The vegetation communities would change with a loss of open water and an initial increase in natural marsh. Eventually these communities would be expected to succeed into a scrub-shrub, and possibly floodplain forest community associated species.

There will be less available habitat to support native plants and pollinators associated with grasslands and other species in the food web that use open habitats.

As in alternative B, alternative C also anticipates an increase in refuge visitation, although most of this increase is anticipated to be from environmental education and interpretation program participation. Effects of increased visitation under alternative C are expected to be similar to those described under alternative B.

4.4.5 Impacts on Vegetation under Alternative D

Benefits
The benefits of alternative D are similar to those discussed under section 4.4.3, alternative B.

Adverse Impacts
The adverse impacts of alternative D are similar to those discussed under section 4.4.3, alternative B; however, alternative D proposes to increase open water habitat to enhance wildlife viewing opportunities. Vegetation loss would result from increasing water levels in the impoundments, not through the removal of sediment or root mass. There will be less available habitat to support waterfowl, shorebirds, and other species in the food web that use an interspersion of emergent marsh and open water habitat.

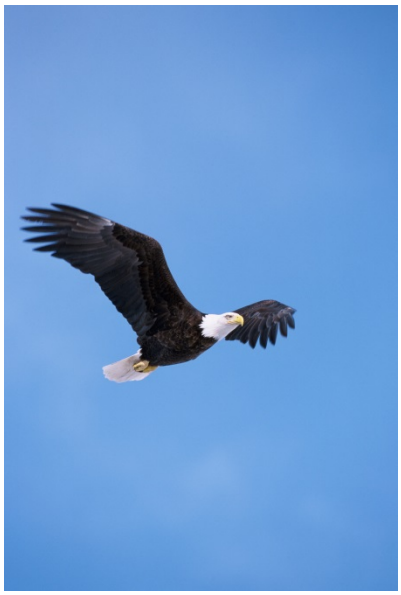
Alternative D anticipates the greatest increase in refuge visitation. Effects of increased visitation under alternative D are expected to be similar to or slightly more than those described under alternative B.

Fishing opportunities, which are not authorized under any other alternative, would be provided in select areas of the refuge. Trampling of vegetation may occur during the fishing season when visitors walk to, from, and along fishable waters. In addition, as previously mentioned, people, vehicles, dogs, and horses can be vectors for invasive plants when seeds are accidentally or deliberately introduced into the refuge. Fishing may pose additional concerns for invasive species since waders and fishing equipment can also serve as vectors for aquatic invasive plants. Once established, invasive species can out-compete native plants or create thick monocultures in water bodies, thereby altering habitats, water quality, and indirectly impacting wildlife. The threat of invasive plant establishment will always be an issue requiring annual monitoring and, when necessary, treatment. Staff and dedicated volunteers will work to eradicate invasive species and educate the visiting public.

4.5 Impacts on Federally Listed and Recently Delisted Species

There are currently two federally listed species that have established populations at Great Swamp NWR, the federally listed threatened bog turtle and the federally listed endangered Indiana bat. Both of these species utilize specific habitats at Great Swamp NWR. As part of the Refuge System, one of our highest priorities is the conservation and management of federally listed or recently de-listed species. We evaluated each of the alternatives for its potential to beneficially or adversely affect habitats where breeding, wintering, hibernating, or foraging occurs. State-endangered species or species of greatest conservation need (including amphibians, reptiles, birds, and plants) also occur on the refuge and are addressed under their individual taxonomic sections.

Indiana Bat
The Indiana bat was listed as endangered by the Federal government in 1967 due to population declines documented in their seven major hibernacula in the Midwest. This species was automatically added to the New Jersey endangered species list following the passage of the State's Endangered and Nongame Species Act in 1973 (Beans and Niles 2003). Reproductively active female and juvenile Indiana bats were first identified on the refuge in 2005. The Indiana bat uses refuge swamp forests and riparian corridors for maternal roosts and as foraging habitat during warmer months.


USFWS

Bog Turtle
The bog turtle was listed as an endangered species in New Jersey in 1974 due to severe population declines, restricted habitat preferences, habitat loss, and collecting. In 1997, the bog turtle was listed as threatened by the FWS. The New Jersey NHP considers the bog turtle "globally, either very rare and local throughout its range or found locally in a restricted range or because of other factors making it vulnerable to extinction throughout its range" and "imperiled in New Jersey because of rarity" (Beans and Niles 2003). The bog turtle is a year-round resident that utilizes certain open wetlands at the refuge.

Bald Eagle
Although the bald eagle was removed from the Federal list of endangered and threatened species on August 12, 2007, it is still a federally protected species under the Bald and Golden Eagle Protection Act and the State continues to list it as threatened during the non-breeding season and endangered during the breeding season. A transient bald eagle may be seen occasionally throughout the year on the refuge.

Peregrine Falcon
The peregrine falcon was classified as a federally endangered species in 1970 and as a New Jersey endangered species in 1974. The peregrine falcon was removed from the Federal list of endangered and threatened species in August 1999. Although the species was removed from the Federal list, the peregrine falcon remains listed in the State of New Jersey. Peregrine falcons are rarely seen on the refuge, primarily during the fall and winter months.

We evaluated the benefits of our actions that would conserve, restore, improve, or increase habitats of federally listed and recently de-listed species.

4.5.1 Impacts on Endangered and Threatened Species That Would Not Vary by Alternative

We do not anticipate any impacts to any endangered or threatened species under any of the alternatives. No public use trails are open on lands which are occupied by threatened Bog Turtle. The endangered Indiana bat is nocturnal and therefore these uses will not affect their foraging activities.

Based on the research done on the refuge using radio-telemetry tracking and bat acoustic surveys, the refuge provides foraging and roosting habitat for Indiana bats. We are planning to continue mist net surveys

to assess the status of Indiana bats within the refuge. Currently roost sites are in closed areas of the refuge or off trails. Indiana bat will continue to be monitored with cooperation of many of our partners and with New Jersey USFWS Ecological Field Office throughout the State and if they are found to use public areas or trail corridors on the refuge public use in those areas will be re-evaluated. We anticipate that these uses are not likely to adversely affect Indiana bats because these activities do not coincide with the area where this species is known to occur.

Based on radio-telemetry tracking the refuge provides foraging, nesting, and hibernation habitat for the bog turtle. The bog turtles will continue to be tracked and trapping will continue in areas that have historically had bog turtles to find all areas this species occurs on the refuge. All known and historical bog turtle sites are closed to the public and not located near trails. We anticipate that these uses are not likely to adversely affect bog turtles.

Disturbance by deer hunting to Indiana bats is unlikely because bats are gone from the refuge during the time of the hunt. The refuge also provides foraging, nesting, and hibernation habitat for the bog turtle. A small population occurs in a few acres of emergent wetland habitat in a refuge Safety Zone area. Additionally, several wetlands associated with seeps that historically have supported bog turtles are scattered throughout the refuge; in the recent past, single occurrences of the species have been documented in two of these areas. In general, activity of bog turtles during fall is limited as the animals reduce their movements and enter hibernacula (e.g., ground water-washed root systems of woody plants). Also, it is very unlikely that a hunter will encounter a bog turtle, as the primary population falls within a Safety Zone and much of the area is protected by fencing.

Disturbance by turkey hunting to Indiana bats is unlikely because bats are rare, they roost during the day under the exfoliating bark of trees, and are they most active at night. Also, it is very unlikely that a hunter will encounter a bog turtle, as the primary population falls within a Safety Zone and much of the area is protected by fencing. Additionally, because turkeys are an upland species, hunters are less likely to enter or remain in wetland habitats, where turtles are found. In fact, the type of habitat that bog turtles use (characterized by shallow water and deep “mucky” soils USFWS 2012) likely will be avoided by hunters as they travel to their desired turkey hunting areas.

4.6 Impacts on Landbirds

The conservation and management of forested habitats are a priority of the refuge and one of our CCP goals. We evaluated each of the alternatives for its potential to benefit or adversely affect early successional and forested habitats and associated landbirds.

We evaluated the benefits of our actions that would conserve, restore, improve, or increase habitats of landbirds and identified focal species in chapter 2 and in our biological objectives:

- Improving and restoring bottomland, upland, riparian, and floodplain forests.
- Increasing monitoring, early detection, and control of invasive species, pests, and diseases.
- Promoting public awareness through environmental education, environmental interpretation, and wildlife-dependent recreation.

- Increasing patch size, reducing fragmentation, and improving vegetation structure and composition of forest, scrub-shrub, and grassland habitats.
- Continuing to maintain and restore vernal habitats.

We evaluated the potential for the proposed actions to cause adverse effects on habitats of landbird focal species:

- Disturbance from public use.
- Impacts to wild turkeys, as well as other land birds, from opening a spring wild turkey hunt for gobblers (males) in select areas of the refuge.
- Potential impacts from spraying of invasive species, forest restoration, removal of hedgerows, and impoundment water level manipulation.
- Construction of additional wildlife observation infrastructure, such as an observation towers.
- Mechanical treatment actions, such as grassland mowing or brushland cutting.
- Construction of new facilities, trails, and parking lots.
- Operation and maintenance of facilities, buildings, and associated infrastructure.

4.6.1 Impacts on Landbirds That Would Not Vary by Alternative

Benefits

Forest Species

There are several State-listed endangered or threatened landbirds that use forest habitats of the refuge, including but not limited to barred owl, long-eared owl, red-shouldered hawk, red-headed woodpecker, and bald eagle. These species primarily use bottomland, upland, riparian, and floodplain forests for breeding, foraging, nesting, and resting habitats.

Numerous other landbirds that are not State-listed as endangered or threatened, but identified as regional conservation priorities are included in this group as well. Species such as the Acadian flycatcher, Eastern wood-pewee, black-and-white warbler, Canada warbler, Cerulean warbler, worm-eating warbler, Kentucky warbler, Louisiana waterthrush, rusty blackbird, Baltimore oriole, scarlet tanager, and wood thrush are all noted as high management priorities in plans such as BCR 28 and 29, PIF 9 and 10, the FWS Birds of Conservation Concern list, the FWS Species of Regional Conservation Concern list, and the NJWAP. These species primarily use upland, bottomland, floodplain, or riparian forests for breeding, foraging, and resting habitats.

Scrub-Shrub Species

Although no scrub-shrub dependent landbirds are currently listed as State-endangered or threatened, several species are identified as regional conservation priorities, including American woodcock, blue-winged warbler, golden-winged warbler, willow flycatcher, eastern towhee, field sparrow, and prairie warbler.

Grasslands Species

There are many State-listed endangered or threatened landbirds that use grassland habitats at the refuge, including vesper sparrow, bobolink, Northern harrier, grasshopper sparrow, and short-eared owl.

Under all alternatives, the refuge would continue to restrict access and management activities, when and where appropriate, near known nesting sites. The refuge delays its mowing program to October to avoid impacts to breeding birds, raptors, reptiles, wildflowers, and pollinators. Long-term benefits to landbirds are anticipated through the ongoing management of forests, scrub-shrub, and grasslands. Invasive species management will enhance the habitats landbirds use for nesting, foraging, and migratory stopover. Ongoing management activities, such as invasive species management, inventory, and monitoring programs, would continue to be completed in a manner that would prevent potential impacts to individual species. The refuge would continue to coordinate with NJDFW, as well as with our conservation partners, to ensure that we use the best available science in our management decisions related to State-listed species.

Adverse Impacts

Minor impacts may occur during habitat management activities, specifically mowing and cutting of grassland and brushland habitats. These activities would occur no matter which alternative is selected, but the degree to which we practice them would vary, and thus, their impacts. As discussed above under *Benefits,* mowing and cutting of fields generally occurs in October to avoid impacts to breeding birds, raptors, reptiles, wildflowers, and pollinators. As expected, mowing has a more substantial effect on bird occupancy in brushland habitats since this form of habitat management has a much more pronounced effect on vegetation structure (Vickery et al. 2005). Brushland habitat will be maintained in various stages of succession to provide wildlife species, including landbirds, foraging, resting, nesting, and cover habitat.

Regardless of the alternative, we would continue to employ a range of invasive species management tools, such as mechanical, biological, and chemical methods, to achieve our objectives in managing for the improved health and integrity of landbird habitats. We would use these tools only when and where appropriate, and only with the proper training and focused application to avoid adverse impacts. Invasive species control can be detrimental to landbirds if proper timing and application are not considered, but we tailor our treatments to protect birds during the nesting and fledgling periods and to avoid harm to amphibians, reptiles, and pollinators. A less noticeable, but long term impact would result from no action with respect to invasive species control or failing to curtail the deer population, as these have the potential to significantly alter vegetation communities upon which birds and their prey base depend.

In general, the presence of humans disturbs wildlife, which typically results in a temporary displacement without long-term effects on individuals or populations. Disturbance varies by wildlife species and the type, level, frequency, duration, and time of year the disturbance occurs. Disturbance can cause shifts in habitat use, abandonment of habitat, and increased energy demands on affected wildlife (Knight and Cole 1991). Miller et al. (1998) found bird abundance and nesting activities (including nest success) increased as distance from a recreational trail increased in both grassland and forested habitats. In this study, common species (e.g. American robins) were found near trails and rare species (e.g., Blackburnian warblers) were found farther from trails. In some cases there was a clear link between the extent of disturbance and either the survival or reproductive success of individuals (e.g., Schulz and Stock 1993). For recreation activities that occur simultaneously, such as hiking, biking, and horseback riding, there would likely be compounding negative impacts to wildlife (Knight and Cole 1991).

Human disturbance can cause an animal to vacate an area or habitat due to the amount or frequency of disturbance. In a study done by Gill et al. 2001, the decision of whether or not to move away from disturbed areas will be determined by factors such as the quality of the site currently being occupied, the distance to and quality of other suitable habitats, the relative risk of predation or density of competitors in different sites, and the investment that an individual has made in a site (for example, in establishing a territory, gaining dominance status or acquiring information).

There is evidence to suggest that species most likely to be adversely affected are those where available habitat is limited thus constraining them to stay in disturbed areas and suffer the costs of reduced survival or reproductive success (Gill et al. 2001). Because of the diversity of habitats represented on the refuge any population level effects to wildlife species from trail use might be minimized by the abundance of habitat on the refuge and adjacent lands.

Wildlife disturbance may be compounded by seasonal needs. For example, some species, like warblers, could be negatively affected by disturbance associated with bird watching particularly during the breeding season. When visitors approach nests too closely, they often cause the adult bird to flush exposing the eggs to weather conditions or predators (Banks and Bryant 2007, Miller et al. 2001).

State-listed bird species that possibly could be present and active on the refuge during the deer hunt include the state-endangered peregrine falcon, bald eagle, red-shouldered hawk, and vesper sparrow, and the state-threatened barred owl, long-eared owl, and red-headed woodpecker. In general, fall is the season for bird migration, and hunting could cause some level of disturbance to migrating birds during this time. Hunting activity may cause birds that are feeding and roosting in upland and wetland habitats to unnecessarily take flight, expending energy resources at a time when food resources are limited. While disturbance to the daily migrating and wintering activities of birds may occur, cumulative negative impacts should be negligible, because the hunting season does not coincide with the nesting season, which would impact reproduction, and the period of disturbance is short (5 days), reducing the likelihood that disturbance associated with the hunt would deplete important fat reserves.

Impacts to birds, such as displacement, may result from lost habitat where current and proposed new construction of building and associated infrastructure takes place. Maintenance, activities, and support structures can have an impact footprint that goes beyond the walls of a given building, and can include such things as light and noise pollution, pets, traffic, lawn maintenance and the type of vegetation, power lines, and cleared areas required for parking, solar panels, septic and drain fields.

Major construction of within the refuge will tend to occur in previously disturbed or partially urbanized habitats. As a result, commonly displaced bird species at the refuge would be disturbance tolerant, generalist passerine species such as robins, jays, finches, mockingbirds, catbirds, and common sparrows. These species tend to be very common, highly adaptable and will regularly utilize common urbanized habitats within the refuge and the surrounding landscape. As a result, we expect that any impacts to landbird populations caused by planned refuge construction will be localized, short-term, and negligible.

The refuge will take all necessary precautions to avoid and minimize adverse impacts to actively nesting birds and will work in accordance with recommendations under the Migratory Bird Treaty Act. These measures include monitoring and inspecting structures or habitats for nesting birds prior to construction. Examples may be checking shrubs for nesting species such as American robin or identifying nests in buildings or structures for species such as Eastern phoebes or barn swallows. Construction near nesting/fledging birds will be avoided as needed to prevent nest disturbance or failure, and mortality of

chicks. If required, timing restrictions during the active breeding season will be utilized for clearing of trees or other activities that have the potential to impact nesting birds. By following these procedures, we would expect to avoid long-term, adverse impacts on nesting birds.

As previously discussed, the refuge is located in a highly urbanized environment with substantial baseline disturbance associated with the several major highways (Route 78, Route 287, and Route 24) and numerous houses, businesses, warehouses, manufacturing plants, and industries. Visitors are currently limited in the Management Area to existing refuge trails and infrastructure; therefore, refuge visitors are not expected to add significantly to existing disturbance levels. Visitors have the option of exploring the entire Wilderness Area on foot, whether on existing trails or beyond. Visitation, however, is much lower in the Wilderness Area due to the more primitive, back-country conditions found there. Overall, direct impacts from public use are expected to have minimal or no adverse effects on landbirds.

4.6.2 Impacts on Landbirds under Alternative A (Current Management)

Impacts to landbirds under alternative A are the same as those discussed in *Impacts on Landbirds That Would Not Vary by Alternative*.

4.6.3 Impacts on Landbirds under Alternative B (FWS-Preferred Alternative)

Benefits

Compared to alternative A, alternative B would provide additional long-term benefits to landbirds through the protection and restoration of forest habitats, and enhancements to managed grasslands and brushlands. We would reconfigure habitats to create large, contiguous patches to promote wildlife use, increase connectivity, and decrease fragmentation. Forest birds would benefit from the consolidation of forest habitats and use of feathered edges. Large tracts of contiguous forested areas are necessary to support breeding populations of migratory songbirds (Robbins et al. 1989; Robinson et al. 1997), especially forest interior species, as well as forest dwelling raptors (Bosakowski et al. 1992; Bosakowski 1994). Consolidation of habitats into larger patch sizes would also reduce fragmentation and undesirable edge effects and associated ecological impacts, such as edge-related nest predation, brood paratism, and the spread of invasive plant species. Feathered edges will reduce fragmentation effects while serving as important ecotonal travel and dispersal corridors (Arbuthnot 2008). Feathered edges also provide important nesting, foraging, and escape cover for a variety of wildlife species.

We would maintain an interspersion of habitat types produced by the management of grasslands and brushlands, which substantially increases ecotonal areas and promotes wildlife diversity. Managing large tracts of grasslands and brushlands would help improve nesting site availability and success. This alternative also benefits the insects and other invertebrates on which these birds depend. Select forest habitats will be converted to an earlier successional stage while other areas will be allowed to succeed through natural regeneration; therefore, it is anticipated that phased removal and conversion of habitats will be performed to help minimize short-term impacts or habitat loss.

Under alternative B, we would increase monitoring, EDRR, and control of invasive species, especially in areas where change in management or land use occurs or emergent infestations develop and along dispersal corridors (roads, ditches, trails, etc.). Management of invasive species will help protect and maintain a diversity and abundance of vegetation in all habitats, which would improve nesting site availability and success for land birds.

Adverse Impacts

Habitat management, consolidation and reconfiguring, and restoration of forests, brushlands, and grasslands under alternative B would likely result in short-term, infrequent, and negligible disturbances to landbirds during necessary work and maintenance of these areas. These habitats may most often support common passerine species such as bluebirds and robins, finches, mockingbirds and other mimics, chickadees and titmice, flycatchers, wrens, and various sparrows; and other landbird species such as common woodpeckers and common raptors.

These common refuge birds may experience short-term, localized, adverse impacts as they may be temporarily displaced by noise or activity from machinery or other management activities. Provided these activities occur in the non-nesting season, this displacement would be expected to result in a temporary relocation of birds that are loafing, foraging, or engaging in other non-breeding behaviors. Displaced birds would have similar habitat options elsewhere throughout the refuge and adjacent areas . As a result, we expect that temporary bird displacement caused by management activity to have a negligible adverse impact on bird populations.

The habitats that will be altered under this alternative are fragmented habitats such as hedgerows and small grassland patches. This reconfiguration will result in a permanent change of the generalist habitat of some nesting or foraging birds. Hedgerows that are removed would be expected to support some common nesting disturbance tolerant species such as robins, cardinals or catbirds. In addition, some of the small grassland patches that are currently utilized by common field foraging species such as bluebirds, mourning doves, or field sparrows will be allowed to succeed into brushland or forest. The hedgerow and small open patch habitats that will be altered under this alternative are common and readily available throughout the regional urbanized landscape. As a result, any permanent alteration of foraging or nesting landbird habitat will have only short-term, localized, and negligible impacts on common bird populations.

We would continue to monitor known nest locations and adjust our management and timing of our actions to minimize impacts on landbirds. We would minimize or restrict certain activities, such as prescribed burns and mechanical vegetation treatments, to the fall and winter (i.e., outside of the breeding season) and would scout areas for nesting birds prior to commencing work.

USFWS/Donna Dewhurst

Alternative B anticipates an increase in refuge visitation over the next 15 years. Much of this increase is expected in the form of school groups and recreational users. Adverse impacts to landbirds are expected to be similar to or slightly greater than those discussed in section 4.7.1, *Impacts on Landbirds That Would Not Vary by Alternative.*

We would pursue creating additional trails and the construction of new wildlife viewing facilities, such as observation towers. Construction timing would be considered where necessary to avoid potential disturbance to nesting species, as well as to minimize impacts on foraging and resting habitat during important seasonal periods such as nesting or migration. As a result, minimal adverse impacts are anticipated from proposed

construction projects. We would evaluate the sites and programs periodically to assess whether these facilities are meeting the objectives and to prevent site degradation. If the use causes evident and unacceptable adverse impacts, the refuge would rotate the activities to secondary sites, curtail, or discontinue the use.

Under this alternative, we would open a spring turkey hunt for gobblers (males) in select areas of the refuge, specifically in the Wilderness Area and areas south of White Bridge Road. There would be no fall hunt for wild turkey. The hunt would be held for recreational purposes only (not for population management) and would sustain low daily densities of hunters. We would collect data to determine the refuge's turkey population through regular winter and spring counts. Estimating the refuge's turkey population will allow us to determine appropriate bag limits, to evaluate the success of the hunt program, and to prevent negative impacts to the refuge's wild turkey population. Turkey hunting would impact individual birds; however, we would expect only negligible impacts to the overall population. Turkey hunting has the most potential to cause disturbance to landbirds, particularly ground nesting forest birds of conservation concern, such as wood thrush. If implemented, the spring hunting season would take place on select days between mid-April and early May, when female birds are likely to be laying or incubating. This timing provides additional protection to the female turkeys, which would not be disturbed by hunters, because turkey hunters stay in one place waiting for turkeys or attempting to call males to them. Hunters may temporarily disrupt feeding and resting of migrating birds. Additionally, off-trail hiking by turkey hunters could disturb low-elevation or ground nesting breeding birds as they attempt to establish and settle into nest territories, build nests, or incubate eggs. Given the low number of turkeys anticipated to be harvested from the refuge, initially likely to range between 1-5 individuals, no cumulative impacts to local, regional or Statewide populations of turkeys are anticipated. In 2012, the Statewide harvest was 2,954 male turkeys. Turkey hunters by the nature of the hunt are mostly sedentary once initial set up has occurred so impacts to landbirds are expected to be negligible.

4.6.4 Impacts on Landbirds under Alternative C

Benefits

Alternative C differs slightly from alternative B in benefits to landbirds. This alternative would provide additional forest and late successional vegetation communities by maximizing natural regeneration. Similar to alternative B, we would continue to manage large tracts of brushlands and grasslands. Shrub and early successional habitats are currently under-represented across the region, and are considered some of the rarest wildlife habitat types in the Northeast. These habitat types benefit various warbler species and other songbirds that use dense shrub cover and open grasslands.

Under this alternative, we would consider the use of deer exclusion devices to promote succession and forest regeneration. This would also provide opportunities to study and document browsing impacts by deer.

Similar to alternative B, providing additional opportunities for environmental education and interpretation would raise public awareness and support for wildlife protection and habitat conservation.

Adverse Impacts

Adverse impacts to landbirds are similar to those discussed in section 4.6.3, alternative B. Alternative C also anticipates a similar increase in refuge participation and visitation as alternative A. Impacts to

landbirds due to visitation are the same as those discussed in section 4.6.1, *Impacts on Landbirds That Would Not Vary by Alternative*.

4.6.5 Impacts on Landbirds under Alternative D

Benefits
Impacts to landbirds under alternative D are the similar to those discussed in section 4.6.3, alternative B.

Alternative D will provide the maximum number of environmental education and interpretation programs, which would likely raise public awareness and support for wildlife protection and habitat conservation.

Adverse Impacts
Alternative D anticipates the greatest increase in refuge participation and visitation over the next 15 years. Much of this increase is expected in the form of school groups and recreational users. This alternative emphasizes, to a greater extent than alternative B, the expansion of infrastructure, including the creation of new trails, observation towers, and parking lots. In addition, seasonal pedestrian access would be provided on existing service roads around Pools 3A and 3B; however, these areas would be closed to the public during migration or other time periods where wildlife may be sensitive to disturbances.

As discussed above, timing of construction would be considered where necessary to avoid potential disturbance to nesting species, as well as to minimize impacts on foraging and resting habitat during important seasonal periods, such as nesting or migration. As a result, minimal adverse impacts are anticipated from proposed construction projects. We would evaluate the sites and programs periodically to assess whether these facilities are meeting the objectives and to prevent site degradation. If any public use or new infrastructure results in evident and unacceptable adverse impacts, the refuge would move the activities to secondary sites, curtail, or discontinue the use.

Adverse impacts to landbirds are expected to be similar to or slightly greater than those discussed in section 4.6.1, *Impacts on Landbirds That Would Not Vary by Alternative,* and section 4.6.3, *Impacts on Landbirds under Alternative B.*

4.7 Impacts on Open Water and Wetland Bird Species

The refuge's wetlands and open water habitats support a number of waterfowl, waterbird and shorebird species (see chapter 2, section 2.6.3). Among the species of regional concern that utilize the refuge open waters and wetlands are American black duck, American bittern, least bittern, and great blue heron. Four rail species, including the king rail, Virginia rail, sora, and common moorhen, nest within the marsh habitats at Great Swamp NWR. Several shorebird species, including greater and lesser yellowlegs, dunlin, semipalmated, and least and solitary sandpipers, utilize the refuge wetlands during migratory periods. The American woodcock, a shorebird of the highest refuge and regional priority, utilizes emergent and scrub-shrub wetlands for nesting and is given the highest consideration in all habitat management of wetlands and waters. We evaluated the management actions for each alternative for their potential to benefit or adversely impact open waters and wetland habitats and refuge priority species that utilize these habitats.

We evaluated the benefits of our actions that would conserve, restore, improve, or increase habitats of open water and wetland bird focal species:

- Allowing natural regeneration of vegetation and emergent wetlands in Pools 3A and 3B.
- Consolidation of scrub-shrub (brushland) and grassland habitats and natural regeneration of small, isolated, or difficult to manage habitat fragments.
- Controlling invasive species.
- Increasing public awareness through environmental education and interpretation programs and wildlife-dependent recreation.
- Improving water quality and flood protection through local and regional partnerships.

We evaluated the potential for the proposed actions to cause adverse effects on habitats of waterbird focal species:

- Disturbance of species from public use, including increases in visitation, expansion of trail systems and public access, and introduction of fishing.
- Disturbances associated with impoundment water level manipulation, including reducing open water habitat and allowing natural regeneration in Pools 3A and 3B.
- Potential impacts from treating invasive species with pesticides or other management practices.
- Construction of additional wildlife observation infrastructure, such as wildlife observation towers.

4.7.1 Impacts on Open Water and Wetland Birds That Would Not Vary by Alternative

Benefits

Under all alternatives, the refuge would continue to restrict public access and management activities, when and where appropriate, including near known nesting sites and important wintering areas. We would monitor and evaluate the breeding success of American woodcock and other priority waterbird, shorebird, and waterfowl species.

The refuge will continue to provide a diversity of wetland habitats dominated by native species, including marshes, open water and mudflats for waterfowl, waterbirds, and shorebirds of regional conservation concern, such as American and least bitterns, sora, king rail, and American black duck.

Under all alternatives, an interspersion of habitats, such as emergent and scrub-shrub wetlands will be maintained to support a stable population of breeding American woodcock on the refuge.

The refuge would monitor and continue to control invasive plant species, including but not limited to common reed and purple loosestrife, that reduce native species diversity and productivity of wetlands. A variety of carefully considered invasive species management tools, such as mechanical, biological, and chemical controls, will be utilized to achieve our objectives in managing for the biological integrity, diversity and environmental health of open water and wetland habitats.

Under all alternatives, the refuge would continue to support programs that feature waterfowl, waterbirds, shorebirds, and their habitats. We would encourage the public to participate in activities, such as wildlife photography, that involve these species at the refuge. We believe that connecting people to nature through these types of activities would help encourage habitat conservation over time.

Adverse Impacts

Bennett and Zuelke (1999) summarize several studies indicating recreational activities that would have at least temporary effects on the behavior and movement of birds using shallow water habitats adjacent to trails and roads on wildlife refuges (Burger 1981, 1986; Klein 1993; Burger et al. 1995; Klein et al. 1995; Rodgers and Smith 1997; Burger and Gochfeld 1998). Some minor disturbance or displacement of shorebirds may occur near the observation pond along Pleasant Plains Road, especially during periods of migration and at peak visitation times. Disturbances or displacement of waterfowl, waterbirds, or shorebirds may also occur along other public access areas near water, such as at the WOC or near impoundments, particularly during peak visitation times of the year or when group activities or programs are occurring. These disturbances are generally limited and temporary in nature. We would evaluate areas potentially impacted by frequent visitation and programs periodically to assess whether they are meeting objectives, degrading sites, or disturbing wildlife. If the use causes evident and unacceptable adverse impacts, the refuge would move the activities to secondary sites, change their seasonal timing or frequency, curtail or discontinue them.

Overall, the effects from public use are expected to have minimal adverse effects on waterbirds utilizing open water and wetland habitats. There are few visitor facilities (e.g., trails) in these habitats due to the presence of open water, saturated soils, and their location in a closed area of the refuge; therefore, they are relatively inaccessible to the public. Large dense emergent vegetation dominant wetlands and portions of open water would be expected to provide adequate buffers to protect wetland bird species against human disturbance (Gibbs and Melvin 1992).

Invasive species control can be detrimental to open water and wetland birds if proper timing and application are not considered. Extreme caution will be used in the application of mechanical, biological and chemical invasive species control within the vicinity of wetlands and open water. Chemical treatments will require the focused application of approved wetland and open water pesticides, restricting pesticide application during sensitive breeding and fledging periods, and during periods when weather conditions exceed application thresholds. The refuge will continue to require all staff utilizing pesticides be properly trained to avoid adverse impacts.

Issues of water quality (see section 4.3), including contaminants from nonpoint source pollution, have the potential to impact refuge waterbirds, waterfowl and shorebirds feeding on aquatic flora and fauna. As previously mentioned, continued partnerships with local communities is the best method for the refuge to improve refuge water quality and ultimately protect wildlife from contamination.

4.7.2 Impacts on Open Water and Wetland Birds under Alternative A (Current Management)

Benefits and adverse impacts to open water and wetland birds are the same as those discussed in section 4.7.1, *Impacts That Would Not Vary by Alternative.*

4.7.3 Impacts on Open water and Wetland Birds under Alternative B (FWS-Preferred Alternative)

Benefits

The consolidation of managed shrubland and grassland habitats will be designed to provide habitat benefits to American woodcock. Grassland or shrubland fragments targeted for natural regeneration and ultimately reforestation are not utilized by nesting or staging woodcock. Other areas of grassland and scrub-shrub habitat proposed to be enhanced or expanded under this alternative currently provide suitable habitat for American woodcock (see chapter 3, alternative B, goal 2) and as a result, we expect direct benefits to American woodcock populations on the refuge. Populations of woodcock will need to be carefully monitored in areas of habitat expansion and management adjusted as needed to maximize the benefit to this species.

Within 5 years, Pools 3A and 3B would be evaluated to determine the ecological costs and benefits of maintaining, enhancing, or altering succession in each of the impoundments. Depending on the findings of these evaluations and the future management of these areas, hydrology and vegetation composition within these impoundments may change. Adverse impacts and benefits to impoundments may eventually be similar to alternative A or alternative C, depending on results of the impoundment study and conclusions. The study results will enable us to minimize impacts to ecological communities under the chosen management scenario.

As a result, alternative D creates more opportunities to educate a greater numbers of individuals on the benefits of wetland preservation, water quality, and the diversity of wetland and open water birds and other wildlife on the refuge. We believe that connecting people to nature through environmental interpretation and education would help encourage habitat conservation over time.

Adverse Impacts

Increases in visitation would be expected to be greater under alternative B than the no-action alternative. This may result from increases in interpretive programs and improvements to infrastructure, such as trail extensions and the development of two observation towers. Wildlife observation towers will be created in existing public access areas. Negligible differences in displacement or disturbance of waterfowl and waterbirds may occur as a result of increased visitation. New trails are not proposed in any sensitive shorebird, waterbird or waterfowl nesting habitats. Any impacts due to increases in visitation can be mitigated by careful monitoring of visitation in these areas and, if needed, the adjustment of programs accordingly to minimize impacts to wildlife. These adjustments may involve use of alternate areas or seasonal restrictions on access, if required.

The creation of infrastructure near wetlands and open water habitats, such as the wildlife observation towers may have a temporary impact on wetland or open water birds or wildlife during construction due to increased activity and noise. The assembly of observation towers at the WOC and along Pleasant Plains Road will be performed with the use of heavy machinery during times of the year that will have the least impact on breeding birds and other sensitive wildlife. We believe that connecting people to nature through wildlife observation and photography and environmental education and interpretive programs would raise public awareness and support for wildlife protection and habitat conservation over time.

The consolidation of habitats, particularly the use of machinery to remove hedgerows and other activities within the vicinity of wetlands or open water, has the potential to temporarily disturb or displace certain

wildlife species, such as American woodcock or wood duck. Timing of construction would be considered to avoid disturbance to sensitive species and impacts to these species is not anticipated.

Overall, adverse impacts to open water and wetland birds would be localized, minor, and short-term.

4.7.4 Impacts on Open Water and Wetland Birds under Alternative C

Benefits

Benefits to open water and wetland birds would be similar to those discussed under section 4.7.3, *Impacts on Open Water and Wetland Birds under Alternative B,* except Pools 3A and 3B would no longer be maintained as impoundments, and as a result, these areas would be allowed to succeed to naturally occurring marsh or shrub swamp plant communities. Allowing these areas to return to a more natural hydrologic condition and vegetative community more closely follows the Refuge System's BIDEH policy. Natural succession of these areas would reduce open water and result in greater densities and variations of native wetland vegetation that would benefit a suite of marsh, scrub-shrub, and wetland dependent species, including American and least bitterns; marsh wren; various herons, rails, and shorebirds; willow flycatcher; and blue-winged warbler. Refer to chapter 3, alternative C for further information of habitat requirements of focal species and the expected benefit from expansion of naturally occurring marsh habitat.

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Adverse Impacts

Since Pools 3A and 3B would no longer be maintained as impoundments under this alternative, there would be a decrease in the amount of open water habitat and an increase in shrub swamp plant communities due to natural regeneration and lower water levels. We would remove boards from the water control structure, which control the water levels of an impoundment, in an attempt to restore the natural hydrology of these areas. We anticipate that the wetlands would contain shallower, seasonal amounts of standing water. The conversion of impoundments (specifically Pools 3A and 3B) to a mix of natural marsh and scrub-shrub wetlands may result in some minor displacement of non-breeding waterfowl from the loss of open water; however, we do not anticipate impacts to overall populations of waterfowl. Although the primary purpose of the refuge is to provide foraging, resting and staging habitat for migratory waterfowl, the refuge's size, inland location, and the largely forested and urbanized surrounding landscape does not significantly contribute to overall waterfowl populations. Regardless, Great Swamp NWR would continue to provide an interspersion of wetland and open water habitats for waterfowl at remaining impoundments.

As with alternative A, alternative C anticipates some increases in refuge visitation. However, as less emphasis is directed toward increasing visitation under this alternative than under alternatives B and D, we would expect slightly less impact from increases in traffic, noise and other disturbances in publically accessed wetlands and open water areas. As mentioned above under section 4.7.1, *Impacts That Would Not Vary by Alternative*, existing precautionary measures would result in infrequent, localized impacts on open water or wetland birds with the anticipated increase in visitation. We would continue to monitor refuge visitation and potential impacts on open water and wetland birds and adjust our management accordingly to continue to protect these species and their habitats.

4.7.5 Impacts on Open Water and Wetland Birds under Alternative D

Benefits

Benefits to open water and wetland birds would be similar to those discussed under section 4.7.3, *Impacts on Open Water and Wetland Birds under Alternative B,* except this alternative places greater emphasis on the expansion of programs, partnerships, and visitation. As a result, alternative D creates more opportunities to educate a greater numbers of individuals on the benefits of wetland preservation, water quality, and the diversity of wetland and open water birds and other wildlife on the refuge. We believe that connecting people to nature through environmental interpretation and education would help encourage habitat conservation over time.

Adverse Impacts

Alternative D anticipates the greatest increase in refuge visitation over the next 15 years. This alternative emphasizes, to a greater extent than alternative B, the expansion of infrastructure, including the creation of new trails, observation towers, and parking lots. Some of the infrastructure proposed under alternative B is included under this alternative as well, such as the development of two observation towers and the introduction of several new trails; however, this alternative also proposes the creation of several more access trails that would increase the likelihood and frequency of disturbance to wildlife. Therefore, the potential for wildlife impacts due to increased visitation would be slightly higher than other alternatives (described under section 4.7.1, *Impacts that Would Not Vary by Alternative*). In addition, seasonal pedestrian access would be provided on existing service roads around Pools 3A and 3B. Access would be restricted to certain times of the year when sensitive wildlife are least vulnerable. Seasonal restrictions may include breeding or migratory periods for waterfowl or waterbirds. It is likely that even with seasonal restrictions, some displacement and disturbance of wildlife may occur. There is also greater potential for unauthorized access to occur as visitors become familiar with these trails. The refuge would strictly enforce and communicate the restrictions on access to these areas to minimize negative impacts. If any public use or new infrastructure results in evident and unacceptable adverse impacts to waterbirds, waterfowl, or shorebirds to public use, the refuge would move the activities to secondary sites, curtail, or discontinue the use altogether.

Other proposed non-wildlife dependent recreational activities proposed under this alternative that are near water, such as allowing canoeing or kayaking access across refuge lands along the Passaic River, also has the potential to displace nesting or wintering waterfowl, waterbirds and other wildlife. The establishment of fishing opportunities on the refuge may result in some impact to open water and wetland dependent birds. Such negative impacts to birds could occur from lost fishing gear, including entanglement in fishing line or ingestion of lead sinkers, hooks, lures, or litter. Ingested tackle may be toxic or cause damage or penetration of the mouth or other parts of the digestive tract that may result in impaired functioning or death. Lost fishing tackle such as fishing lures may harm waterfowl and waterbirds that become impaled by a hook. Fishing line may also become wrapped around body parts and hinder movement (legs, wings), impair feeding (bill), or cause a constriction with subsequent reduction of blood flow and tissue damage. Any introduction of fishing would require careful monitoring of litter and its impact on wildlife

4.8 Impacts on Fisheries

The refuge supports a relatively diverse fish community with at least 21 documented species. The refuge is primarily host to a warmwater fishery, with some cold water species existing near the refuge border (i.e.,

within Primrose Brook). Among the coldwater species identified are the non-native brown trout (*Salmo trutta*) and native brook trout (*Salvelinus fontinalis*). Although a comprehensive inventory of fish species inhabiting the refuge has not been conducted recently; studies of the Lower Passaic-Hackensack River Watershed have been conducted. Approximately 39 species of freshwater fish have been reported in or immediately adjacent to the Great Swamp NWR within the Passaic-Hackensack River Watershed.

The refuge does not support any Federal trust fish species. No anadromous (Clupeids or striped bass) species have been reported within the refuge, as there are significant migratory impediments along major downstream waters (i.e., Great Falls of the Passaic River).

Fishing is the only priority public use ("Big Six" public use) that is not currently authorized on the refuge. Although the refuge has found some evidence of unauthorized fishing, demand for the activity on the refuge has remained low. Some fishing opportunities exist adjacent to the refuge and nearby.

We evaluated the benefits of our actions that would conserve, restore, improve, or increase habitats of fish species likely to utilize refuge habitats:

- Managing and restoring bottomland, upland, riparian, and floodplain forests; scrub-shrub; grasslands; open waters; and non-forested wetlands and emergent marsh.
- Controlling invasive species.
- Increasing public awareness through environmental interpretation and wildlife-dependent recreation.

We evaluated the potential for the proposed actions to cause adverse effects on habitats of fish:

- Opening fishing in select areas of the refuge.
- Impacts on habitat quality from the construction or expansion of facilities.
- Potential impacts from spraying of invasive species and impoundment water level manipulation.
- Construction of additional wildlife observation infrastructure, such as trails, observation towers, and viewing blinds.

4.8.1 Impacts on Fisheries That Would Not Vary by Alternative

Benefits

Many of the same management actions for protecting wetlands and other species, such as controlling non-native invasive plants and providing or improving vegetated buffers around wetland-upland interfaces and riparian edges, are actions that would take place regardless of which alternative we select, and would not only benefit wetlands, but the fish species that depend upon good water quality and a well-functioning wetland ecosystem.

Where floodplain forests are found adjacent to open water, the debris from trees and other vegetation falling into the water provides cover and food. Trees along streams and adjacent to open water also helps

lower water temperatures. Many related benefits of floodplain forests are also described under the section on hydrology and water quality.

Adverse Impacts

Overall, the effects from public use (both current and anticipated) are not likely to have an impact on fisheries utilizing open water and wetland habitats on the refuge. Other sources of environmental contamination can be created by stormwater runoff from surrounding lands and the watershed. While it has never happened on the refuge, the use of pesticides in invasive species control could potentially cause small localized and temporary contamination in the event of a spill or misapplication. Glyphosate is nearly non-toxic to fish which generally excrete the chemical in an unchanged form (USEPA 1987). Glyphosate does have a high solubility rate in water (Schuette 1998). However, the potential for glyphosate to accumulate in the tissues of aquatic invertebrates or other aquatic organisms is considered low (PIP 1984). Triclopyr is not labelled for aquatic applications and is toxic to fish at high concentrations. Residues are not persistent (Berisford et al. 2006), however, and dissipate rapidly in the environment (Johnson et al. 1995; Woodburn et al. 1993; Petty et al. 2001; Kreutzweiser et al. 1995). We would continue to employ BMPs in terms of applicator training, pesticide selection, use, spill prevention, and spill response to avoid impacts from pesticide contamination. Since glyphosate strongly adsorbs to soil and sediment and dissipates rapidly in the water column, spill cleanup would involve primarily excavation and containerization of contaminated soil or sediment. Due to its higher toxicity in aquatic systems (than glyphosate), triclopyr spills would require containment by absorbing with sand, vermiculite or other inert absorbent before placement of contaminated material in appropriate container for disposal. Large spills might require diking using absorbent or impervious material such as clay or sand and recovery of as much free liquid as possible for reuse. Absorbed material would be allowed to solidify, then scraped up for disposal.

4.8.2 Impacts on Fisheries under Alternative A (Current Management)

Benefits and adverse impacts to fisheries are the same as those discussed in *Impacts That Would Not Vary by Alternative*.

4.8.3 Impacts on Fisheries under Alternative B (FWS-Preferred Alternative)

Benefits

The consolidation and reconfiguration of habitat types will include the conversion of isolated, small, or difficult to manage brushland and grassland fields to later successional stages or forest. The consolidation of habitats will result in a long-term reduction in maintenance efforts, which will ultimately reduce the potential for water pollution due to leaks and exhausts from equipment. Additional forest cover will likely improve water quality by increasing nutrient and contaminant uptake.

This alternative would expand environmental education and interpretive opportunities. Some programs will be designed to promote awareness on regional issues, including water quality, watershed protections, and climate change. Maintaining and expanding a network of partnerships is the largest component to improving refuge water quality under this alternative.

Under alternative B, we would increase monitoring, EDRR, and control of invasive species, including aquatic invasive species. Management of aquatic invasive species will help protect and maintain the ecological health of our streams and fisheries.

Refer to section 4.3.3, *Impacts on Hydrology and Water Quality under Alternative B* above for additional information.

Adverse Impacts
Habitat management, consolidation and reconfiguring, and restoration of forests, brushlands, and grasslands may result in short-term disturbances to soil. The most disturbances will likely occur during the reconfiguration of habitat patches and removal of hedgerows. This alternative also proposes the construction of additional trails and new wildlife viewing facilities, such as observation towers. The use of BMPs, including sediment and soil erosion controls (see 4.3.1, *Impacts on Soils That Would Not Vary by Alternative*) would be implemented during any construction to minimize the release of sediment into environmentally sensitive areas, such as wetlands and waterbodies. In addition, we would not perform any activity that may introduce sediment into a stream or cause a stream to become turbid during the NJDEP's recommended timing restriction of April 1 through June 30 for warmwater fisheries. As a result, minimal adverse impacts are anticipated from proposed construction projects.

Alternative B anticipates an increase in refuge visitation over the next 15 years; however, at this time, increased public use is not likely to have an impact on fisheries utilizing open water and wetland habitats on the refuge. We would monitor and periodically assess roads, trails and facilities for evidence of erosion. If any public use causes evident and unacceptable adverse impacts, the refuge would limit or discontinue the use.

4.8.4 Impacts on Fisheries under Alternative C

Benefits
This alternative proposes to maximize natural regeneration, which would provide additional forest and late successional vegetation communities. This would likely improve water quality by lowering water temperatures, filtering out sediments and contaminants, preventing stream bank erosion, and increasing the water's capacity to retain DO.

Although all alternatives would continue to maintain relationships with partners to provide consistent watershed protection in the communities surrounding the refuge, alternative C provides the greatest emphasis on partnerships and efforts that expand unifying ordinances and legislation to protect the GSW.

Under alternative C, Pools 3A and 3B would be allowed to succeed to natural marsh and scrub shrub wetlands. Allowing natural regeneration to occur within these impoundments will likely improve water quality by increasing nutrient and contaminant uptake.

Adverse Impacts
Pools 3A and 3B are heavily vegetated and contain areas of shallow water. Some fish may reside in the impoundments; therefore, impacts to individual species may occur due to changes in hydrology from the removal of boards from water control structures. Pool 3A contains an emergency overflow that discharges to the Passaic River and Pool 3B drains directly to the river through a water control structure; therefore, the removal of boards from these water control structures has the potential to result in minor, temporary increases in turbidity in the Passaic River as water is released from the impoundments.

Removal of boards would be conducted in a controlled fashion, over an appropriate period of time, and under appropriate (non-flooding) conditions. These precautions would eliminate the possibility of a rapid

change in water levels or a rapid release of sediments into the Passaic River. This carefully controlled activity, relative to the large drainage area and surface water volume of the Passaic River, would have short-term localized and negligible impacts on the River and associated watershed.

In general, the refuge would use BMPs, including soil erosion and sedimentation controls, as part of all construction projects to minimize the impacts to fisheries.

Impacts due to programs, expansion or construction of facilities, maintenance, and visitation would be similar to those discussed under section 4.8.3, *Impacts on Fisheries under Alternative B.*

4.8.5 Impacts on Fisheries under Alternative D

Benefits

Alternative D would provide visitors with fishing opportunities in select areas of the refuge. Fishing would create isolated negative impacts for some individual fish and would increase potential for adverse impacts associated with increased public use (e.g., littering, introduction of non-native fish or aquatic invasives, etc.); however, we feel that connecting people to nature through this activity would help encourage habitat conservation over time.

Adverse Impacts

Similar to alternative B, alternative D anticipates an increase in refuge participation and visitation; however, alternative D would most likely result in slightly higher numbers of public use visitation when compared to alternative B.

By providing fishing opportunities, we would have impacts to individual fish. Anglers on the refuge would be required to comply with State fishing regulations, which are intended to protect fish populations. While we encourage catch and release because of the potential contaminants present in game fish, this also helps maintain local fish populations. We feel that the long-term protection benefits gained by connecting people to nature through this public use do not affect the health of fish populations as a whole and outweigh the adverse impacts on individual fish. Regardless of the alternative, we would continue to employ a range of management tools to achieve our objectives in managing for the improved health and integrity of open water and wetland habitats.

As mentioned above, fishing would increase the potential for adverse impacts associated with increased public use, such as littering (trash, fishing line, and other tackle) and inadvertent introduction of aquatic invasives. Several aquatic invasives are becoming problematic in New Jersey, including Eurasian watermilfoil (*Myriophyllum spicatum*), didymo or “rock snot”, water chestnut (*Trapa natans*), and Hydrilla (*Hydrilla verticillata*). In addition, accidental or deliberate introductions of non-native fish through public fishing may negatively impact native fish populations. The refuge will provide educational outreach and signage on these subjects, and minimize impacts associated with non-native species introductions or aquatic invasives, if they occur, through EDRR methods.

Providing fishing opportunities may lead to unnecessary wildlife hazards from lost fishing gear, including ingestion of lead sinkers, hooks, lures, or litter, or entanglement in fishing line or hooks. Lost fishing tackle may harm waterfowl, kingfishers, herons, and other birds by catching on and tearing skin. Fishing line may also become wrapped around body parts and hinder movement (legs, wings), impair feeding (bill), or cause

a constriction with subsequent reduction of blood flow and tissue damage. Birds may also ingest sinkers, hooks, floats, lures, and fishing line. Ingested tackle may be toxic or cause damage or penetration of the mouth or other parts of the digestive tract that may result in impaired function or death. The refuge would provide education and outreach on the hazards of fishing tackle, and encourage the use of lead-free weights and fishing tackle and biodegradable fishing line.

Effects of construction and restoration projects would be similar to those described under alternative B.

4.9 Impacts on Mammals

Mammals in the vicinity of Great Swamp NWR occupy a diverse array of habitat types and food webs. As a taxonomic group, mammals benefit from refuge land protection and management of upland, bottomland, riparian, and floodplain forests; grasslands; managed and naturally-occurring scrub-shrub fields; open water; and wetlands. Likewise, refuge habitats would benefit from careful attention to the impacts on mammals resulting from any of its activities.

With exception to a few species, mammals on the refuge consist largely of relatively common species found across the Mid-Atlantic. Most of these species are able to use a variety of wetland or terrestrial habitats, and their populations on the refuge would not be expected to change under any of the alternatives.

Great Swamp NWR is documented as having maternal roost colonies of Indiana bats, a State- and federally listed endangered species. Roosting by Indiana bat occurs within the Management and Wilderness Areas of the refuge where an interspersion of forests, shrubland, open water, and wet meadow exists (Kitchell 2008). Pregnant or lactating bats forage primarily within wooded or riparian corridors, streams, associated floodplain forests and impounded bodies of water; however, they will sometimes use hedgerows, upland forest, early successional fields and croplands (Kitchell 2008). Other bat species that have been documented at the refuge include: little brown, tri-colored, Northern long-eared, big brown, Eastern small footed, hoary, silver haired, and Eastern red bats. As discussed in previous chapters, more than 5.5 million hibernating bats have died since WNS was documented in the winter of 2006-2007 (USFWS 2012d); see chapter 1, section 1.4.14 and chapter 2, section 2.6.1 for details. The majority of bats dying in the Northeast have been little brown bats; however, WNS has also affected tri-colored bat, Northern long-eared bat, Eastern small footed bat, Indiana bat, and big brown bat (USFWS 2010c).

As discussed in section 1.4.14, potential declines were documented at the refuge post-WNS; however, detecting WNS related impacts on the maternity colony is extremely difficult in absence of substantial baseline data and significant mist netting survey efforts. Data collected at the refuge between 2006 and 2010 indicates that peak emergence counts showed a potential decline in Indiana bat colony size. Although few bats showed evidence of wing scarring, significant changes in both the bat population and in the proportion of reproductive females were evident following the onset of WNS. Survey results also indicated substantial declines in little brown bat populations; declines in Indiana bat and Northern long-eared bat populations; and significant increases in big brown bat populations after the onset of WNS (Kitchell and Wight undated). We are concerned about the status of our cave hibernating bats given the presence of WNS and the important role bats play in the foodweb and ecosystems.

River otters and mink have also been identified in the streams and rivers on and adjacent to the refuge. The river otter was once extirpated from the Great Swamp NWR until it reappeared in the 1970s. The refuge's streams and open water habitats provide suitable habitat for these two species, as well as numerous other wildlife species, including but not limited to black bear, muskrat, beaver, and raccoon.

We evaluated the benefits of our actions that would conserve, restore, improve, or increase habitats of mammal species likely to utilize refuge habitats:

- Managing and restoring an interspersion of bottomland, upland, riparian and floodplain forests, open water, grasslands, and brushlands.
- Controlling and monitoring invasive species.
- Increasing public awareness through environmental interpretation and wildlife-dependent recreation.

We evaluated the potential for the proposed actions to cause adverse effects on habitats of mammals:

- Management of existing and proposed changes to the hunting program (e.g., opening deer archery season).
- Disturbance to mammals from public use.
- Potential impacts from treating invasive species, forest restoration, reconfiguration and consolidation of habitats, and water level manipulation of impoundments.
- Construction of additional wildlife observation infrastructure, such as observation towers.

4.9.1 Impacts on Mammals That Would Not Vary by Alternative

Benefits

Our strategies for habitat improvement measures and controlling invasive or nuisance species hold the potential for impacts on mammals, and would continue regardless of the alternative we select. Each management action indirectly benefits mammals over the long term by ensuring the continuation of quality natural habitats on the refuge. Ongoing management activities, such as invasive species management and inventory and monitoring programs, would continue to be completed in a manner that would minimize potential impacts to individual species. We will continue to allow dead trees and snags to persist (i.e., no cutting or removal) for various wildlife species, especially bats, woodpeckers, owls, and other wildlife species.

We will continue to monitor and control white-tailed deer. This will benefit the deer herd and other wildlife species by improving the quality of habitat and reducing property damage. Other furbearers and rodents will benefit from the habitat diversity and quality, and promotion of native plants species emphasized across all alternatives. Expanded and improved forest corridors on the refuge and locally via refuge land protection partnerships will benefit bats and aquatic or wetland mammals, such as river otter and mink. Beaver, when determined to be a nuisance because of undesired flooding of adjacent private property or refuge lands, will continue to be relocated to areas of the refuge where they are less likely to be a problem.

Adverse Impacts

Regardless of the alternative, we would continue to employ a range of management tools to achieve our objectives in managing for the improved health and integrity of terrestrial and wetland habitats. We would use these tools only when and where appropriate, and only with the proper training and focused application to avoid adverse impacts.

Examples of management techniques include control of invasive species, brushland cutting, and mowing activities associated with roadsides, facilities, or habitats. Areas where invasive species control or habitat diversity objectives warrant clearing an entire monotypic stand occur on a very small scale. The timing of pesticide applications varies depending on target species, treatment method, and environmental conditions. Occasionally, eliminating large monocultures of a non-native species is necessary, but in most cases, the treatments are highly targeted and spot-specific. Treated sites soon re-grow, and mammals still have similar habitat or other areas nearby for alternate use; therefore, this activity is expected to have minimal negative impacts on some individuals that are localized and short-term.

Hunting of white-tailed deer would occur under all of the alternatives. The 2011 Annual Deer Hunting Program indicates that hunting was allowed on approximately 6,376 acres of the refuge (i.e. 82 percent of the refuge) with the remaining area designated as safety zone or no entry. The maximum hunter density is approximately one hunter per 32 acres. To maintain quality habitat within the refuge, the refuge manages for a deer population density of 18 to 20 deer per square mile (USFWS 2011e). In the event that the population density falls below desired levels, as evidenced by an annual evaluation of harvest data and pre-hunt spotlight surveys, bag limits and harvest strategies are adjusted to reduce harvest pressure on the herd. For the 2009 deer season, 113 deer were harvested, including 48 bucks and 65 antlerless animals (does and fawns). For the 2010 deer season, a total of 121 deer were harvested, including 56 bucks and 65 antlerless animals. For the 2011 deer season, a total of 42 deer were harvested, including 22 bucks and 18 antlerless animals. The significant decline in harvested deer was due to an outbreak of Epizootic hemorrhagic disease (EHD) in the summer of 2011 resulting in a significant deer die-off (refer to section 3.1.16 for information regarding EHD). Similar temporary declines were also evident in 2007 and 2008 deer harvest numbers following an EHD outbreak in 2007. In both cases, bag limits and harvest strategies were adjusted to reduce the number of adult does harvested. For example, rather than allowing an unlimited number of antlerless deer and one antlered buck per hunter as had been the case from 2002 to 2006, from 2007 to 2011, the bag limit was reduced to two deer total, with a limit of one antlered buck per hunter; to help maintain a more natural buck age-class distribution, shotgun hunters were required to shoot an antlerless deer first, before harvesting a buck. However, following the 2011 season, the bag limit was further reduced to one deer of either sex per hunter. In general, recent levels of harvest are expected to maintain deer populations within the refuge to a density that reduces impacts to the forest understory and allows for forest regeneration. Although the refuge's hunt does impact individual deer on the refuge, it is unlikely that current levels of deer harvest would negatively impact the overall deer population of New Jersey. In fact, deer populations have reached problematic levels in numerous areas of the State, including communities near the refuge, but beyond the influence of the refuge's annual harvest. New Jersey's deer

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population was estimated (prior to hunting season) to be approximately 110,000 in 2010, although populations vary geographically. To elaborate, New Jersey is sub-divided into 70 Deer Management Zones. The refuge comprises Deer Management Zone 38 and the annual refuge deer hunt is administered by the FWS in cooperation with NJDFW. The refuge is surrounded by State Deer Management Zone 13, which includes portions of Morris, Somerset, and Union Counties. State regulations in Zone 13 are liberal due to the overabundance of deer. For example, in 2011-12, a total of 1,706 deer were harvested from Zone 13. The State archery season spanned 135 days over three seasons, with a bag limit of 3 bucks and an unlimited number of antlerless deer per hunter; the muzzleloader season spanned 62 days, with a bag limit of one buck and unlimited antlerless deer; and the shotgun season spanned 50 days over two seasons, with a bag limit of two bucks and unlimited antlerless deer. Additionally, there was a 1-day youth archery hunt and 1-day youth firearm hunt, with bag limits of one deer of either sex (NJDFW 2012). Having an annual, limited firearm season for deer on the refuge (currently 5 days with a bag limit of 1 deer of either sex per hunter) coupled with adding a limited fall archery season (initially 5 days with a bag limit similar to that of the firearm season) will not impact New Jersey's deer population. In fact, in the communities surrounding the refuge, while a huntable deer population exists, there are limited public hunting opportunities, as the majority of land surrounding the refuge is developed and privately owned. Because there are so few large public places open for hunting, the refuge actually is providing a large contribution of deer control, which is not only benefiting refuge lands, but also the adjacent communities.

Overall, the effects from public use are not likely to have a negative impact on mammals. There is the potential for some negative impacts from increased vehicle use associated with greater visitation. Low refuge speed limits would likely keep the number of mammals hit by vehicles very low. An expected increase in visitation may create isolated negative impacts for some individual mammals; however, we feel that connecting people to nature through appropriate wildlife-dependent recreation, such as wildlife observation and photography, would minimize potential impacts and help encourage habitat conservation over time.

4.9.2 Impacts on Mammals under Alternative A (Current Management)

Benefits and adverse impacts to mammals are the same as those discussed in section 4.9.1, *Impacts on Mammals That Would Not Vary by Alternative*.

4.9.3 Impacts on Mammals under Alternative B (FWS-Preferred Alternative)

Benefits and Adverse Impacts

Benefits and adverse impacts to mammals are the same as those discussed in section 4.9.1, *Impacts on Mammals That Would Not Vary by Alternative*. In addition, management changes proposed under alternative B would result in approximately 100 acres less of grassland fields. In the short-term, there could be slightly less feeding habitat for bats, which forage over fields adjacent to woodlands, and less food and cover for open-habitat small mammals. However, significant adverse impacts to these species are not anticipated because the refuge would continue to provide sufficient roosting and foraging habitat for bats and small mammal populations are abundant. In fact, in the long-term, more bat roosting habitat would be available as trees mature and some die becoming valuable snags for these species. Moreover, under this alternative, where feasible, hedgerows less than 25 feet wide would be removed to create larger grassland patch sizes. Hedgerows provide important travel and feeding habitat for some species of carnivores (e.g., black bear, red fox, gray fox, and coyote); removing long hedgerows that connect forest patches could temporarily displace individuals or reduce home range quality for these species.

The introduction of a fall archery hunt for white-tailed deer will result in adverse impacts to individual deer on the refuge. This hunt would precede the current shotgun and muzzleloader season, and would occur within the Wilderness Area and on refuge lands south of White Bridge Road. Populations of hunted wildlife will be closely and regularly monitored. The target goal is to maintain levels of deer at 18 to 20 per square mile. Parameters of the hunt, including seasons and limits, will be adjusted as needed to maintain healthy populations of hunted wildlife.

4.9.4 Impacts on Mammals under Alternative C

Benefits and adverse impacts to mammals are similar to those discussed in section 4.9.1, *Impacts on Mammals That Would Not Vary by Alternative.* There could be less forage habitat for bats, which forage over fields adjacent to woodlands or over impoundments, and less food and cover for open-habitat small mammals. In the long-term, more bat roosting habitat could be available as trees mature and some die becoming valuable snags. As mentioned above, pregnant or lactating bats forage primarily within wooded or riparian corridors, streams, associated floodplain forests and impounded bodies of water; however, they will sometimes use hedgerows, upland forest, early successional fields and along croplands. Although alternative C proposes to maximize natural regeneration, which includes allowing Pools 3A and 3B to succeed, the refuge would continue to provide sufficient roosting and foraging habitat for bats. In addition, in the long term, more bat roosting habitat would be available as trees mature and some die becoming valuable snags. Therefore, adverse impacts to bats are not anticipated.

4.9.5 Impacts on Mammals under Alternative D

Benefits

Benefits to mammals under alternative D are the similar to those discussed in section 4.9.3, alternative B. Alternative D will provide the maximum number of environmental education and interpretation programs, which will raise public awareness and support for wildlife protection and habitat conservation.

Adverse Impacts

Alternative D anticipates the greatest increase in refuge participation and visitation over the next 15 years. This alternative emphasizes, to a greater extent than alternative B, the expansion of infrastructure, including the creation of new trails, observation towers, and parking lots. In addition, seasonal pedestrian access would be provided on existing service roads around Pools 3A and 3B; however, these areas would be closed to the public during migration or other time periods where wildlife may be sensitive to disturbances. If any public use or new infrastructure results in evident and unacceptable adverse impacts to mammals or other wildlife species, the refuge would move the activities to secondary sites, restrict, or discontinue the use altogether.

Adverse impacts to mammals are expected to be similar to or slightly greater than those discussed in section 4.9.1, *Impacts on Mammals That Would Not Vary by Alternative,* and section 4.9.3, *Impacts on Mammals under Alternative B.*

4.10 Impacts on Amphibians and Reptiles

The habitats of Great Swamp NWR support a diversity of amphibians and reptiles common to the northeastern United States (see chapter 2, section 2.6.5). Protection and management of emergent wetlands, riparian corridors, vernal pools, forests and successional habitats will benefit these species. Refuge priorities related to the long term viability of herptile populations would include the continued protection of regional water quality, control of invasive species, genetic viability, monitoring of chytrid fungus and other disease, and attention to ecological changes associated with global climate change.

The refuge currently provides critical habitat to and supports populations of certain threatened and endangered reptiles and amphibians including the federally-threatened bog turtle, the State-listed wood turtle and the blue–spotted salamander. These species and the protection of their habitats will continue to be prioritized under all alternatives.

We evaluated the benefits of our actions that would conserve, restore, improve, or increase habitats of amphibians and reptiles likely to utilize refuge habitats:

- Consolidation and maintenance of forests, scrub-shrub, grasslands, open water, and wetlands.
- Management and restoration of spring-fed, emergent wetlands for bog turtle.
- Controlling invasive species.
- Maintenance and restoration of vernal pool habitats.
- Increasing public awareness through environmental education and interpretive programs.
- Changes in management of impoundments, including allowing natural regeneration of Pools 3A and 3B.

We evaluated the potential for the proposed actions to cause adverse effects on habitats of amphibians and reptiles:

- Disturbance of herptile species from increased visitation, public use, and vehicles.
- Potential impacts from the application of pesticides to treat invasive species, forest restoration, or impoundment water level manipulation.
- Impacts from construction of new infrastructure, including facilities, trails, and wildlife observation towers.

4.10.1 Impacts on Amphibians and Reptiles That Would Not Vary by Alternative

Benefits

Long-term improvements in water quality would benefit amphibian and reptile species, among others. The greatest water quality improvements to Great Swamp NWR will ultimately be achieved through partnerships, which promote continued watershed protection.

Under all alternatives, there will be continued habitat management to benefit populations of threatened and endangered herptile species, particularly the bog turtle. We would continue to maintain and restore spring-fed emergent wetlands to directly benefit the bog turtle, a year-round inhabitant of the refuge. Maintenance of these spring-fed habitats would also benefit a suite of other herptiles including spotted turtle, box turtles, pickerel frogs, leopard frogs and many additional species that utilize these habitats. Maintaining and improving key forest areas, grasslands, emergent wetlands and riparian habitats will ensure the continued protection of foraging, hibernating and nesting habitat of wood turtles and other herptiles that utilize similar habitats.

Protection of floodplain and vernal pools would continue to benefit amphibians and reptiles that rely on these sites for breeding habitat, including the State-endangered blue spotted salamander and the spotted turtle. The continued management of deer and invasive species across the refuge will improve natural regeneration of native ground cover, shrub vegetation, and other microhabitat conditions utilized by salamanders, snakes, and other herptiles.

Open grasslands adjacent to woodlands and forest are beneficial to box and wood turtles, which emerge to bask in the sun and feed on vegetation and invertebrates. These grassland areas also provide basking and foraging opportunities for common snake species at the refuge.

On- and offsite efforts to improve water quality and reduce non-point source pollution through protection of riparian buffers and wetlands will benefit frogs and other aquatic herptiles. Refuge partnerships and programs that focus on herptiles, their habitats and associated issues such as water quality will have a beneficial impact on the protection of these species. We will continue to monitor the success of habitat management for all threatened and endangered herptile species on the refuge.

Adverse Impacts

Some large-scale threats to herptiles, such as spread of chytrid fungus and climate change are global in nature and require cooperation between agencies, organizations, and nation to prevent impacts to herptile populations. The refuge, particularly through education, outreach and partnerships, will work to control and mitigate these larger regional herptile impacts while continuing to protect refuge herptile populations.

Climate change related issues such as increased rainfall or drought or extreme temperatures presents a major threat to amphibians and reptiles on the refuge and elsewhere. The refuge will carefully monitor sensitive herptile populations and apply adaptive management as needed to prevent impacts to these species.

Introduced diseases from pet wildlife or other sources are a constant threat to herptiles in New Jersey's urban environments and elsewhere. An amphibian disease of major concern in New Jersey is the chytrid fungus (see chapter 2, section 2.1.5). This deadly disease infects the skin of amphibians and is found in populations of frogs and salamanders around the world. The refuge in cooperation with NJDEP will continue to monitor amphibian populations for the disease to determine its impact and methods to potentially control the fungus. The refuge is also actively monitoring for ranavirus. Ranaviruses are members of the *Iridovirus* family and may infect insects, fish, amphibians, and turtles. Ranavirus infection in amphibians typically causes death in larvae or recently metamorphosed individuals and infected individuals often have ulcers on their skin. Turtles typically show signs of skin lesions, respiratory distress,

and multiple organ failure. The impact of ranaviruses on amphibian populations has been compared to the chytrid fungus.

Amphibians and reptiles would likely continue to be impacted by environmental contaminants, unrelated to refuge activities, known to occur in waters around the refuge. These may be from non-point source pollution from surrounding development or contaminants from historic landfills, such as Rolling Knolls. As mentioned above, strong partnerships that forge protections and legislation within local communities is the most effective way to improve refuge water quality and minimize impacts to aquatic herptiles.

The general maintenance of facilities, including the mowing of grass around buildings, will potentially result in minor impacts to herptiles. The construction of new facilities would have minor or temporary impacts primarily associated with soil disturbance, temporary increases in traffic, and use of heavy machinery. During these activities, BMPs, including well maintained exclusion fencing (when appropriate) and soil erosion and sediment control measures, would be employed during construction activities to protect herptiles and their habitats.

Management activities, such as the continued maintenance of grasslands for the purpose of achieving habitat and public use goals would result in minor impacts to herptiles. We would continue to avoid mowing in early successional habitats and wet grasslands during the active season when amphibians or reptiles may be breeding or seasonally moving through transitional zones.

Some amphibians and reptiles may be present during the application of pesticides and as a result, herptiles may come into contact with spray drift. We do not expect this to occur frequently and will continue to only use aquatically-labelled products in wetland areas in ways that minimize drift and non-target impacts. Invasive species management, inventory, and monitoring programs would continue to be completed in a manner that would minimize potential impacts to herptile species. We would continue to employ BMPs in terms of applicator training, pesticide selection, use, spill prevention, and spill response to avoid impacts from pesticide misapplication or contamination. As described in Section 4.9.1, spill cleanup would consist of containment by diking, use of absorbent materials, and excavation of contaminated soil. Adverse impacts would be localized and short-term.

We would expect some negligible impacts associated with the disruption or minor displacement of some herptile species from public use of trails and outdoor facilities. These impacts would vary slightly under all alternatives and would be slightly greater under alternative D. For example, public use may result in temporary displacement of snakes that use trails, water edges, other habitat edges, or structures for shelter, thermoregulation, and foraging.

Vehicle usage on roads within the refuge results in some unavoidable mortality and impact on herptiles under all alternatives. Particular times of the day and during certain conditions and seasons, herptiles are especially vulnerable to vehicular traffic. Examples include sunning snakes during morning hours, gravid pond turtles nesting in the spring, and amphibians moving to or from breeding grounds on warm rainy nights in the spring and summer. We place “Turtle Crossing” signs along high traffic refuge roads during peak turtle breeding season to alert the public. We have also recently started participating in the “Wildlife Guardians Project” to identify and protect important herptile road crossing locations on and around the refuge. Staff, interns, and volunteers are also trained in methods to protect or move herptiles found on roads. Other road related impacts come from de-icing agents and chemicals leaking from automobiles on township roads. The refuge only uses de-icers when necessary to protect public safety. In areas adjacent

to sensitive sites such as ponds or streams, we only use CMA which is more benign to the environment than rock salt. This contamination may affect surrounding water quality and consequently herptiles, particularly amphibians, utilizing aquatic habitats.

4.10.2 Impacts on Amphibians and Reptiles under Alternative A (Current Management)

Benefits and adverse impacts to amphibians and reptiles would be the same as those discussed in section 4.10.1, *Impacts on Amphibians and Reptiles That Would Not Vary by Alternative*.

4.10.3 Impacts on Amphibians and Reptiles under Alternative B (FWS-Preferred Alternative)

Benefits

Amphibian species (e.g., red-backed salamanders, *Ambystoma* salamanders, wood frogs, chorus frogs, spring peepers) that utilize forested wetlands may benefit from regeneration of forest due to the expansion of canopy cover and additional microhabitat opportunities, such as fallen trees, that provide shelter and moist conditions suitable for these species.

USFWS/Frank Miles

Expansion of bog turtle habitat, including the selected opening of canopy and suppression of woody and invasive species, will provide increased basking and nesting opportunities for bog turtles and a suite of other herptiles that also utilize these emergent wetland environments. Expansion and restoration of bog turtle habitat will be conducted in ways that minimize impacts to other wildlife and are known to be effective.

The use of prescribed burning under this alternative would benefit herptiles by maintaining high quality grassland areas for basking species, such as wood and box turtles, while minimizing disturbance to soil that is associated with mowing alternatives. The proper maintenance of grasslands will provide a diversity of invertebrate prey opportunities for foraging herptiles. Prescribed burning would likely occur during ability and a frequent preference (by many species) for shelter under boards and other construction refuse, reptiles and amphibians are particularly vulnerable to direct mortality on construction sites from equipment or vehicles. There is also potential for secondary impacts aquatic or wetland herptile habitats from runoff or sedimentation.

Sensitive habitats or known amphibian and reptile breeding sites would be avoided for all construction. BMPs will be employed at the refuge to reduce the probability of direct and indirect impacts to herptiles. To avoid direct impacts, herptile exclusion fence will be properly installed and maintained to keep species out of the construction site. Inspection and clearing of the site for any herptiles should be completed by a staff member or biologist before machinery is utilized and periodically during construction. Removal of potential herptile shelters such as old debris piles or logs should occur before construction. All animals within the site can be relocated to a nearby safe and appropriate location on the refuge. Periodic inspection of the fence by a biologist or qualified individual will ensure that any breaches or compromises are immediately fixed.

By practicing BMPs and avoiding sensitive habitat areas, the displacement of common herptiles by the development of additional infrastructure is expected to have only short-term, localized and negligible adverse impacts on populations.

Increased visitation resulting from the expansion of infrastructure and programs may result in increased impacts to herptiles. Increased foot traffic would likely result in more frequent displacement or disturbance of herptiles in public access areas. Any increase in vehicular traffic will result in a greater probability of road mortality than under alternative A. Impacts from traffic or other public use activities may be reduced by increasing visitor education and awareness of low mobility herptiles through signage and programs.

Changes and disturbances to vegetation resulting from habitat consolidation under alternatives B, C, and D, such as allowing natural regeneration of select brushland or grassland areas, would result in negligible impacts to herptiles. It would be expected that these changes in vegetation may displace some species, such as common refuge snakes, that use edge habitats for sunning and foraging. Because such habitats will remain common at the refuge and because natural regeneration is a slow process, we do not anticipate these activities will be a limiting factor to any population of herptiles onsite. Any removal or disturbance of rocks or woody debris during management operations may result in minor impacts to herptiles utilizing these areas as shelter.

4.10.4 Impacts on Amphibians and Reptiles under Alternative C

Benefits

The succession of the Pools 3A and 3B may result in minor changes to herptile usage, which would result in a net benefit to herptile species. The creation of increased shrub swamp or marsh habitat may benefit both wood and spotted turtles that may use vegetated wetland habitats of intermediate amounts of standing water for foraging and basking. Generalist aquatic species, including painted turtles, snapping turtles, green frogs, spring peepers and water snakes, would be expected to continue utilizing these habitats.

Adverse Impacts

With regard to grassland and forest management, adverse impacts to amphibians and reptiles would be similar to those discussed under section 4.10.2, *Impacts on Amphibians and Reptiles under Alternative B*. We would anticipate only negligible differences in some herptile behavior patterns and habitat usage based on the terrestrial vegetation variations between this alternative and alternative B.

As a result of natural regeneration in Pools 3A and 3B, some shifts in herptile habitat usage would be associated with changes in hydrology and vegetation structure, density and composition. Based on the species requirements and the amount of available open water and wetland habitat, we do not anticipate any negative impacts to populations of herptiles as a result of the proposed natural regeneration of these habitats.

Impacts related to increases in visitation would not change from alternative A as efforts under this alternative are not designed to substantially increase visitation numbers.

4.10.5 Impacts on Amphibians and Reptiles under Alternative D

Benefits
The primary distinguishing benefit to herptiles under alternative D is the expansion of education and interpretive programs. Programs that focus on wetlands, watershed management, and reptiles and amphibians can have a direct benefit to populations of these species. These programs, especially when conducted in partnerships with other institutions or organizations involved in herptile conservation, will benefit these species on a regional scale by raising public awareness and support for wildlife protection and habitat conservation.

Adverse Impacts
It is anticipated that the significant increase in visitation and participation under alternative D would result in greater increases to reptile and amphibian disturbance and mortality than under any other alternative. These impacts would be related to increased foot and automobile traffic, as discussed under section 4.10.1, *Impacts to Reptiles and Amphibians That Would Not Vary by Alternative.* Increased mortality during the nesting season would likely occur as a result of increased vehicles. The introduction of fishing would likely result in increased disturbance of herptiles that utilize the edges of open water habitats in fishing access areas. Species such as painted turtles, water snakes and various frog species may be displaced or disturbed by increased activity within these areas.

4.11 Impacts on Invertebrates

This broad group is the least studied within the ecosystems around the refuge. Yet, they are likely the most important contributor and modifier in the functioning of those ecosystems and related food webs. Invertebrates play key roles in those ecosystems as:

- Detritivores, returning nutrients and basic elements back to the soil and the ecosystem.
- Pollinators, without which many sexually reproducing plants would not be able to propagate.
- Prey for other species in the food web, such as the millions of mosquitoes upon which fish, frogs, birds, and bats feed.
- Predators, such as spiders, that help keep rapidly producing insects in check.
- Filters of sediment, nutrients, and other contaminants, making conditions better for fish and aquatic life.

We evaluated the benefits of our actions that would conserve, restore, improve, or increase habitats of invertebrates likely to utilize refuge habitats:

- Managing and restoring forests, brushlands, grasslands, open waters, and emergent wetlands.
- Controlling invasive species.
- Increasing public awareness through environmental interpretation and wildlife-dependent recreation on important roles invertebrates play in the ecosystems.

We evaluated the potential for the proposed actions to cause adverse effects on habitats of invertebrates:

- Disturbance from public use.
- Potential impacts from the pesticides, forest restoration, or impoundment water level manipulation
- Construction of additional infrastructure, such as facilities, trails, parking lots, and observation towers.
- Impacts of light pollution from artificial lighting.

4.11.1 Impacts on Invertebrates That Would Not Vary by Alternative

Invasive species control, grounds maintenance, rotational mowing or cutting of managed grasslands and brushlands, and forest health measures are actions common to all alternatives that may impact refuge invertebrates. Invasive species control and grounds maintenance are recurring activities done primarily during the growing season.

Benefits

The refuge's land management provides a wide array of general habitat types and microhabitats that serve as foraging, breeding, and overwintering habitat for many groups of invertebrates. Improving stream water quality will benefit aquatic insects and other invertebrates.

Removing and controlling invasive species allows native plants to reestablish and expand. This especially benefits insects that coevolved with the native plants in our area, particularly those that are host-specific, such as the monarch butterfly, which uses milkweed as the host plant for their eggs. Many species of invasive, non-native plants are not optimal hosts for native insects, and do not contribute to the health or diversity of the pollinator community. Therefore, we presume that removing these non-native plants and planting or allowing native species to regenerate would be beneficial to native invertebrates. The number of native insects that use non-native plant species as host plants is minimal and therefore, removing them would not result in unacceptable losses in the insect populations.

Adverse Impacts

Maintaining refuge grounds currently involves mowing of roadsides, parking areas, walking paths, and small lawn areas. Generally, regularly mowed areas are kept short in vegetation height (less than 6 inches); therefore, they provide very limited sources of nectar, usually clovers. Where grasses and forbs have grown tall, such as along seldom-used roads or paths where they begin to flower and set seed, pollinators and herbivorous insects would be found. Mowing in the warm months, when insects are breeding, may destroy the eggs or pupae attached to leaves, consume adults, remove food sources, or unfavorably alter microhabitat; however, the area we maintain is a very small fraction of the amount of land serving as habitat. Managed grasslands and brushlands are generally mowed in October to avoid impacts to pollinators, birds, wildflowers, and reptiles. Managed grasslands are mowed on a rotational basis on one to four year cycles; therefore, some standing cover is left each year for overwintering insects.

A variety of exotic insects have impacted forests of the Northeastern United States. The gypsy moth has impacted the oak forests of Great Swamp NWR in the past. Other insect species such as the Asian long-horned beetle and emerald ash borer may threaten the refuge tree populations. Control of these species, particularly with the use of insecticide, has the potential to have short-term and localized adverse impacts

on non-target native and beneficial insects. Although the FWS approves the pesticides we use in controlling invasive species because of their relative neutrality on animal life; soft-bodied insects, eggs, pupae, or organisms with permeable skin that come in direct contact with a pesticide or its adjuvants may experience mortality, reduced fitness, or abnormal development.

The consequences of inaction to both insect pests and invasive plants are more likely to result in major, long-term adverse impacts to substantial portions of refuge forests and other vegetated habitats; and consequently the various native invertebrate populations that utilize these habitats.

Since we treat limited portions of the refuge each year to control invasive plants, overall negative effects on invertebrates are expected to be minimal. We only use pesticides that are systemic operants on plants and approved by the EPA as having little or no impact on terrestrial insects. Very few native invertebrates use non-native plants for feeding, breeding, or pupating. We presume that any dependence on those plants is incidental and, therefore, removing them would not result in unacceptable losses in the insect populations. The refuge will continue to follow FWS guidelines and standards when applying pesticides or herbicides (see section 4.2.1). We would consult with forestry experts and FWS IPM specialists for recommendations on the least harmful products and methods to avoid impacts to non-target species.

4.11.2 Impacts on Invertebrates under Alternative A (Current Management)

Benefits and adverse impacts to invertebrates are the same as those discussed in section 4.11.1, *Impacts on Invertebrates That Would Not Vary by Alternative*.

USFWS/Mao Lin

4.11.3 Impacts on Invertebrates under Alternative B (FWS-Preferred Alternative)

Benefits

Alternative B would provide an important, direct benefit to pollinating, herbivorous, and predatory insects by managing large tracts of diverse grasslands in the Management Area. We would perform native wildflower plantings in attempt to increase plant and invertebrate diversity. Well-established grasslands possess a diverse variety of plant species and structures that would provide food and cover year round for the annual life cycles of many species. This also benefits small mammals, reptiles, amphibians, and grassland dependent birds.

Under alternative B, we propose to introduce prescribed burning for habitat management, when and where appropriate and compatible. As previously discussed, prescribed burning is a cost-effective and ecologically sound tool for the management of forest, grassland, and wetlands that removes plant residues, controls insects and disease, improves wildlife habitat and forage production, increases water yield, maintains natural succession of plant communities, and reduces the need for pesticides. Prescribed fire increases the production of seed in legumes and grasses in frequently burned areas. Grassland fires cause early green up of warm season grasses, improved seed-germination, and greater production of grasses and forbs. It also increases the production of berries, drupes, and pomes for 2 to 4 years after fire

(Lyon et al. 2000). Fire modifies the invertebrate communities, which may continue to change a few years post burn. Different orders of invertebrates respond differently to fire depending on season and year, but prairies where fires occur in different years and seasons tend to have greater species diversity (Lyon et al. 2000.) Thus, indirect benefits may be derived to invertebrates from variable applications of a refuge fire regime. An indirect benefit is derived through increased habitat quality.

Maintenance of grasslands requires periodic disturbance. Managed grasslands and brushlands are generally mowed in October to avoid impacts to wildflowers, pollinators, birds, and reptiles. It is impossible to manage grasslands without cost to some species, especially above ground insects using plant structures for roosting, egg laying, and development; however, we would not burn or mow all the fields at once, some are left in reserve, and thus some grassland units would remain undisturbed for overwintering insects.

Under this alternative, we would also create 5 acres of habitat specifically for pollinators to promote awareness on the importance of native plants and the key roles of pollinators. Providing additional opportunities for environmental education and interpretation would raise public awareness and support for wildlife protection and habitat conservation.

Adverse Impacts
No additional adverse impacts to invertebrates are anticipated under this alternative.

4.11.4 Impacts on Invertebrates under Alternative C

Benefits and adverse impacts to invertebrates would be similar to those discussed under section 4.11.3, *Impacts on Invertebrates under Alternative B,* except there would be less grassland or grassy cover available to support the insects associated with native forbs and grasses. In addition, Pools 3A and 3B contain areas of shallow water and are heavily vegetated. Under this alternative, both impoundments would be allowed to undergo natural regeneration, which may result in changes in numbers and diversity of insects on a localized level.

4.11.5 Impacts on Invertebrates under Alternative D

Although alternative D anticipates the greatest increase in refuge visitation over the next 15 years, we anticipate that the benefits and adverse impacts to invertebrates would be similar to those discussed under section 4.11.3, *Impacts on Invertebrates under Alternative B.*

4.12 Impacts on Public Use and Access

Based on data collected from 2001 through 2011, refuge visitation ranges between approximately 140,000 and 165,000 visitors per year (Refuge Annual Performance Planning data and T. McFadden, USFWS Great Swamp NWR, pers. com. 2009). The most recent visitation information for the refuge is for FY 2011 (October 1, 2010 through September 30, 2011). During this time period, the refuge reported an estimated 165,000 visitors. Most visitors to the refuge engage in some form of wildlife-dependent recreation. Wildlife observation and photography account for the largest proportion of visits. According to the USGS Visitor Survey (Sexton et al. 2012), wildlife observation (64 percent), including bird watching (62 percent), as the most common use by visitors of the refuge during the course of a year. Hiking (57 percent) and photography (36 percent) were the next most common uses identified during the survey.

4.12.1 Impacts on Public Use and Access That Would Not Vary by Alternative

Benefits

The primary goals of the Visitor Services Program would be to continue working with volunteers and partners to promote the benefits of wildlife and habitat conservation and management, to foster an awareness and appreciation for the refuge and its role along the Atlantic Flyway and within the Refuge System, and to provide quality wildlife-dependent recreational opportunities to visitors. We would continue to provide high quality wildlife observation and photography opportunities by facilitating various forms of access. We would continue to participate in, develop, and present environmental education and interpretive programs. For many residents of the New York City Metropolitan area, refuge staff may be their one and only interaction with the FWS. Under all alternatives, refuge staff would continue to be active in outreach and partnership development, increasingly directed towards urban populations.

Adverse Impacts

We would continue to limit access to ecologically sensitive areas, such as nesting sites during breeding seasons and vulnerable wetlands. While these would result in short-term restrictions on public access and use, we would minimize these restrictions to the extent possible while ensuring proper protection of wildlife and their habitats. We do not anticipate any long-term negative impacts on public use and access.

The presence of dogs can lead to short-term and long-term adverse impacts to wildlife populations. Some wildlife species are particularly sensitive to the presence of dogs and their response to disturbance is amplified above and beyond disturbance effects from recreationists traveling without dogs. Studies have found declines in bird diversity and abundance on trails where leashed dogs were permitted exceeded declines observed from human disturbance alone (Banks and Bryant 2007). In all alternatives, the refuge permits dogs on leash as long as the activity is restricted to Pleasant Plains Road or the parking lots of the Visitor Center and Wildlife Observation Center.

During the firearm hunting season for white-tailed deer, the entire refuge would be closed to all other public use activities; however, during the 1-day youth hunt, only the western half (Management Area) of the refuge would be closed. In recent years, the firearm hunt occurred over a 5-day period in November, beginning with a 1-day youth hunt on Saturday and followed by a 4-day regular hunt the following Wednesday through Saturday. The regular hunt currently coincides with school closings associated with the annual New Jersey Teacher Convention to maximize youth hunting opportunities. Hunting hours will be from one-half hour before sunrise to one-half hour after sunset. Signs would be posted at public access points and the closure would also be publicized in local newspapers. As population surveys are conducted and biological data are collected from harvested deer or turkey and assessed annually, season dates may change and the season length may be extended or reduced.

4.12.2 Impacts on Public Use and Access under Alternative A (Current Management)

Benefits

Under alternative A, we would continue to allow currently approved public uses on currently open refuge lands. These are noted in chapter 3, alternative A. Appendix B documents the refuge manager's justification for why they are deemed appropriate and compatible. Other ownerships nearby or elsewhere sufficiently provide opportunities for other activities not determined to be compatible with the purposes of the refuge.

No major additions or changes in facilities would occur. The refuge would continue to allow already approved public uses. These include wildlife observation and photography, environmental education and interpretation, and hunting.

Adverse Impacts
Adverse impacts to public use and access are the same as those discussed in section 4.12.1, *Impacts on Public Use and Access That Would Not Vary by Alternative*.

4.12.3 Impacts on Public Use and Access under Alternative B (FWS-Preferred Alternative)

Benefits
Under alternative B, the refuge would moderately expand public uses and strive to maintain a better balance among the wildlife-dependent public uses on the refuge. For example, hiking trails would be kept open during the fall archery hunt for white-tailed deer and spring wild turkey hunt, if implemented. Wildlife observation and photography would be enhanced by creating trails, providing additional parking opportunities, expanding the Wildlife Tour Route, and constructing observation towers. We would expand Visitor Center operational hours to 7 days per week year round and increase the number of environmental education and interpretation programs on and off the refuge.

Adverse Impacts
Adverse impacts to public use and access are the same as those discussed in section 4.12.1, *Impacts on Public Use and Access That Would Not Vary by Alternative*.

4.12.4 Impacts on Public Use and Access under Alternative C

Benefits
Benefits on public use and access would be similar to those discussed under section 4.12.1, *Impacts on Public Use and Access That Would Not Vary by Alternative,* except environmental education and interpretative programs would be emphasized and expanded, as described under section 4.12.2, *Impacts on Public Use and Access under Alternative B.*

Adverse Impacts
Adverse impacts on public use and access would be the same as section 4.12.1, *Impacts on Public Use and Access That Would Not Vary by Alternative.* No additional adverse impacts would occur under this alternative.

4.12.5 Impacts on Public Use and Access under Alternative D

Benefits
Under alternative D, public use and access would be maximized to the greatest extent practical, while minimizing impacts to wildlife, through the creation of new trails, observation towers, and parking lots. We would increase open water habitat to improve public viewing opportunities. Contrary to the other alternatives, this alternative would provide public access to view currently off-limits open water areas by allowing seasonal, non-vehicular access along Pool 3A and 3B service roads. Most notably, fishing opportunities, which are not authorized under any other alternative, would be provided in select areas of the refuge. The refuge's hunting program would be expanded as described under alternative B. In addition,

this alternative would maximize public outreach, enhance and develop new environmental interpretation and education programs, aggressively expand partnerships, and increase staff presence at programs and events.

Adverse Impacts

Adverse impacts on public use and access would be the same as section 4.12.1, *Impacts on Public Use and Access That Would Not Vary by Alternative.* No additional adverse impacts would occur under this alternative.

4.13 Impacts on Cultural and Historic Resources

4.13.1 Impacts on Cultural and Historic Resources That Would Not Vary by Alternative

As discussed in section 2.8.1, John Milner Associates, Inc. (JMA) was contracted by the FWS to complete a study of known cultural resources on the refuge. The results of this study were referenced during the planning process. Building off a previous study completed in 1978 (Thomas 1978), JMA completed a document describing the current status of known cultural resources (JMA 2010). The JMA report (2010) identified 123 cultural resources within the refuge's approved acquisition boundary, 100 of which are within or intersect parcels the FWS has acquired interest in or currently owns. The remaining 23 are located within parcels that have not been acquired by the FWS at this time. Thirty-two of the identified cultural resources are considered prehistoric sites (i.e., before 1750), 57 are from the historic era (1750 to mid 1900s), 3 have prehistoric and historic components, and 31 are standing structures. To date, no sites within the acquisition boundary are listed on the National Register of Historic Places (NRHP) or the New Jersey Register of Historic Places. Two sites within the acquisition boundary have been characterized as eligible for listing on the NRHP, one pre-historic site and one standing structure. The pre-historic site was recommended for eligibility based on a single Munsee-incised ceramic shard of the Late woodland period (1300 AD to European Settlement) (Harris and Ziesing 2010). The structure, Baird Tenant House, is a rare intact example of a once locally common house type, the East Jersey cottage and was therefore recommended for eligibility (Harris and Ziesing 2010).

Benefits

Under all alternatives, we would provide appropriate and compatible opportunities for visitors of all ages to appreciate the cultural and natural resources of the refuge. We would provide interpretation of cultural and historic resources related to the refuge and conservation; however, the extent and emphasis of resource interpretation varies between alternatives. Under alternatives B and D, we would increase efforts to include information about cultural and historic resources of the refuge compared to alternatives A. For example, the refuge would promote the Heritage Trail, similar heritage resources, and the "Crossroads of the American Revolution National Heritage Area." The Heritage Trail Association offers area residents and visitors alike an opportunity to learn about the rich history of greater Somerset County while celebrating the area's unique place in our nation's history.

Under alternative D, we would expand partnerships with various interest groups, such as cultural resource and historic preservation groups, to promote use of the refuge. Under all scenarios, the refuge would continue to communicate the importance of understanding and appreciating the area's rich cultural history and how it relates to our natural history. In doing so, we would potentially provide long-term benefits to regional cultural and historic resources.

Adverse Impacts
As a Federal land management agency, we are entrusted with protecting historic structures and archaeological sites on our land, which are eligible for or listed on the National Register of Historic Places. FWS archaeologists in the Regional Office keep an inventory of known sites and structures and ensure that we consider them in planning new ground disturbing or structure altering changes to the refuge. We consult with the New Jersey State Historic Preservation Office (SHPO) concerning projects that might affect sites and structures, and conduct archaeological or architectural surveys, when needed. Projects can usually be redesigned to avoid affecting National Register eligible sites or structures.

While no adverse impacts to cultural or historic resources are anticipated at this time, we will send this draft CCP/EA to the SHPO for review in compliance with Section 106 of the National Historic Preservation Act. In all of the alternatives, we will consult with our regional archeologist and the State Historic Preservation Office as needed to ensure compliance with the Act and other applicable laws and regulations.

4.14 Impacts on the Socioeconomic Environment

The refuge management activities of economic concern in the analysis are:

- Purchasing of goods and services within the local community for refuge operations.
- Spending of salaries by refuge personnel.
- Spending in the local area by refuge visitors.
- Purchasing additional refuge land and resulting changes in local tax revenues.
- Effects of refuge management on local townships.

Tourism is an important part of New Jersey's economy. While tourism is important to the State's economy, it plays a smaller role in the region around Great Swamp NWR. A 2008 regional analysis of tourism in New Jersey shows the northwestern New Jersey Skylands region, including Great Swamp NWR, comprised the smallest share of total statewide tourism spending at 8.5 percent (IHS Global Insight 2009). Morris County itself; however, was listed as ninth out of the 21 New Jersey counties for overall tourism expenditure in 2008 at a total of $1,323,000,000.

According to the "Banking on Nature" report, prepared by the FWS Division of Economics in 2004, ecotourism is one method of deriving economic benefits from the conservation of wildlife and habitats. The report evaluates the total visitor spending, including both non-resident (visitors that live >30 miles from the refuge) and local refuge visitors, to show its significance on the local economy. For example, the report focuses on how recreational visits impact local income and employment. Daily visitor expenditures for both residents and non-residents were divided into four categories, including food, lodging, transportation, and other expenses for six activities, including freshwater fishing, saltwater fishing, migratory bird hunting, small game hunting, big game hunting, and non-consumptive activities. Non-consumptive uses are recreational activities that enjoy wildlife without consuming it, such as birding and photography (Caudill and Henderson 2004).

In FY 2004, visitors to Great Swamp NWR enjoyed both non-consumptive activities and big game hunting. Non-consumptive activities included the use of nature trails, observation platforms, other wildlife observation (i.e., observing wildlife while on the auto tour route), and other recreation (i.e., jogging, bicycling, and cross-country skiing). Eighty percent of visits were by residents. Visitor recreation expenditures totaled $1.7 million in FY 2004, 99 percent which were related to non-consumptive activities. Residents spent approximately $721,700 and non-residents spent approximately $986,100. Recreational benefits (recreation-related expenditures plus net economic value) totaled nearly $5.3 million, and budget expenditures summed to $1.1 million; therefore, comparing these two estimates shows that for every $1 of budget expenditures, $4.79 in recreational benefits are derived. The budget also contributes an additional stimulus to the local economy (Caudill and Henderson 2004).

According to the 2010-2011 Visitor Survey Results for Great Swamp NWR, most surveyed visitors (82 percent) live in the local area (i.e., within 50 miles of the refuge), while 18 percent are non-local visitors. Local visitors traveled an average of 16 miles to get to the refuge, whereas non-local visitors traveled an average of 132 miles. Non-local visitors stayed in the local area for an average of 2 days. Non-local visitors spent an average of $42 per person per day and local visitors spent an average of $31 per person per days. It should be noted that only 29 non-local visitors were surveyed (small sample size where n < 30); therefore, non-local expenditures may not provide a reliable representation of that population.

Great Swamp NWR has the potential to increase visitation, and associated economic benefits to the area, because of its proximity to highly populated areas. The Great Swamp NWR currently attracts approximately 150-165,000 visitors per a year to the area from throughout the United States and various countries. The refuge has great potential to increase visitation through partnerships and by coordinating with local cultural attractions and transportation hubs. Another important aspect of the socioeconomic setting is the number of educational institutions and environmental education centers in the New York-New Jersey Metropolitan Area. This allows the refuge partnership and recruitment opportunities from a wide range of social and cultural backgrounds.

Refer to section 2.2 of chapter 2 for additional information on the socioeconomic environment of the refuge and its context within the region.

4.14.1 Impacts on Socioeconomic Environment That Would Not Vary by Alternative

Benefits

Ongoing public uses related to wildlife-dependent recreation would continue to have a small but positive effect on the local economies surrounding the refuge. Refuge visitors, researchers, and volunteers would continue to utilize businesses around the refuge for food, fuel, supplies, and lodging. The refuge would continue to provide environmental education and interpretation programming free-of-charge to communities and schools. Great Swamp NWR has the potential to increase visitation, and associated economic benefits to the area, because of its proximity to highly populated areas. The Great Swamp NWR currently attracts

an estimated 150-165,000 visitors per a year to the area from throughout the United States and various countries.

As discussed in section 2.2.4, national wildlife refuges also contribute to local economies through shared revenue payments. Under the provisions of the *Refuge Revenue Sharing Act* (the Act of June 15, 1935; 16 U.S.C. 715s), the FWS pays an annual refuge revenue sharing payment at a rate set by Congress to municipalities that contain lands the FWS administers. Great Swamp NWR's revenue payments to Chatham, Harding, and Long Hill Townships are listed in table 2-12 for the years 1988-2012.

The economic value of the ecosystem services provided by the extensive forest, wetland, and other vegetation cover types provided by the refuge and any future land protection efforts achieved by refuge partnerships has not been quantified. The services provided by refuge forests and wetlands include groundwater recharge, flood control, nutrient filtration and uptake, improved air quality, and temperature moderation. Tools, models, or programs to measure such values, such as iTree (Nowak et al 2011), have been developed and are available to put a dollar value on those ecosystem services. Land managers can input information about the tree cover of a parcel of interest and obtain monetary value, or volume measures on the ecosystem services provided.

Adverse Impacts

The impact of protecting land is considered negligible on the economy of the region. Although some loss of tax revenue and commercial income results from protecting lands, the ecosystem services provided by natural landscapes (e.g., flood control, carbon sequestration, sediment and erosion control) offset much of the lost tax revenue. In fact, preserved lands have negligible infrastructure and emergency response requirements, while attracting visitors to the surrounding area and improving the quality of life for those who visit. In addition, as mentioned above, the FWS pays an annual refuge revenue sharing payment to counties that contain lands the FWS administers.

4.14.2 Impacts on Socioeconomic Environment under Alternative A

Benefits

In summary, implementing alternative A would continue to provide socioeconomic benefits to the community. The refuge helps to maintain the quality of life not only for local residents, but also for all refuge visitors. Alternative A would continue to provide opportunities for public use, and current refuge regulations would remain in effect (see chapters 2 and 3).

The refuge provides economic benefits mainly through spending in the local area by refuge visitors and staff and the sales taxes derived from local spending. It also provides benefits from public use, as in the increasingly important ecotourism industry.

Adverse Impacts

Adverse impacts under this alternative are the same as those discussed under section 4.14.1, *Impacts on Socioeconomic Environment That Would Not Vary by Alternative*.

4.14.3 Impacts on Socioeconomic Environment under Alternative B (FWS-Preferred Alternative)

Benefits
Under alternative B, the refuge would moderately expand public uses and strive to maintain a better balance among the wildlife-dependent public uses on the refuge. Wildlife observation and photography would be enhanced by creating new trails, providing additional parking opportunities, expanding the Wildlife Tour Route, and constructing observation towers. We would expand Visitor Center operational hours to seven days per week year round and increase the number of environmental education and interpretation programs on and off the refuge. This would help improve the quality of and access to environmental education in the region, and ultimately foster environmental stewardship and support for conservation in their own lives.

Adverse Impacts
Adverse impacts under this alternative are the same as those discussed under section 4.14.1, *Impacts on Socioeconomic Environment That Would Not Vary by Alternative*.

4.14.4 Impacts on Socioeconomic Environment under Alternative C

Benefits
Benefits under alternative C are similar to those discussed in section 4.14.3, *Impacts on Socioeconomic Environment under Alternative B,* except environmental education and interpretation programs would be further emphasized and expanded. The expansion of these public uses could bring new and increased numbers of visitors to the refuge which may also lead to increases in visitor spending in the surrounding areas.

Adverse Impacts
Adverse impacts under this alternative are the same as those discussed under section 4.14.1, *Impacts on Socioeconomic Environment That Would Not Vary by Alternative*.

4.14.5 Impacts on Socioeconomic Environment under Alternative D

Benefits
As discussed in section 4.12.5 above, public use and access would be maximized to the greatest extent practical, while minimizing impacts to wildlife. Fishing opportunities, which are not authorized under any other alternative, would be provided in select areas of the refuge. We would maximize public outreach, enhance and develop new environmental interpretation and education programs, aggressively expand partnerships, and increase staff presence at programs and events. Similar to alternative B, we would expand Visitor Center operational hours to 7 days per week year round and increase the number of environmental education and interpretation programs on and off the refuge. By doing so, we would provide more opportunities to reach visitors, and ultimately foster environmental stewardship and support for conservation in their own lives.

We anticipate that the expansion of public uses would bring new and increased numbers of visitors to the refuge, which may also lead to increases in visitor spending in the surrounding areas.

Adverse Impacts
Adverse impacts under this alternative are the same as those discussed under section 4.14.1, *Impacts on Socioeconomic Environment That Would Not Vary by Alternative*.

4.15 Cumulative Impacts

According to the Council on Environmental Quality (CEQ) regulations on implementing NEPA (40 CFR 1508.7), a cumulative impact is the impact on the environment that results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions, regardless of what agency (Federal or non-Federal) or person undertakes the other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over time.

This cumulative impacts assessment includes the actions of other agencies or organizations, if they are interrelated and influence the same environment. Thus, this analysis considers the interaction of activities at the refuge with other actions occurring over a larger spatial and temporal frame of reference.

4.15.1 Cumulative Impacts on the Physical and Natural Environment

The area surrounding the refuge is highly developed and influenced by suburban and urban development. The actions in the area of the refuge that we considered for the cumulative impacts assessment include further residential development in the surrounding area, potential deer control at Morristown Historical Park, and existing commercial development in the area, including major corporation headquarters in the vicinity of the refuge. Based on the environmental analysis that is presented in this document, the actions of the refuge when added to other actions in the surrounding area will provide an overall minor, long-term benefit to the environment. Overall, the refuge has removed over 10 buildings and restored the footprint of the buildings and associated lawns to natural habitat conditions, which provides an overall benefit. In addition, vehicle use associated with habitat management activities and visitors is a very small percentage of the number of vehicles that use local roads and the interstate highway in the area. This use will not add cumulative adverse impacts to air quality in a noticeable way. Increased residential development within the watershed will likely lead to additional pesticide and herbicide use and greater levels of impervious surface. The refuge will continue to act as a water quality buffer and help to mitigate the adverse effects associate with this development. This residential development will also fragment forested areas surrounding the refuge. The larger acres of intact habitat and native vegetation will provide a consistent area of habitat available for local plant and animal species populations.

Controlling exotic and invasive plants may involve the use of chemical herbicides. The selective use of herbicides will be based upon an IPM strategy that incorporates pest ecology, the size and distribution of the population, site-specific conditions, known efficacy under similar site conditions. Best management practices will reduce potential effects to non-target species, sensitive habitats, and quality of surface and groundwater. Herbicide applications will be targeted to control discreet pest populations in localized areas. Combinations of two or more herbicides at labeled rates would not likely result in additive or synergistic adverse effects to non-target fish, wildlife, plants, or their habitats. The Forest Service (2005) found that mixtures of herbicides commonly used in land (forest) management likely would not cause either additive or synergistic effects to non-target species based upon a review of scientific literature regarding toxicological effects and interactions of agricultural chemicals (ATSDR 2004). Moreover, combined herbicides with different modes of action may be used more effectively, likely requiring less retreatment over the long term.

Herbicides applied on the refuge would be short-lived, resulting from environmental and microbial breakdown to less or non-hazardous degradation products.

All of the proposed alternatives would maintain or improve biological resources on FWS-owned lands. The long-term land protection and management activities proposed under all alternatives would complement other neighboring conservation efforts by other county, state, and federal organizations. Cumulatively, these large areas of protected lands provide many acres of protected lands for a variety of species.

Cumulative impacts from research activities are not expected, but could occur if multiple research projects were occurring on the same resources at the same time or if the duration of the research was excessive.

We do not anticipate any significant cumulative effects on biological resources by other wildlife-dependent recreational activities. Impacts caused by these activities can be found earlier in this chapter.

4.15.2 Cumulative Impacts Related to Climate Change

Climate Change Impacts on Vegetation

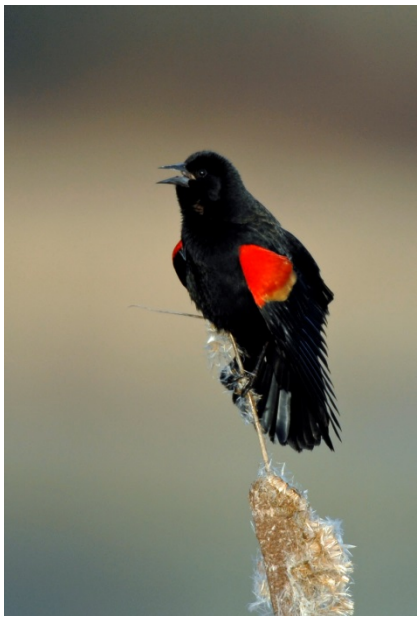
Climate is a major factor on the range, growth rate, and reproduction of trees. As with all types of flora and fauna, certain tree species are more likely to adapt to climate shifts while other species will not be as successful. Plant communities and species adapted to warmer subtropical latitudes are expected to expand and establish beyond their northern boundaries. Cool climate coniferous forests of the Northeast are considered particularly vulnerable. Other deciduous hardwood species, such as sugar maple, American beech, birches, quaking aspen, white ash, and black cherry, may be lost in portions of their range (Stout et al., 2008; Frumhoff et al., 2007). Oak-hickory and oak-pine forests may expand northward in the United States (NABCI 2010). Certain species, such as white oak, black oak, and black gum, may expand their range northward under various warming scenarios within the Northeast (Stout et al. 2008).

Impacts to red maple (*Acer rubrum*), one of the most dominant forest tree species of Great Swamp NWR, may vary greatly under different warming scenarios. Although this species is projected to be impacted under certain high emissions conditions, red maple is highly adaptable and has expanded its range in the past 100 years (Frumhoff et al 2007; Fei and Steiner 2007). Studies have shown significant growth increases (130 percent) among juvenile red maples corresponding with increases in soil temperature of up to 9ºF (Frumhoff et al., 2007). Due to the significant proportions of red maple-dominant communities at Great Swamp NWR, these varying scenarios could have significant implications for the refuge with regard to rates of succession and management responses.

Some positive effects on forests may include increased forest productivity due to longer growing seasons, increased precipitation, and increased carbon dioxide fertilization, which will increase primary production and yield greater biomass and soil inputs. Mature trees in particular are expected to fare better because of developed root systems and higher carbon reserves (Swanston et al. 2011).

Some negative effects include extreme weather events that can cause flooding, erosion, and wind damage; altered timing of aquifer recharge leading to potential declines in summer seasonal streamflow; species range shift, which would result in a decline of some species; and increased susceptibility to disturbance, disease, and pests. We anticipate expanded pest and disease ranges due to decreased probability of lower lethal temperatures, migrations to the north, and accelerated life cycles. An increase in frequency or intensity of fire may also occur where there is less summer moisture (Swanston et al. 2011).

Climate Change Impacts on Biological Resources



USFWS/George Gentry

Climate change will have a range of effects on vegetation and ecological systems. It is expected that species ranges will shift northward or toward higher elevations as temperatures rise, but responses will likely be highly variable and either species or family-specific. Under these rapidly changing conditions, migration, not evolution, will determine which species are able to survive. Species that cannot migrate will suffer the most. For example, plants, mussels, and amphibians are more vulnerable to temperature shifts that may affect their ability to survive, grow, and reproduce (USFWS 2010a). Severe weather events of greater intensity may increase flooding occurrence, which will affect various wildlife species. For example, increased flooding will threaten amphibians by enabling access of predatory fish into vernal breeding pools and by spreading pollutants.

Four types of responses by animal and plant species are possible:

1. The density of species may change locally and their ranges may shift in response to the need to find areas within their range of tolerance.
2. There will likely be changes in phenology, or the timing of such important life history events as flowering, egg-laying, and migration.
3. Changes in body sizes and behaviors may occur.
4. Genetic frequencies may shift.

Species with short generation times, such as insects and annual plants, might be helped in adapting to change because of their more rapid evolution. In addition, since insects are poikilothermic (cold-blooded) animals and sensitive to temperature fluctuation, climate change may also result in redistributions of pest insects and subsequent forest impacts (Logan et al. 2003). As growing and reproductive seasons are prolonged, some insects, including pest insects, will likely produce more generations per season (Ibanez et al. 2011). Insects that may benefit from warming scenarios may include the wooly adelgid, emerald ash borer, and gypsy moth. Certain parasitic fungi and other diseases, including Dutch elm disease, white pine blister rust and beech bark disease, are also expected to benefit from climate change (Frumhoff et al. 2007).

Evolution may be slower in long-lived species, such as trees; therefore, these species may be less adaptable (Rogers and McCarty 2000). Since so many animal species time important events in their life cycles, particularly reproduction, so that young are produced when food sources are available, changes in other phenological events, such as flowering and insect hatching, could be disastrous for species that fail to quickly adapt to decoupled synchronies. We cannot, at this time, predict how this will affect the refuge, but we can apply generally accepted conservation biology strategies to provide biologically diverse habitats and connected corridors to increase ecological flexibility and maximize ecosystem resilience.

Climate Change Impacts on Birds

According to a recent analysis of Christmas Bird Count data over the past 40 years, a significant northward shift of the winter center of abundance is occurring among at least 305 bird species in North America (Niven et al. 2009). Of these, 208 species shifted north with 123 species shifting more than 50 miles. Landbirds as a group shifted more than waterfowl or coastal species. Seventy-five percent of land birds shifted north an average of 48 miles. Landbirds were further analyzed according to four habitat guilds: woodland, grassland, shrub, and generalist. Woodland birds shifted the most, followed by shrub species, while grassland birds and generalist shifted the least. This study confirmed a northward shift of species already suspected, such as red-bellied woodpecker (*Melanerpes carolinus*), tufted titmouse (*Baeolophus bicolor*), Carolina wren (*Thryothorus ludovicianus*), and northern cardinal (*Cardinalis cardinalis*), and which are all common species at the refuge throughout the year (Niven et al. 2009).

Habitat specific and migratory species, especially northern forest birds, have been determined to be particularly vulnerable to global climate change. Changes in migratory timing, including the seasonal availability of food resources, would be a major contributing factor to these declines (NABCI 2010). Due to their ability to adapt to varying conditions, common generalist resident bird species may be less affected or increase under various emissions scenarios. Thirty-six percent of the 165 wetland breeding birds in the United States show medium or high vulnerability to climate change (NABCI 2010). Wetland birds that occur at Great Swamp NWR that are projected to decline due to climate driven drought and flood cycles include common loon (*Gavia immer*), sora (*Porzana carolina*), and American bittern (*Botaurus lentiginosus*) (Frumhoff et al. 2007). Waterfowl and wading bird habitat may be affected as climate change results in changes in rainfall and temperature. Waterfowl range contraction is anticipated as milder, warmer winters shift northward, reducing the need to migrate as far south. The Great Swamp is a low, flat floodplain in the lower, receiving end of its watershed. More frequent rain events of greater intensity will increase flooding occurrence and a greater possibility of nests being destroyed by flooding.

Northern grassland areas are expected to become drier with increased evapotranspiration caused by global climate change impacts. It is also suspected that increased atmospheric carbon dioxide may contribute to faster succession of woody species in grassland habitats (NABCI 2010). Approximately 50 percent of grassland bird species of the United States, including the State-listed bobolink (*Dolichonyx oryzivorus*), are expected to be impacted by global climate change (NABCI 2010). Christmas bird count data indicates that grassland birds were the only general group of birds unable to shift north in response to global climate change over the last 40 years. This inflexible response has been attributed to the poor quality of northern grassland habitats (NABCI 2010).

Department of the Interior Secretarial Order 3226 states that “there is a consensus in the international community that global climate change is occurring and that it should be addressed in governmental decision making. This order ensures that climate change impacts are taken into account in connection with Departmental planning and decision making.” Additionally, it calls for the incorporation of climate change considerations into long-term planning documents, such as a CCP.

The Wildlife Society published an informative technical review report in 2004 titled “Global Climate Change and Wildlife in North America” (Inkley et al. 2004). It interprets results and details from such publications as the Intergovernmental Panel on Climate Change reports (1996 to 2002) and describes the potential impacts and implications on wildlife and habitats. It mentions that projecting the impacts of climate change is hugely complex because not only is it important to predict changing precipitation and temperature patterns,

but more importantly their rate of change, as well as the exacerbated effects of other stressors on the ecosystems. Those stressors include loss of wildlife habitat to urban sprawl and other developed land uses, pollution, ozone depletion, non-native species, disease, and other factors. Projections over the next 100 years indicate major impacts such as extensive warming in most areas, changing patterns of precipitation, and significant acceleration of sea level rise. According to the Wildlife Society report, "…other likely components of on-going climate change include changes in season lengths, decreasing range of nighttime versus daytime temperatures, declining snowpack, and increasing frequency and intensity of severe weather events" (Inkley et al. 2004). The report details known and possible influences on habitat and wildlife, including: changes in primary productivity, changes in plant chemical and nutrient composition, changes in seasonality, sea level rise, snow, permafrost, sea ice decline, increased invasive species, pests and pathogens, and impacts on major vertebrate groups.

The effects of climate change on populations and range distributions of wildlife are expected to be species specific and highly variable with some effects considered negative and others considered positive. Generally, the prediction in North America is that the ranges of habitats and wildlife would generally move upwards in elevation and northward as temperature rises. Species with small or isolated populations and low genetic variability would be least likely to withstand impacts of climate change. Species with broader habitat ranges, wider niches, and greater genetic diversity should fare better or may even benefit. This would vary depending on specific local conditions, changing precipitation patterns, and the particular response of individual species to the different components of climate change (Inkley et al 2004). The report notes that developing precise predictions for local areas is not possible due to the scale and accuracy of current climate models, which is further confounded by the lack of information concerning species-level responses and to ecosystem changes, their interactions with other species, and the impacts from other stressors in the environment. In other words, only crude generalizations can be made about the implications of our refuge management on regional climate change.

Our evaluation of the proposed actions concludes that only one area of activities may contribute negligibly, but incrementally, to stressors regionally affecting climate change: our use of vehicles and equipment to administer the refuge. We discuss the direct and indirect impacts of those activities elsewhere in chapter 4. We also discuss measures to minimize the impacts of both. With regards to our equipment and facilities, we are trying to reduce our carbon footprint wherever possible by using alternative energy sources and energy saving appliances, using recycled or recyclable materials (e.g. benches and boardwalk construction), changing management plans to reduce equipment use, and other conservation measures.

In our professional judgment, most management actions we propose would not exacerbate climate change in the region or project area, and in fact, some might incrementally prevent or slow down local impacts. We discuss our actions relative to the 18 recommendations the Wildlife Society report gives to assist land and resource managers in meeting the challenges of climate change when working to conserve wildlife resources (Inkley et al. 2004).

> *Recommendation #1: Recognize global climate change as a factor in wildlife conservation. This recommendation relates to land managers and planners becoming better informed about the consequences of climate change and the variability in the resources they work with.*

Throughout our alternatives we have highlighted the need to address climate change, specifically in regard to habitat changes. We have proposed a series of strategies involving monitoring and other potential

impacts of climate change as it relates to the long-term protection and management of habitats in light of our defined refuge purposes and proposed goals outlined in this draft CCP/EA.

The FWS is taking a major role among Federal agencies in distributing and interpreting information on climate change. There is a dedicated webpage for this issue at *http://www.fws.gov/home/climatechange/* (accessed April 2012). The FWS Northeast Region also co-hosted a workshop in June 2008 titled "Climate Change in the Northeast: Preparing for the Future." A similar workshop for all Federal, state, and nongovernmental organization land managers and conservationists of the Mid-Atlantic was held in March 2009. Both workshops provided valuable scientific information and resources to aid managers in land management planning in the context of climate change. All Northeast Region refuge supervisors and planners attended, as did over 20 refuge field staff.

> *Recommendation #2: Manage for diverse conditions. This recommendation relates to developing sound wildlife management strategies under current conditions, anticipating unusual and variable weather conditions, such as warming, droughts and flooding.*

Our proposed habitat management actions described in chapter 3 promote healthy, functioning bottomland, upland, riparian and floodplain forests, scrub-shrub, wetlands, open waters, and grasslands. We have identified monitoring elements, which will be fully developed in the Habitat Management and Population Management step-down plans (see section 3.1.1), to evaluate whether we are meeting our objectives and to assess changing conditions. We will implement an adaptive management approach as new information becomes available.

> *Recommendation #3: Do not rely solely on historical weather and species data for future projections without taking into account climate change. This recommendation relates to the point that historical climate, habitat and wildlife conditions are less reliable predictors as climate changes. For example, there may be a need to adjust breeding bird survey dates if migratory birds are returning earlier to breed than occurred historically.*

We are aware of these implications and plan to build these considerations into our Population Management Plan so that we can make adjustments accordingly. The FWS is working to establish long-term monitoring protocols and sites to document future trends in the Northeast.

> *Recommendation #4: Expect surprises, including extreme events. This recommendation relates to remaining flexible in management capability and administrative processes to deal with ecological "surprises" such as floods or pest outbreaks.*

Refuge managers have flexibility within their operations funds to deal with emergencies. The refuge has experienced "extreme" weather events with greater frequency in recent years, including flooding. For example, record flooding occurred after Tropical Storm Irene (August 2011) and an unexpected Nor'easter snowstorm (October 2011) caused massive tree damage and widespread power outages. Due to the frequency experienced, we may begin considering these types of events a "new normal" when planning annual needs. Other regional operations funds would also be redirected as needed to deal with emergencies.

> *Recommendation #5: Reduce non-climate stressors on the ecosystem. This recommendation relates to reducing human factors that adversely affect resiliency of habitats and species.*

Similar to our response to #2 above, the objectives of our habitat management program are to protect the biological integrity, diversity and environmental health of refuge lands. Our objectives to create healthy, diverse native and resilient vegetation communities and expand "core" forest habitat through the consolidation of management units would help offset the local impacts of climate change.

> *Recommendation #6: Maintain healthy, connected, genetically diverse populations. This recommendation relates to the fact that small isolated populations are more prone to extirpations than larger, healthy, more widespread populations. Large tracts of protected land facilitate more robust species populations and can offer better habitat quality in core areas.*

As noted in chapter 2, the refuge is in many ways a biological island surrounded by dense urbanization. Where we can restore or preserve connections, we pursue these opportunities. We would also continue to work with our many conservation partners at the State and regional level to support and complement restoration and protection efforts, expand existing conserved tracts and target others to create corridors.

> *Recommendation #7: Translocate individuals. This recommendation suggests that in some cases, it may be necessary to physically move wildlife from one area to another to maintain species viability. This recommendation also cautions that translocation is not only expensive, but also poses ecological risks to native ecosystems (e.g., introduction of disease and other unpredictable consequences). The potential for irreversible consequences should be carefully considered and translocation should be severely limited as a conservation strategy to cope with climate change.*

As described in chapter 3, we would evaluate the feasibility and ecological risk of reintroducing bog turtle hatchlings to increase population viability and genetic diversity on the refuge. This would likely only occur if the refuge's populations were determined to be in danger of collapse and the risk of introducing disease (or other environmental consequences) has been determined to be low. All reintroductions are regulated by State and federal permits.

> *Recommendation #8: Protect coastal wetlands and accommodate sea level rise. This recommendation relates to impacts of sea level rise and provides suggestions for reducing and coping with these risks, such as establishing inland buffer zones to provide an opportunity for habitats and wildlife to migrate inland.*

The refuge is not located within or near the coastal zone; therefore, this recommendation does not apply.

> *Recommendation #9: Reduce the risk of catastrophic fire. This recommendation acknowledges that fire can be a natural part of the ecosystem, but that climate change could lead to more frequent fires and/or a greater likelihood of a catastrophic fire.*

Our plans to use prescribed fire as a management tool; control invasive plants, especially dense monotypic stands; and provide for structural diversity in combination with natural conditions and man-made firebreaks (roads, utility corridors, etc.) found across the refuge would reduce the overall risk of a catastrophic fire.

> *Recommendation #10: Reduce likelihood of catastrophic events affecting populations. This recommendation states that increased intensity of severe weather can put wildlife at risk. While the severe weather cannot be controlled, it may be possible to minimize the effects by supporting multiple, widely spaced populations to offset losses.*

Our response to recommendations #2, #3, and #6 above describes the actions we are taking to minimize this risk. Unfortunately, the limited footprint of the refuge and scarcity of large tracts of nearby undeveloped lands limits opportunities for the refuge itself to support multiple, widely spaced populations. We will work with other regional conservation land managers to support this effort.

> *Recommendation #11: Prevent and control invasive species. This recommendation emphasizes the increased opportunities for invasive species to spread because of their adaptability to disturbance. Invasive species control will be essential, including extensive monitoring and control to preclude larger impacts.*

Invasive species control is currently a major initiative within the FWS and on the refuge. The Northeast Region, in particular, has taken a very active stand. In chapter 3, we provide detailed descriptions of our current and future plans on the refuge to control existing invasive plant infestations. We also describe monitoring and inventorying strategies to protect against new infestations and emerging invasive species, including EDRR.

> *Recommendation #13: Account for known climatic conditions. This recommendation states we should monitor key resources through predictable short-term periodic weather phenomenon, such as El Nino, to aid us in future management efforts.*

We plan to develop an Inventory and Monitoring Plan, which will include guidelines for inventory and monitoring, marking and banding, and disease prevention and response. This plan will help us evaluate our assumptions and success in achieving objectives, assess the health and contribution of our habitats toward our objectives, and assist us in making future management decisions. Any restoration activities or management actions would be carefully planned and their effectiveness monitored and documented so we can use this information in future management decisions.

> *Recommendation #14: Conduct medium- and long-range planning. This recommendation states that plans longer than 10 years should take into account potential climate change and variability as part of the planning process.*

This 15-year CCP addresses climate change with its emphasis on restoring and maintaining healthy, contiguous, native habitat areas; reducing human stressors on refuge lands; expanding environmental education and interpretation programs with additional focus on climate change; reducing the refuge's carbon footprint and increasing use of green technologies; and expanding partnerships. Our monitoring program and adaptive management strategies would also facilitate our ability to respond to climate change.

Recommendation #15: Select and manage conservation areas appropriately. This recommendation states that establishing refuges, parks and reserves is used as a conservation strategy to try to minimize the decline of wildlife and habitats in North America. Decisions on locating future conservation areas should take into account potential climate change and variability. For example, it is suggested that decisions on new acquisitions consider the anticipated northward migrations of many species, or the northern portion of species ranges. Managers of existing conservation lands should consider climate change in future planning.

The FWS as a whole is working with partners on making decisions on where and how to provide conservation areas in light of climate change through a science-based process known as "Strategic Habitat Conservation." Specifically, the FWS is developing Landscape Conservation Cooperatives throughout the country to provide science support for these decisions. The refuge would continue to support these nationwide initiatives, as well as more local efforts.

Recommendation #16: Ensure ecosystem processes. This recommendation suggests that managers may need to enhance or replace diminished or lost ecosystem processes, such as manually dispersing seed, reintroducing pollinators, and treating invasive plants and pests.

We have and will continue to take an aggressive approach to treating invasive plants species and pest outbreaks. If necessary, we will take actions to enhance or replace ecosystem processes, such as manually dispersing seed. None of our proposed management actions would diminish natural ecosystems processes already underway. Should our monitoring results reveal that we must take a more active role in enhancing or replacing those processes, we will reevaluate and/or refine our management objectives and strategies.

Recommendation #17: Look for new opportunities. This recommendation states that managers must be continually alert to anticipate and take advantage of new opportunities that arise. Creating wildlife conservation areas out of abandoned or unusable agricultural land, and taking advantage of industry interest in investing in carbon sequestration or restoration programs, are two examples cited.

Refuge staff has maintained many conservation partners in the area which, in turn, are networked throughout the larger region. We are aware of many opportunities for land protection or habitat restoration through this broad-based network. Our Northeast Region has field offices and a Regional Office that integrates the other FWS program areas, including those that work with private entities. We have developed outreach materials, and make ourselves available to interested organizations and groups, to provide more detailed information on the FWS and Refuge System missions, refuge goals and objectives, and partnership opportunities.

Recommendation #18: Employ monitoring and adaptive management. This recommendation states that we should monitor climate and its effects on wildlife and their habitats and use this information to adjust management techniques and strategies. Given the uncertainty with climate change and its impacts on the environment, relying on traditional methods of management may become less effective.

We agree that an effective and well-planned monitoring program, coupled with an adaptive management approach, will be essential to dealing with the future uncertainty of climate change. We have built both aspects into alternatives B, C, and D of our draft CCP/EA. We will develop detailed step-down Population and Habitat Management Plans, which will include guidelines for inventory and monitoring, to evaluate our assumptions and management effectiveness in light of on-going changes. With that information in hand, we would either adapt our management techniques, or reevaluate or refine our objectives as needed.

4.15.3 Unavoidable Adverse Effects

Unavoidable adverse effects are the effects of those actions that could cause harm to the environment and that cannot be avoided, even with mitigation measures. All of the alternatives would result in some minor, localized, unavoidable adverse effects. For example, reconfiguration and consolidation of managed habitat units would produce minor, short-term, localized, adverse effects on landbird populations and increased visitation could have minor unavoidable effects on various wildlife species. However, we do not believe that any of these effects would rise to a significant level.

Many of the habitat management and facility construction projects in the proposed alternatives have a certain level of unavoidable adverse effects, especially during the actual construction. Those effects can be mitigated to a large degree by the use of BMPs and precautions that safeguard water quality, avoid sensitive habitats, or time the actions (or include safeguards) to avoid or minimize impacts on fish and wildlife. The adverse effects generally are short-term and more than offset by the long-term gains in habitat quality and fish, wildlife, and plant productivity.

Forest, scrub-shrub, and grassland habitats would be reconfigured and maintained to create large (greater than 50 acres), contiguous patches to promote wildlife use, increase connectivity, decrease fragmentation, increase maintenance efficiency, and reduce maintenance costs. As a result, these vegetation communities are likely to undergo changes in species composition and structure. Reconfiguration and consolidation of habitats may cause an initial adverse effect on some plant or wildlife species; however, in the long-term, populations are expected to benefit. As previously mentioned, timing of activities would be considered to avoid potential disturbance to nesting species, as well as to minimize impacts on foraging and resting habitat during important seasonal periods, such as nesting or migration.

Some aspects of wildlife-dependent recreation, such as hunting or fishing, would result in the unavoidable adverse impacts on individual fish and wildlife as a result of providing these consumptive activities; however, we would ensure that populations are protected from adverse effects by requiring all participants follow applicable State and refuge regulations. In addition, we anticipate long-term benefits to species and habitats from connecting people with nature through these activities. Fishing, under alternative D, would be permitted in designated areas on the refuge. This activity results in the unavoidable adverse loss of individual fish; however, this activity constitutes a relatively minor impact on species populations. Similarly, the introduction of a spring wild turkey hunt under alternatives B, C, and D would result in unavoidable adverse loss of individuals; however, population data and trends will be monitored carefully to avoid adverse impacts to the overall population. The deer management hunt program, under all alternatives, would also result in the unavoidable adverse loss of individuals; however, overall health of the refuge's deer population would likely improve by maintaining or reducing (when necessary) competition for limited resources. In addition, there would be long-term benefits to refuge habitats and the other species that depend on them through reduction in browse intensity.

All of these unavoidable adverse effects on the physical and biological environment would be relatively local and more than offset by the long-term benefits to the diversity and ecological health of the broader landscape.

Some impacts on certain individuals or refuge neighbors may be unavoidable, such as a minor increase in traffic due to increases in visitation, but our responsibility is to provide equal opportunities to the American public, not a select few. We believe we have sought a fair balance in minimizing and mitigating adverse impacts while providing quality recreational opportunities to the public. All of what we propose in the arena of public use has been subject to public involvement and input during the planning process.

4.15.4 Potential Irreversible and Irretrievable Commitments of Resources

Irreversible commitments of resources are those that cannot be undone, except perhaps in the extreme long term. One example is an action that contributes to a species' extinction. Once extinct, it can never be replaced and is an irreversible loss. By comparison, irretrievable commitments of resources are those that are lost for an extended period of time, but could be undone given sufficient time and resources, although there may be a loss in productivity or use for a time. An example of an irretrievable commitment is converting what was once a mature forest and actively managing and maintaining it as early successional habitat. If, for some reason, that early successional habitat was no longer an objective, those acres could progress gradually to mature forest again over a period of 70 or more years, or we could determine it best to expedite the reversion by planting shrubs and trees and controlling invasive plants.

4.15.5 Environmental Justice

On February 11, 1994, President Clinton signed Executive Order No. 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations," to focus Federal attention on the environmental and human health conditions of minority and low-income populations, with the goal of achieving environmental protection for all communities. The order directs Federal agencies to develop environmental justice strategies to aid in identifying and addressing disproportionately high, adverse human health or environmental effects of their programs, policies, and activities on minority and low-income populations. The order is also intended to promote nondiscrimination in Federal programs substantially affecting human health and the environment, and to provide minority and low-income communities' access to public information and participation in matters relating to human health or the environment.

We expect none of the four proposed alternatives to have significant adverse cumulative impacts on for the towns or counties in which the refuge lies. We would expect none of the alternatives to alter the demographic or economic characteristics of the local community. The actions we propose would neither disproportionately affect any communities nor damage or undermine any businesses or community organizations. Consequently, no adverse impacts would be expected including changes in the community character or demographic composition.

Overall, we expect none of the alternatives would place disproportionately high, adverse environmental, economic, social, or health effects on minority or low-income persons. Our programs and facilities are open to all who are willing to adhere to the refuge's rules and regulations, we acquire land only from willing sellers, and we do not discriminate in our responses for technical assistance in managing private lands. In addition, proposed refuge construction projects under alternatives B, C, and D would occur within the refuge boundary and are not expected to have disproportionate adverse effects on any group or area.

Chapter 5

USFWS/Bill Thompson

Consultation and Coordination

- Introduction
- Planning to Protect Land and Resources
- Partners Involved in Refuge Planning
- Contact Information
- Members of the Core Planning Team
- Assistance from Other Service Personnel

5.0 Introduction

This chapter describes how we engaged others in developing the CCP. In chronological order, this chapter details our efforts to encourage the involvement of the public and conservation partners: other Federal and state agencies, county officials, civic groups, non-government conservation and education organizations, and use groups.

This chapter does not detail the dozens of informal discussions the refuge manager and his staff have had since the CCP planning process began. These informal discussions involved a wide range of audiences, including congressional representatives or their staffs, organizations, local community leaders and other residents, refuge neighbors, refuge visitors, and other interested individuals. During those discussions, the refuge manager and his staff often would provide an update on our progress and encourage comments and other participation.

According to Service policy, we must review and update our final CCP at least once every 15 years, or sooner, in response to significant new information that would markedly change management direction or, our Director or Regional Director deem it necessary. If so, we will once again announce our revised planning and encourage your participation.

5.1 Planning to Protect Land and Resources

Our refuge planning began informally in 2008 to become familiar with the planning process and to start collecting information on refuge resources and public use. Subsequently, we initiated State and Tribe involvement in September 2008. An initial strategy meeting between the refuge staff and regional office staff was held at the refuge in July 2009. One major outcome of this meeting was a timetable for accomplishing the major steps in the planning process and determining when and how we should involve others. Please contact the refuge manager for additional details.

July 2008
We began to prepare for developing a CCP by becoming familiar with the planning process and collecting information on refuge resources and public uses.

September 2008
We initiated coordination and involvement with the State and Tribes.

July 2009
Refuge and regional office planning staff met on the refuge. We identified preliminary issues and management concerns, and developed preliminary vision statements and goals.

July 2010
Our public scoping period began. We distributed approximately 500 copies of the initial CCP planning announcement newsletter to local conservation and interest groups; research organizations; local, State and Federal government agencies; federally recognized Tribes; and interested individuals. We also posted the July 2010 newsletter on the refuge's Web site to reach a broader audience. The newsletter described the CCP planning process, provided an overview of the refuge, identified draft goals, presented our draft vision statement, and announced the date and location of our first public scoping meeting.

July 19, 2010
We published a Notice of Intent to prepare a CCP/EA in the *Federal Register* (Volume 75, Number 137).

July 28, 2010
We hosted two public scoping meetings at Chatham Township Municipal Building at 1 p.m. and 6 p.m. At each meeting, we presented an overview of current refuge management, described the CCP planning process, and explained how people can get involved. We also shared our preliminary vision and goals for the refuge and the issues we already know we need to address. We requested feedback and encouraged public involvement, and answered any questions about the planning process. A total of 31 attendees, including six organizations, participated in the public scoping meeting.

September 2010
Our core planning team was expanded to include Amy S. Greene Environmental Consultants, Inc. (Flemington, New Jersey).

October-November 2010
USGS began conducting a visitor survey at the refuge, which included two sampling periods, one of which was completed in the fall of 2010 and the other in the spring of 2011. The survey is designed to help us gain further insight into visitors' desires and concerns regarding public use opportunities and facilities at the refuge.

January 2011
We distributed a second planning update newsletter to everyone on our mailing list. The newsletter provided the results of the first public scoping period, which included a summary of public comments received at the public scoping meeting and by mail. The newsletter also provided an update on the progress of the CCP planning process.

March15-16, 2011
We hosted a 1-day alternatives workshop, focusing on ecosystems and natural resources, to discuss ideas, issues, and opportunities for the refuge as part of the planning process. Participants of this workshop included the core planning team, other refuge staff, and representatives from the Natural Resources Conservation Service, Friends of Great Swamp NWR, The Nature Conservancy, and The Land Conservancy of New Jersey.

A 1-day alternatives workshop, focusing on public use and visitor services, was also hosted to discuss ideas, issues, and opportunities for the refuge. Participants of this workshop included the core planning team, other refuge staff, and representatives from the Somerset County Park Commission Environmental Education Center, The Raptor Trust, Friends of Great Swamp NWR, National Park Service Morristown National Historical Park, Alliance of New Jersey Environmental Education, and American Museum of Natural History.

Comments from the workshops were carefully considered in the development of the CCP.

April-May 2011
USGS completed the refuge visitor survey for the spring sampling period. A total of 336 visitors agreed to participate in the survey during the two sampling periods. In all, 219 visitors completed the survey for a 67 percent response rate and plus or minus 5 percent margin of error at the 95 percent confidence level.

February 2012
We distributed our third planning update newsletter. This newsletter provided a status update on the CCP planning process, a summary of draft alternatives, an updated vision statement, and a planning timeline.

June 2012
We submitted the draft CCP/EA to the Regional Office for review.

5.2 Partners Involved in Refuge Planning

Refuge programs enjoy a great deal of support from outside the Service in many fields: conducting biological surveys, enhancing public use and refuge programs, restoring habitat, and protecting land. Our partnerships will continue to expand under the increasing interest in conserving refuge resources. During the past few years, we contacted the following partners to encourage their involvement in the planning process and encourage their involvement.

- Alliance of New Jersey Environmental Education
- American Museum of Natural History
- Association of New Jersey Environmental Commissions
- Drew University
- Ducks Unlimited
- Friends of Great Swamp National Wildlife Refuge
- Great Swamp Watershed Association
- Morris County Park Commission
- Natural Resource Conservation Service
- New Jersey Audubon Society
- New Jersey Conservation Foundation
- New Jersey Division of Fish and Wildlife
- New Jersey Division of Parks and Forestry

- New Jersey Endangered and Non-Game Species Program
- New Jersey Land Conservancy
- New Jersey State Historic Preservation Office
- Rutgers University
- Skylands Magazine
- Somerset County Park Commission
- The Nature Conservancy
- The Raptor Trust
- Trust for Public Lands
- William Patterson University

5.3 Contact Information

Steve Henry, Deputy *Project Leader*
Great Swamp National Wildlife Refuge
241 Pleasant Plains Road
Basking Ridge, New Jersey
Phone: 973-425-1222, ext. 157
http://greatswamp.fws.gov

Bill Perry, Natural Resource Planner
U.S. Fish and Wildlife Service, Region 5
300 Westgate Center Drive
Hadley, Massachusetts 01035-9589
Phone: 413-253-8688
Facsimile: 413-253-8468
http://www.fws.gov/northeast/planning/index.html

5.4 Members of the Core Planning Team

Bill Perry, *Regional Natural Resource Planner,* USFWS Regional Office
Bill Koch, former *Project Leader*, Great Swamp NWR
Steven Henry, *Deputy Project Leader*, Great Swamp NWR
Dorothy Fecske, *Wildlife Biologist*, Great Swamp NWR
Jonathan Rosenberg, *Visitor Services Manager*, Great Swamp NWR
Harry Strano, *Project Manager*, Amy S. Greene Environmental Consultants, Inc.
Jennifer LaStella, *Project Manager*, Amy S. Greene Environmental Consultants, Inc.

Patrick Carr, *Supervising Wildlife Biologist*, New Jersey Division of Fish and Wildlife
Tamara Francis, *Cultural Preservation Director*, The Delaware Nation

5.5 Assistance from Other Service Personnel

Robert Allen, former *Contaminants Biologist,* Great Swamp NWR
Craig Bitler, former *Wildlife Biologist,* Great Swamp NWR
John Eaton, *Regional Cartographer and Spatial Data Services Specialist,* USFWS Regional Office
Andrew Ferreira*,* former *Biological Science Technician* and active *Volunteer*, Great Swamp NWR
Beth Goldstein, former *Refuge Planner* for Great Swamp NWR CCP, USFWS Regional Office
Michael Horne, *Refuge Manager,* Wallkill NWR Complex
Marilyn Kitchell, *Wildlife Biologist*, Wallkill NWR Complex
David Miller, *Equipment Operator,* Great Swamp NWR
Colin Osborn, *Fish and Wildlife Biologist,* Wallkill NWR
Monica Patel, former *Intern,* Great Swamp NWR
Jerfelis Pimentel, *Office Automation Clerk*, Great Swamp NWR
David Sagan, *Visitor Services Specialist,* Great Swamp NWR
Janith Taylor, *Chief, NWRS Division of Natural Resources,* USFWS Regional Office
Will Waldron, former *Realty Specialist,* USFWS Regional Office

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Glossary

adaptive management	a process in which projects are implemented within a framework of scientifically driven experiments to test predictions and assumptions outlined within the comprehensive conservation plan. The analysis of the outcome of project implementation helps managers determine whether current management should continue as is or whether it should be modified to achieve desired conditions.
abiotic	nonliving; a physical feature of the environment such as climate, temperature, geology, soils.
avullium	an unconsolidated accumulation of stream-deposited sediments, often including sands, silts, clays, or gravels.
alternative	a set of objectives and strategies needed to achieve refuge goals and the desired future condition.
ambient	of the surrounding area or outside environment.
anadromous fish	fish that spend a large portion of their life cycle in the ocean and return to freshwater to breed.
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 National Wildlife 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 U.S. Fish and Wildlife Service approves upon completion of the planning and environmental compliance process. An approved acquisition boundary only designates those lands that 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 National Wildlife 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.
avian	of or having to do with birds.

basin	the surrounding land that drains into a water body.
best management practice	land management practices that produce desired results (usually describing forestry or agricultural practices effective in reducing non-point source pollution.
biological diversity	the variety of life forms and its processes, including the variety of living organisms, the genetic differences among them, and the communities and ecosystems in which they occur.
biological integrity	biotic composition, structure, and functioning at genetic, organism, and community levels comparable with historic conditions, including natural biological processes that shape genomes, organisms, and communities.
bird conservation region	ecologically distinct regions in North America with similar bird communities, habitats, and resource management issues.
brackish	brackish water is water that is more salty than freshwater, but less salty that seawater. It is generally defined as water with a salinity of 0.5 to 30 dissolved salts parts per thousand.
buffer	lands bordering water bodies that reduce runoff and nonpoint source pollution.
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.
categorical exclusion	a category of Federal agency actions that do not individually or cumulatively have a significant effect on the human environment.
compatible use	a wildlife-dependent recreational use, or any other use on a refuge that will not materially interfere with or detract from the fulfillment of the mission of the Service or the purposes of the refuge.
compatibility determinations	a required determination for wildlife-dependent recreational uses or any public uses of a refuge.
Comprehensive Conservation Plan	a document that describes the desired future conditions of the refuge, and specifies management direction to achieve refuge goals and the mission of the National Wildlife Refuge System.
community	a distinct assemblage of plants that develops on sites characterized by particular climates and soils, and the species

	and populations of wild animals that depend on the plants for food, cover and/or nesting.
cover type	the current vegetation of an area.
cultural resource	those parts of the physical environment – natural and built – that have cultural values to some sociocultural group or institution. Cultural resources include historic sites, archaeological sites and associated artifacts, sacred sites, buildings, and structures.
diameter at breast height	(dbh) – 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.
disturbance	a disruption in the natural plant succession of a community or ecosystem resulting in a new community.
early successional habitat	Succession is the gradual replacement of one plant community by another. In a forested ecosystem, tree cover can be temporarily displaced by natural or human disturbance (e.g., flooding by beaver, or logging). The open environments created by removal of tree cover are referred to as 'early-successional' habitats because as time passes, trees will return. The open conditions occur 'early' in the sequence of plant communities that follow disturbance. We define *early successional forest* in this CCP as: the shrub-sapling stage; 0-20 years old.
ecological integrity	native species populations in their historic variety and numbers naturally interacting in naturally structured biotic communities. For communities, integrity is governed by demographics of component species, intactness of landscape-level ecological processes (e.g., natural fire regime), and intactness of internal community processes (e.g., pollination).
ecological succession	the orderly progression of an area through time in the absence of disturbance from one vegetative community to another.
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 and interrelated complex of plant and animal communities and their associated non-living environment.
emergent marsh	wetlands dominated by erect, rooted, herbaceous plants.
endangered species	any species of plant or animal defined through the Endangered Species Act as being in danger of extinction throughout all or a significant portion of its range, and published in the *Federal Register*.

Environmental Assessment	a systematic analysis to determine if proposed actions would result in a significant effect on the quality of the environment.
environmental health	the composition, structure, and functioning of soil, water, air, and other abiotic features comparable with historic conditions, including the natural abiotic processes that shape the environment.
exotic species	a species that is not native to an area and has been introduced intentionally or unintentionally by humans.
extinction	the termination of existence of a lineage of organisms (e.g., a subspecies or species.
federally listed species	a species listed either as endangered, threatened, or species at risk (formerly a "candidate" species) under the Endangered Species Act of 1973, as amended.
fragmentation	the process of reducing the size and connectivity of habitat patches; the disruption of extensive habitats into isolated and small patches.
geographic information system	a computer system capable of storing and manipulating spatial mapping data; more commonly referred to by the acronym GIS
goals	descriptive statements of desired future conditions.
habitat	the sum of environmental factors – food, water, cover, and space – that each species needs to survive and reproduce in an area.
hectare	equal to 2.47 acres.
historic conditions	the composition, structure, and functioning of ecosystems resulting from natural processes that we believe, based on sound professional judgment, were present prior to substantial human-related changes to the landscape.
impoundment	a body of water, such as a pond, confined by a dam, dike, floodgate, or other barrier, that is used to collect and hold water.
interjurisdictional fish	populations of fish that are managed by two or more State or national or tribal governments because of the scope of their geographic distributions or migrations.
invasive species	a non-native species whose introduction causes or is likely to cause economic or environmental harm or harm to human health.
issue	any unsettled matter that requires a management decision. For example, a resource management problem, concern, a threat to

	natural resources, a conflict in uses, or in the presence of an undesirable resource condition.
marl	An unconsolidated sedimentary rock or soil consisting of clay and lime.
migratory bird	a bird species that migrates between wintering and breeding grounds.
National Wildlife Refuge System	all lands, waters, and interests therein administered by the U.S. Fish and Wildlife Service as wildlife refuges, wildlife ranges, wildlife management areas, waterfowl production areas, and other areas for the protection and conservation of fish, wildlife and plant resources.
nonpoint 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 and control.
objectives	actions to be accomplished to achieve a desired outcome or goal. Objectives are more specific, and generally more measurable, than goals.
physiographic area	a bird conservation planning unit with relatively uniform vegetative communities, bird populations, and species assemblages, as well as land use and conservation issues, developed by Partners in Flight.
point source pollution	a source of pollution that involves discharge of waste from an identifiable point, such as a smokestack or sewage-treatment plant.
preferred alternative	the Service's selected alternative identified in the draft Comprehensive Conservation Plan.
prescribed burning/fire	the application of fire to wildland fuels, either by natural or intentional ignition, to achieve identified land use objectives.
priority public use	a compatible wildlife-dependent recreational use of a refuge involving hunting, fishing, wildlife observation and photography, or environmental education and interpretation.
range	the geographic area within which a particular species is found.
restoration	management of a disturbed or degraded habitat that results in the recovery of its original state (e.g., restoration may involve planting native species, removing invasive shrubs, prescribed burning).
riparian	relating the floodplains, banks, and terraces that line rivers.

riparian area	habitat along the banks of a stream, river, or wetland.
scoping	a process for determining the scope of issues to be addressed by a comprehensive conservation plan and for identifying the significant issues. Involved in the scoping process are federal, state and local agencies; private organizations; and individuals.
shifting mosaic	an interconnected patchwork of distinct vegetation types that may shift across the land surface as a result of dynamic ecosystem processes, such as periodic wildfire or flooding.
spawn	the act of reproduction of fishes--the mixing of the sperm from the male fish and the eggs of a female fish.
special use permit	a permit authorized by the refuge manager for an activity that is not usually available to the general public.
species	a distinctive kind of plant or animal having distinguishable characteristics, and that can interbreed and produce young. In taxonomy, a category of biological classification that refers to one or more populations of similar organisms that can reproduce with each other but is reproductively isolated from – that is, incapable of interbreeding with – all other kinds of organisms.
species richness	a simple measure of species diversity calculated as the total number of species in a habitat or community.
stand	an easily defined area of the forest that is relatively uniform in species composition or age and can be managed as a single unit.
stopover habitat	habitat where birds rest and feed during migration. Also called staging area.
strategies	a general approach or specific actions to achieve objectives.
structure	the horizontal and vertical arrangement of trees and other vegetation having different sizes, resulting in different degrees of canopy layering, tree heights, and diameters within a stand.
succession	the natural, sequential change of species composition of a community in a given area.
terrestrial	living on land.
threatened species	those plant or animal species likely to become endangered species throughout all of or a significant portion of their range within the foreseeable future. A plant or animal identified and defined in accordance with the 1973 Endangered Species Act and published in the *Federal Register*.

torpor	a state of decreased activity in an animal, usually short-term, often characterized by a reduced body temperature and rate of metabolism.
trust resources	national resources entrusted by Congress to the U.S. Fish and Wildlife Service for conservation and protection. These “trust resources” include migratory birds, federal-listed endangered and threatened species, inter-jurisdictional fishes, wetlands, and certain marine mammals.
understory	the lower layer of vegetation in a stand, which may include short trees, shrubs, and herbaceous plants.
vernal pool	depressions holding water for a temporary period in spring and other high water periods, and in which several species of amphibians lay eggs.
water rights	the right of a user to use water from a source such as a river, stream, pond, or groundwater source.
watershed	the geographic area within which water drains into a particular river, stream, or body of water. A watershed includes both the land and the body of water into which the land drains.
Wilderness Area	An area designated by Congress as part of the National Wilderness Preservation System.
wilderness study area	Lands and waters identified by inventory as meeting the definition of wilderness and being evaluated for a recommendation that they be included in the Wilderness System.
wildfire	an unplanned, unwanted wildland fires including unauthorized human-caused fires, escaped wildland fires, escaped prescribed fires, and all other wildland fires where the objective is to put the fire out.
wildland fire	any non-structure fire that occurs in the wildland. Three distinct types of wildlife fire have been defined and include wildfire, wildland fire use, and prescribed fire.
wildlife-dependent recreation	A use of a refuge involving hunting, fishing, wildlife observation, wildlife photography, environmental education, or interpretation. The National Wildlife Refuge System Improvement Act of 1997 specifies that these are the six priority general public uses of the National Wildlife Refuge System.

Acronyms and Abbreviations

ACJV	Atlantic Coast Joint Venture
AFWA	Association of Fish and Wildlife Agencies
AGO	America's Great Outdoors
ALB	Asian Longhorned Beetle
AMNET	Ambient Biological Monitoring Network
APHIS	USDA Animal and Plant Health Inspection Service
ATV	All Terrain Vehicle
AQI	Air Quality Index
BCC	Birds of Conservation Concern
BCE	Before Current Era
BCR	Bird Conservation Region
BIDEH	Biological Integrity, Diversity, and Environmental Health
BLS	Bacterial Leaf Scorch
BMP	Best Management Practices
CCP	Comprehensive Conservation Plan
CD	Compatibility Determination
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CEQ	Council on Environmental Quality
CMA	Calcium Magnesium Acetate
CO	Carbon Monoxide
CO_2	Carbon Dioxide
CWD	Chronic Wasting Disease
dbh	Diameter at Breast Height
DO	Dissolved Oxygen
EA	Environmental Assessment
EAB	Emerald Ash Borer
EDRR	Early Detection Rapid Response
EHD	Epizootic Hemorrhagic Disease
EIS	Environmental Impact Statement
ESA	Endangered Species Act
EBTJV	Eastern Brook Trout Joint Venture

EPA	U.S. Environmental Protection Agency
ENSP	New Jersey Endangered and Non-Game Species Program
FMP	Fire Management Plan
FONSI	Finding of No Significant Impact
FWS	U.S. Fish and Wildlife Service
FY	Fiscal Year
GIS	Geographic Information Systems
GPS	Global Positioning System
GSW	Great Swamp Watershed
GSWA	Great Swamp Watershed Association
HMP	Habitat Management Plan
HUA	Hydrologic Unit Area
HUC	Hydrologic Unit Code
IBA	Important Bird Area
IPCC	Intergovernmental Panel on Climate Change
IPM	Integrated Pest Management
LED	Light Emitting Diode
LNE/NP	Lower New England/ Northern Piedmont
LWCF	Land and Water Conservation Fund
MSL	Mean Sea Level
NABCI	North American Bird Conservation Initiative
NAAQS	National Ambient Air Quality Standards
NAWMP	North American Waterbird Management Plan
NEPA	National Environmental Policy Act
NEPARC	New England Partners in Amphibian & Reptile Conservation
NFHAP	National Fish Habitat Action Plan
NHCR	National State Agency Herpetological Conservation Report
NHP	Natural Heritage Program
NHPA	National History Preservation Act
NJDEP	New Jersey Department of Environmental Protection
NJDFW	New Jersey Division of Fish and Wildlife
NJWAP	New Jersey Wildlife Action Plan
NJICS	New Jersey Invasive Species Council
NNL	National Natural Landmarks

NO_2	Nitrogen Oxide
NOAA	National Oceanic and Atmospheric Administration
NPL	National Priorities List
NPS	National Park Service
NVCS	National Vegetation Classification System
NWPS	National Wilderness Preservation System
NWR	National Wildlife Refuge
O_3	Ozone
OGBB	Obligate Grassland Breeding Bird
OU2	Operable Unit 2
OU3	Operable Unit 3
O&M	Operation and Maintenance
PARC	Partners in Amphibian and Reptile Conservation
PASA	Policy Analysis and Science Assistance
Pb	Lead
PCBs	Polychlorinated Biphenyls
PIF	Partners in Flight
PM	Particulate Matter
PUP	Pesticide Use Proposal
SHPO	New Jersey Historic Preservation Office
SO_2	Sulfur Dioxide
SSURGO	Soil Survey Geographic
SWG	State Wildlife Grants
SUP	Special Use Permit
TSS	Total Suspended Solids
USDA	U.S. Department of Agriculture
USGS	U.S. Geological Survey
VOCs	Volatile Organic Compounds
VSP	Visitor Services Plan
WNS	White-Nose Syndrome
WNV	West Nile Virus
WOC	Wildlife Observation Center
WSP	Wilderness Stewardship Plan
YCC	Youth Conservation Corps

Appendix A

USFWS

Tree Swallow

Suspected or Known Species on Great Swamp National Wildlife Refuge

Table A-1. VERTEBRATE SPECIES DOCUMENTED AT GREAT SWAMP NWR

Species[1]	Seasons on the Great Swamp National Wildlife Refuge (Birds)[2]					CCP Resource of Concern	Focal Species
	Spring	Summer	Fall	Winter	Nesting		
BIRDS							
Loons, Grebes and Cormorants							
Red-throated loon							
Common loon							
American Coot							
Horned grebe			r			X	
Double-crested cormorant							
Pied-billed grebe	u	r	o	r		X	
Herons and Ibis							
Least bittern	u	u	u		Y	X	
American Bittern					Y	X	
Little blue heron	o	o	o			X	
Black-crowned night heron							
Yellow-crowned night heron	r	r				X	
Green Heron							
Glossy Ibis							
White Ibis	Accidental						
Cattle Egret							
Snowy egret	r	r	r			X	
Coots and Rails							
American coot							
King rail						X	
Virginia rail	c	c	c	r	Y	X	
Sandhill Crane	Accidental						
Sora	u	u	u	r	Y	X	
Gulls							
Herring gull	o	o	o	u			
Ring-billed gull	u		u	c			
Laughing gull							
Greater black-backed gull							
Lesser black-backed gull	Accidental						
Black-tern	Accidental						
Ducks and Geese							
American black duck	c	u	c	u	Y	X	
American widgeon	u	r	c	o		X	
Atlantic brant	Accidental						
Atlantic Canada goose				c		X	

Species[1]	Seasons on the Great Swamp National Wildlife Refuge (Birds)[2]					CCP Resource of Concern	Focal Species
	Spring	Summer	Fall	Winter	Nesting		
(migrant)							
Atlantic Canada goose	c	c	c	c	Y		
Blue-winged teal	u	u	u		Y	X	
Bufflehead	r		r	r			
Canvasback	r		r	r		X	
Common goldeneye			r	r		X	
Common merganser	r			r		X	
Gadwall	u	r	u	o		X	
Greater White-fronted goose	Accidental						
Green –winged teal	c	r	c	u	Y	X	
Hooded merganser	u	u	u	o	Y	X	
Lesser scaup	Accidental						
Mallard	a	a	a	a	Y		
Mute swan (e)							
Northern pintail	u	r	c	u		X	
Northern shoveler	o	r	o	r		X	
Red-breasted merganser				r		X	
Ring-necked duck	c			o		X	
Ruddy duck			r	r		X	
Snow goose	r		o	o			
Tundra swan	Accidental						
Wood duck	a	a	a	u	Y	X	
Wrens/Nuthatches							
House wren	c	a	c		Y		
Marsh wren	c	c	c	r	Y	X	
Carolina wren	c	c	c	u	Y	X	
Common grackle	a	c	a	o	Y		
Red–breasted nuthatch	o	o	u	o			
Cedar waxwing	c	u	c	u	Y		
Downy woodpecker	c	c	c	c	Y		
Eastern meadowlark	u	u	u	o	Y	X	
Brown Creeper	u	u	u	u	Y	X	
White-breasted nuthatch	c	c	c	c	Y		
Winter wren	u		u	u		X	
Woodpeckers							
Pileated woodpecker	o	o	o	o	Y		
Northern flicker	c	c	c	u	Y	X	
Hairy woodpecker	u	u	u	u	Y	X	
Red-headed woodpecker	o	o	o	u	Y	X	

Species[1]	Seasons on the Great Swamp National Wildlife Refuge (Birds)[2]					CCP Resource of Concern	Focal Species
	Spring	Summer	Fall	Winter	Nesting		
Red-bellied woodpecker	c	c	c	c	Y		
Horned lark		r	r	r		X	
Yellow-bellied sapsucker	u		u	r		X	
Shrikes and Vireos							
White-eyed vireo	u	u	u		Y		
Northern shrike	r		r	r			
Yellow-throated vireo	u	u	u		Y	X	
Philadelphia vireo			o				
Red-eyed vireo	c	c	c		Y		
Warbling vireo	c	u	r		Y		
Loggerhead shrike	Accidental						
Owls							
Eastern screech-owl	u	u	u	u	Y	X	
Barred owl	u	u	u	u	Y		
Barn owl	o	o	o	o		X	
Northern saw-whet owl	r		r	r		X	
Long-eared owl	o		o	o		X	
Short-eared owl	r			r		X	
Great horned owl	c	c	c	c	Y		
Swallows, Swifts and Nightjars							
Cliff swallow	u					X	
Bank swallow	u	u	u				
Chimney swift	c	c	c		Y	X	
Common nighthawk	u	u	c			X	
Purple martin	u	u			Y	X	
Tree swallow	a	a	a	r	Y		
Chuck-will's widow	Accidental						
Tanagers, Grosbeaks and Buntings							
Evening grosbeak	o		o	r			
Indigo bunting	u	o	u		Y	X	
Snow bunting			r	r			
Rose-breasted grosbeak	c	c	c		Y	X	
Orchard oriole	u	u			Y		
Summer tanager	Accidental						
Scarlet tanager	c	c	c		Y	X	X
Cardinal, Finches and Old World Finches							
American goldfinch	a	a	c	c	Y		
Purple Finch	u		u	u		X	
Baltimore oriole	c	c	c		Y	X	

Species[1]	Seasons on the Great Swamp National Wildlife Refuge (Birds)[2]					CCP Resource of Concern	Focal Species
	Spring	Summer	Fall	Winter	Nesting		
House finch	c	c	c	c	Y		
Northern cardinal	c	c	c	c	Y		
White-winged crossbill			r	r			
Red crossbill			r	r		X	
Pine siskin	o		o	o			
Gallanaceous Birds							
Ring-necked pheasant (e)	Accidental						
Wild turkey	c	c	c	c	Y		
Crows and Jays							
American crow	a	a	a	a	Y		
Fish crow	u	o	u	o	Y		
Doves and Cuckoos							
Black-billed cuckoo	u	u	o		Y	X	
Mourning dove	a	a	a	a	Y		
Yellow-billed cuckoo	u	u	o		Y	X	
Rock dove	c	c	c	c	Y		
Sanpipers and Plovers							
American woodcock	a	c	a	o	Y	X	X
Common snipe	a	r	c	o	Y	X	
Dunlin	r					X	
Greater yellowlegs	u	u	u			X	
Killdeer	c	c	c	o	Y	X	
Least sandpiper	c	u	o			X	
Lesser yellowlegs	u	o	u			X	
Pectoral sandpiper	u	u	u			X	
Ruff	Accidental						
Semipalmated sandpiper	o	o	o			X	
Short-billed dowitcher	r	r				X	
Solitary sandpiper	c	u	u			X	
Spotted sandpiper	c	u	u		Y	X	
Upland sandpiper	r					X	
Flycatchers							
Acadian flycatcher	o	o			Y	X	
American pipit	u		u				
American robin	a	a	a	u	Y		
Eastern kingbird	c	c	c		Y	X	
Eastern phoebe	c	c	c	r	Y		
Eastern wood pewee	c	c	c		Y	X	X
Great-crested flycatcher	c	c	c		Y	X	

Species[1]	Seasons on the Great Swamp National Wildlife Refuge (Birds)[2]					CCP Resource of Concern	Focal Species
	Spring	Summer	Fall	Winter	Nesting		
Least flycatcher	u	o	o		Y	X	
Olive-sided flycatcher	o	r	o			X	
Yellow-bellied flycatcher	o	r	o			X	
Willow flycatcher	c	c	c		Y	X	X
Hawks, Eagles, Falcons, Osprey							
American kestrel	c	u	c	u	Y	X	
Bald eagle	o	o	o	o		X	
Cooper's hawk	u	u	u	u	Y	X	
Golden eagle			r	r		X	
Merlin	o		o	r			
Northern harrier	c	r	c	c		X	X
Osprey	u		u			X	
Peregrine falcon			r			X	
Red-shouldered hawk	u	u	u	o	Y	X	
Red-tailed hawk	c	u	c	c	Y		
Rough-legged hawk	r		r	o			
Sharp-shinned hawk	u		c	u		X	
New World Vultures							
Turkey vulture	c	c	c	c			
Black vulture	u	u	u	u	Y		
Thrushes and Mimics							
Brown thrasher	c	c	c	r	Y	X	
Eastern bluebird	c	c	c	c	Y		
Gray catbird	a	a	a	r	Y	X	
Gray-cheeked thrush	u		o			X	
Hermit thrush	c		c	o			
Northern mockingbird	c	c	c	c	Y		
Swainson's thrush	u		u				
Veery	c	c	c		Y		
Varied thrush	Accidental						
Wood thrush	c	c	c		Y	X	X
Chickadees and Titmice							
Tufted titmouse	a	a	a	a	Y		
Golden-crowned kinglet	c		c	u			
Ruby-crowned kinglet	c		c	o			
Black -capped chickadee							
Warblers							
American redstart	c	c	c		Y		
Black-and-white warbler	c	c	c		Y	X	

Species[1]	Seasons on the Great Swamp National Wildlife Refuge (Birds)[2]					CCP Resource of Concern	Focal Species
	Spring	Summer	Fall	Winter	Nesting		
Blackburnian warbler	u	o	u			X	
Blackpoll warbler	c	o	c				
Black-throated blue warbler	c	o	c			X	
Black-throated green warbler	c	o	c			X	
Blue-winged warbler	c	c	c		Y	X	X
Canada warbler	c	r	c			X	
Cerulean warbler	o	o				X	
Common yellowthroat	a	a	a	r	Y		
Connecticut warbler			o				
Golden-winged warbler	o					X	
Hooded warbler	o		o			X	
Blue-gray gnatcatcher							
Kentucky warbler	o	r				X	
Louisiana waterthrush	u	o	o		Y	X	
Magnolia warbler	c	o	c				
Mourning warbler	u	o	o				
Nashville warbler	u		u			X	
Northern parula	c	o	c			X	
Northern waterthrush	c	u	u		Y		
Ovenbird	c	c	c		Y		
Palm warbler	c		u				
Pine warbler	u		o			X	
Prairie warbler	o					X	
Prothonotary warbler	o	r	r		Y	X	
Tennessee warbler	u	o	u				
Wilson's warbler	u		u			X	
Worm-eating warbler	u	o				X	
Yellow warbler	a	a	u		Y		
Yellow-breasted chat	o	o	o		Y	X	
Yellow-rumped warbler	a		c				
Yellow-throated warbler	r					X	
Sparrows, Towhees, Juncos							
Chipping sparrow	c	c	c	r	Y		
Eastern towhee	a	a	a	r	Y	X	X
Dark-eyed junco	c		c	c			
Field sparrow	c	c	c	u	Y	X	
Fox sparrow	u		u	o			
Grasshopper sparrow	r		r			X	
Savannah sparrow	u		u	r		X	

Species[1]	Seasons on the Great Swamp National Wildlife Refuge (Birds)[2]					CCP Resource of Concern	Focal Species
	Spring	Summer	Fall	Winter	Nesting		
Lincoln's sparrow	o		u				
White-throated sparrow	c		c	c		X	
Swamp sparrow	a	a	a	u	Y		
Vesper sparrow	o	r	o	r		X	
American tree sparrow	c		c	c			
Common redpoll	r		r	r			
Le Conte's Sparrow	Accidental						
Sharp-tailed Sparrow (Nelson's)	Accidental						
White-crowned sparrow	o		o				
Song sparrow	a	a	a	c	Y		
Blackbirds and Orioles							
Red winged blackbird	a	a	a	u	Y		
Rusty blackbird	c		c	u		X	
bobolink						X	
Ruby-throated hummingbird	u	o	u		Y		
Brown headed cowbird	c	c	c	o	Y		
Yellow-headed blackbird	Accidental						
Monk Parakeet (e)	Accidental						
MAMMALS							
Beaver							
Big brown bat							
black bear							
Coyote							
Eastern chipmunk							
Eastern cottontail							
Eastern pipistrelle							
Eastern red bat						X	
Eastern small-footed bat						X	
Gray fox							
Gray squirrel							
Hoary bat						X	
house mouse							
Indiana bat						X	X
Little brown bat							
Longtail weasel							
Masked shrew							
Meadow jumping mouse							
Meadow vole							

Species[1]	Seasons on the Great Swamp National Wildlife Refuge (Birds)[2]					CCP Resource of Concern	Focal Species
	Spring	Summer	Fall	Winter	Nesting		
Mink							
Muskrat							
Opossum							
raccoon							
Red fox							
Red squirrel							
River otter						X	
Short-tailed shrew							
Silver-haired bat						X	
Smoky shrew							
Southern flying squirrel							
Southern red-backed vole							
Starnose mole							
Striped skunk							
White-footed mouse							
Whitetail deer							
Woodchuck							
Woodland jumping mouse							
Woodland vole							
AMPHIBIANS							
Blue-spotted salamander						X	X
Red-spotted newt							
Northern dusky salamander							
Redback salamander							
Northern slimy salamander							
Four –toed salamander						X	
Northern red salamander							
Upland chorus frog							
Spring peeper							
Northern cricket frog							
Northern gray treefrog							
Bullfrog							
Green frog							
Wood frog							
Pickerel frog							
Northern leopard frog							
Southern leopard frog							
American toad							
Fowler's toad							

Species[1]	Seasons on the Great Swamp National Wildlife Refuge (Birds)[2]					CCP Resource of Concern	Focal Species
	Spring	Summer	Fall	Winter	Nesting		
REPTILES							
Eastern mud turtle							
Black rat snake							
Bog turtle						X	X
Common musk turtle							
Common snapping turtle							
Eastern box turtle						X	
Eastern garter snake							
Eastern hognose snake							
Eastern milk snake							
Eastern ribbon snake							
Eastern smooth earth snake							
Eastern worm snake							
Five-lined skink							
Northern black racer							
Northern brown snake							
Northern ringneck snake							
Northern water snake							
Painted turtle							
Redbelly turtle							
Red-eared slider							
Smooth green snake						X	
Spotted turtle						X	
Wood turtle						X	X
FISH							
American Brook Lamprey						X	
Banded Killifish							
Banded Sunfish						X	
Black Crappie							
Blacknose Dace							
Bluegill							
Bluespotted sunfish							
Bridle Shiner						X	
Brook Trout						X	
Brown trout							
Brown Bullhead							
Chain Pickerel							
Common Carp							
Common Shiner							

Species[1]	Seasons on the Great Swamp National Wildlife Refuge (Birds)[2]					CCP Resource of Concern	Focal Species
	Spring	Summer	Fall	Winter	Nesting		
Creek Chub							
Creek Chubsucker							
Eastern Mudminnow							
Eastern Silvery Minnow							
Fallfish							
Golden Shiner							
Grass Pickerel							
Green Sunfish							
Inland Silverside							
Johnny Darter							
Largemouth Bass							
Mud Sunfish							
Pumpkinseed							
Redbreast Sunfish							
Redfin Pickerel							
Satinfin Shiner							
Smallmouth Bass							
Spotfin Shiner							
Spottail Shiner							
Tessellated Darter							
White Crappie							
White Sucker							
Yellow Bullhead							
Yellow Perch							

NOTES

[1] Species List compiled from Great Swamp NWR Inventory Lists and NJDEP Bureau of Freshwater Fisheries (2009)

[2] Seasonal occurrence is based upon the likelihood of viewing a species while birding at the refuge (a = abundant, c = common, u = uncommon, o = occasional, r = rare), as indicated in the US Fish and Wildlife Service Great Swamp National Wildlife Refuge Bird List (http://www.fws.gov/northeast/greatswamp/).

Table A-2. INVERTEBRATE SPECIES DOCUMENTED AT GREAT SWAMP NW

Class or Subclass	Order/Suborder	Family/Subfamily	Genius/Species	Common Name
Butterflies				
Insecta	Lepidoptera	Pieridae	*Colias philodice*	Clouded sulphur
Insecta	Lepidoptera	Pieridae	*Colias eurytheme*	Orange sulfur
Insecta	Lepidoptera	Pieridae	*Phoebis sennae*	Cloudless sulphur
Insecta	Lepidoptera	Pieridae	*Pieris rapae*	Cabbage white
Insecta	Lepidoptera	Papilionidae	*Battus philenor*	Pipevine swallowtail
Insecta	Lepidoptera	Papilionidae	*Papilio glaucus*	Eastern tiger swallowtail
Insecta	Lepidoptera	Papilionidae	*Papilio troilus*	Spicebush swallowtail
Insecta	Lepidoptera	Lycaenidae	*Feniseca tarquinius*	Harvester
Insecta	Lepidoptera	Lycaenidae	*Lycaena philaeas*	American copper
Insecta	Lepidoptera	Lycaenidae	*Satryium titus*	Coral hairstreak
Insecta	Lepidoptera	Lycaenidae	*Satryium calanus*	Banded hairstreak
Insecta	Lepidoptera	Lycaenidae	*Satryium liparops*	Striped hairstreak
Insecta	Lepidoptera	Lycaenidae	*Parrhasius m-album*	White M hairstreak
Insecta	Lepidoptera	Lycaenidae	*Satyrium favonius*	Southern hairstreak
Insecta	Lepidoptera	Lycaenidae	*Strymon melinus*	Gray hairstreak
Insecta	Lepidoptera	Lycaenidae	*Everes comyntas*	Eastern tailed blue
Insecta	Lepidoptera	Lycaenidae	*Celastrina ladon*	Spring azure
Insecta	Lepidoptera	Lycaenidae	*Celastrina neglecta*	Summer Azure
Insecta	Lepidoptera	Lycaenidae	*Callophrys augustinus*	brown elfin
Insecta	Lepidoptera	Nymphalidae	*Speyeria cybele*	Great spangled fritillary
Insecta	Lepidoptera	Nymphalidae	*Phyciodes tharos*	Pearl crescent
Insecta	Lepidoptera	Nymphalidae	*Euphydryas phaeton*	Baltimore checkerspot
Insecta	Lepidoptera	Nymphalidae	*Polygonia interrogationis*	Question mark
Insecta	Lepidoptera	Nymphalidae	*Polygonia comma*	Eastern comma
Insecta	Lepidoptera	Nymphalidae	*Nymphalis vau-album*	Compton tortoiseshell
Insecta	Lepidoptera	Nymphalidae	*Nymphalis antiopa*	Mourning cloak
Insecta	Lepidoptera	Nymphalidae	*Vanessa virginensis*	American lady
Insecta	Lepidoptera	Nymphalidae	*Vanessa cardui*	Painted lady
Insecta	Lepidoptera	Nymphalidae	*Vanessa atalanta*	Red admiral
Insecta	Lepidoptera	Nymphalidae	*Junonia coenia*	Common buckeye
Insecta	Lepidoptera	Nymphalidae	*Lirnenitis arthemis astynax*	Red-spotted purple
Insecta	Lepidoptera	Nymphalidae	*Lirnenitis archippus*	Viceroy
Insecta	Lepidoptera	Nymphalidae/ Satyrinae	*Enodia anthedon*	Northern pearly-eye
Insecta	Lepidoptera	Nymphalidae/ Satyrinae	*Satyrodes eurydice*	Eyed brown
Insecta	Lepidoptera	Nymphalidae/ Satyrinae	*Satyrodes appalachia*	Appalachian brown
Insecta	Lepidoptera	Nymphalidae/ Satyrinae	*Megisto cymela*	Little wood-satyr
Insecta	Lepidoptera	Nymphalidae/ Satyrinae	*Cercyonis pegala*	Common wood-nymph
Insecta	Lepidoptera	Nymphalidae/ Danainae	*Danaus plexippus*	Monarch

Class or Subclass	Order/Suborder	Family/Subfamily	Genius/Species	Common Name
Insecta	Lepidoptera	Hesperiidae	*Epargyreus clarus*	Silver -spotted skipper
Insecta	Lepidoptera	Hesperiidae	*Achalarus lyciades*	Hoary edge
Insecta	Lepidoptera	Hesperiidae	*Thorybes bathyllus*	Southern cloudywing
Insecta	Lepidoptera	Hesperiidae	*Erynnis horatius*	Horace's duskywing
Insecta	Lepidoptera	Hesperiidae	*Erynnis juvenalis*	Juvenal's duskywing
Insecta	Lepidoptera	Hesperiidae	*Erynnis baptisiae*	Wild indigo duskywing
Insecta	Lepidoptera	Hesperiidae	*Nastra lherminier*	Swarthy skipper
Insecta	Lepidoptera	Hesperiidae	*Ancyloxypha numitor*	Least skipper
Insecta	Lepidoptera	Hesperiidae	*Thymelicus lineola*	European skipper
Insecta	Lepidoptera	Hesperiidae	*Hyephila phyleus*	Fiery skipper
Insecta	Lepidoptera	Hesperiidae	*Polites themistocles*	Tawny-edged skipper
Insecta	Lepidoptera	Hesperiidae	*Polites peckius*	Peck's skipper
Insecta	Lepidoptera	Hesperiidae	*Polites orignenes*	Crossline skipper
Insecta	Lepidoptera	Hesperiidae	*Wallengrenia egeremet*	Northern broken-dash
Insecta	Lepidoptera	Hesperiidae	*Pompeius verna*	Little glassywing
Insecta	Lepidoptera	Hesperiidae	*Atalopedes campestris*	Sachem
Insecta	Lepidoptera	Hesperiidae	*Anatrytone logan*	Delaware skipper
Insecta	Lepidoptera	Hesperiidae	*Poanes massasoit*	Mulberry wing
Insecta	Lepidoptera	Hesperiidae	*Poanes hobomok*	Hobomok skipper
Insecta	Lepidoptera	Hesperiidae	*Poanes zabulon*	Zabulon skipper
Insecta	Lepidoptera	Hesperiidae	*Poanes viator*	Broad-wing skipper
Insecta	Lepidoptera	Hesperiidae	*Euphyes dion*	Dion skipper
Insecta	Lepidoptera	Hesperiidae	*Euphyes conspicua*	Black dash
Insecta	Lepidoptera	Hesperiidae	*Euphyes vestris*	Dun skipper
Insecta	Lepidoptera	Hesperiidae	*Panoquina ocola*	Ocola skipper
Moths				
Insecta	Lepidoptera	Apatelodidae	*Apelodes torrefacta*	
Insecta	Lepidoptera	Apatelodidae	*Olceclostera angelica*	
Insecta	Lepidoptera	Arctiidae	*Cisseps fulvicollis*	
Insecta	Lepidoptera	Arctiidae	*Clamensia albata*	
Insecta	Lepidoptera	Arctiidae	*Crambidia pallida*	
Insecta	Lepidoptera	Arctiidae	*Cycnia tenera*	
Insecta	Lepidoptera	Arctiidae	*Ecpantheria scribonia*	
Insecta	Lepidoptera	Arctiidae	*Grammia virgo*	
Insecta	Lepidoptera	Arctiidae	*Halysidota tessellaris*	
Insecta	Lepidoptera	Arctiidae	*Haploa clymene*	
Insecta	Lepidoptera	Arctiidae	*Hyphantria cunea*	
Insecta	Lepidoptera	Arctiidae	*Lophocampa caryae*	
Insecta	Lepidoptera	Arctiidae	*Phragmatobia fulignosa*	
Insecta	Lepidoptera	Arctiidae	*Phragmatobia lineata*	
Insecta	Lepidoptera	Arctiidae	*Pyrrharctia isabella*	
Insecta	Lepidoptera	Arctiidae	*Spilosoma virginica*	
Insecta	Lepidoptera	Attevidae	*Atteva punctella*	
Insecta	Lepidoptera	Cossidae	*Zeuzera pyrina*	
Insecta	Lepidoptera	Drepanidae	*Drepana arcuata*	

Class or Subclass	Order/Suborder	Family/Subfamily	Genius/Species	Common Name
Insecta	Lepidoptera	Drepanidae	*Drepana bilineata*	
Insecta	Lepidoptera	Drepanidae	*Oreta rosea*	
Insecta	Lepidoptera	Gelechiidae	*Arogalea cristifasciella*	
Insecta	Lepidoptera	Gelechiidae	*Chionodes mediofuscella*	
Insecta	Lepidoptera	Geometridae	*Alsophila pometaria*	
Insecta	Lepidoptera	Geometridae	*Anavitrinella pampinaria*	
Insecta	Lepidoptera	Geometridae	*Cepphis armataria*	
Insecta	Lepidoptera	Geometridae	*Chloroclystis rectangulata*	
Insecta	Lepidoptera	Geometridae	*Coryphista meadii*	
Insecta	Lepidoptera	Geometridae	*Costaconvexa centrostrigaria*	
Insecta	Lepidoptera	Geometridae	*Cyclophora pendulinaria*	
Insecta	Lepidoptera	Geometridae	*Ectropis crepuscularia*	
Insecta	Lepidoptera	Geometridae	*Ennomos magnaria*	
Insecta	Lepidoptera	Geometridae	*Ennomos subsignaria*	
Insecta	Lepidoptera	Geometridae	*Eubaphe mendica*	
Insecta	Lepidoptera	Geometridae	*Euchlaena serrata*	
Insecta	Lepidoptera	Geometridae	*Eulithis gracilineata*	
Insecta	Lepidoptera	Geometridae	*Euphyia unangulata intermediata*	
Insecta	Lepidoptera	Geometridae	*Eupithecia miserulata*	
Insecta	Lepidoptera	Geometridae	*Eusarca confusaria*	
Insecta	Lepidoptera	Geometridae	*Eutrapela clemataria*	
Insecta	Lepidoptera	Geometridae	*Haematopis grataria*	
Insecta	Lepidoptera	Geometridae	*Heliomata cycladata*	
Insecta	Lepidoptera	Geometridae	*Idaea dimidiata*	
Insecta	Lepidoptera	Geometridae	*Itame pustularia*	
Insecta	Lepidoptera	Geometridae	*Lytrosis unitaria*	
Insecta	Lepidoptera	Geometridae	*Melanophia signataria*	
Insecta	Lepidoptera	Geometridae	*Metarranthis homuraria*	
Insecta	Lepidoptera	Geometridae	*Nacophora quemaria*	
Insecta	Lepidoptera	Geometridae	*Nematocampa limbata*	
Insecta	Lepidoptera	Geometridae	*Nemoria mimosaria*	
Insecta	Lepidoptera	Geometridae	*Orthonama centrostrigaria*	
Insecta	Lepidoptera	Geometridae	*Paleacrita merricata*	
Insecta	Lepidoptera	Geometridae	*Paleacrita vernata*	
Insecta	Lepidoptera	Geometridae	*Phigalia denticulata*	
Insecta	Lepidoptera	Geometridae	*Phigalia strigataria*	
Insecta	Lepidoptera	Geometridae	*Phigalia titea*	
Insecta	Lepidoptera	Geometridae	*Pleuroprucha insularia*	
Insecta	Lepidoptera	Geometridae	*Scopula inductata*	
Insecta	Lepidoptera	Geometridae	*Scopula limboundata*	
Insecta	Lepidoptera	Geometridae	*Semithothsia aequiferaria*	
Insecta	Lepidoptera	Geometridae	*Tetracis crocallata*	
Insecta	Lepidoptera	Geometridae	*Xanthotype utricaria*	

Class or Subclass	Order/Suborder	Family/Subfamily	Genius/Species	Common Name
Insecta	Lepidoptera	Lasiocampidae	*Artace cribraria*	
Insecta	Lepidoptera	Lasiocampidae	*Malacosoma americanum*	
Insecta	Lepidoptera	Lasiocampidae	*Malacosoma disstria*	
Insecta	Lepidoptera	Limacodidae	*Apoda biguttata*	
Insecta	Lepidoptera	Limacodidae	*Apoda y-inversum*	
Insecta	Lepidoptera	Limacodidae	*Parasa chloris*	
Insecta	Lepidoptera	Limacodidae	*Sibine stimulea*	
Insecta	Lepidoptera	Lymantriidae	*Dasychira cinnamomea*	
Insecta	Lepidoptera	Mimallonidae	*Lacosoma chiridota*	
Insecta	Lepidoptera	Lymantriidae	*Acronicta americana*	
Insecta	Lepidoptera	Lymantriidae	*Orgyia leucostigma*	
Insecta	Lepidoptera	Noctuidae	*Acronicta oblinita*	
Insecta	Lepidoptera	Noctuidae	*Acronicta ovata*	
Insecta	Lepidoptera	Noctuidae	*Agrotis ipsilon*	
Insecta	Lepidoptera	Noctuidae	*Allotria elonympha*	
Insecta	Lepidoptera	Noctuidae	*Amphipyra pyramidoides*	
Insecta	Lepidoptera	Noctuidae	*Anagrapha falcifera*	
Insecta	Lepidoptera	Noctuidae	*Anathix ralla*	
Insecta	Lepidoptera	Noctuidae	*Apamea dubitans*	
Insecta	Lepidoptera	Noctuidae	*Apamea ophiogramma*	
Insecta	Lepidoptera	Noctuidae	*Archanara oblonga*	
Insecta	Lepidoptera	Noctuidae	*Autographia precationis*	
Insecta	Lepidoptera	Noctuidae	*Balsa labecula*	
Insecta	Lepidoptera	Noctuidae	*Bellura anoa*	
Insecta	Lepidoptera	Noctuidae	*Bomolocha manalis*	
Insecta	Lepidoptera	Noctuidae	*Caenurgina erechtea*	
Insecta	Lepidoptera	Noctuidae	*Catocala amica*	
Insecta	Lepidoptera	Noctuidae	*Catocala andromedae*	
Insecta	Lepidoptera	Noctuidae	*Catocala blandula*	
Insecta	Lepidoptera	Noctuidae	*Catocala cara*	
Insecta	Lepidoptera	Noctuidae	*Catocala coccinata*	
Insecta	Lepidoptera	Noctuidae	*Catocala concumbens*	
Insecta	Lepidoptera	Noctuidae	*Catocala connubialis*	
Insecta	Lepidoptera	Noctuidae	*Catocala gracilis*	
Insecta	Lepidoptera	Noctuidae	*Catocala grynea*	
Insecta	Lepidoptera	Noctuidae	*Catocala ilia*	
Insecta	Lepidoptera	Noctuidae	*Catocala lineella*	
Insecta	Lepidoptera	Noctuidae	*Catocala obscura*	
Insecta	Lepidoptera	Noctuidae	*Catocala palaeogama*	
Insecta	Lepidoptera	Noctuidae	*Catocala praeclara*	
Insecta	Lepidoptera	Noctuidae	*Catocala residua*	
Insecta	Lepidoptera	Noctuidae	*Catocala retecta*	
Insecta	Lepidoptera	Noctuidae	*Catocala serena*	
Insecta	Lepidoptera	Noctuidae	*Catocala ultronia*	
Insecta	Lepidoptera	Noctuidae	*Cerma cerintha*	
Insecta	Lepidoptera	Noctuidae	*Chaetaglaea sericea*	

Class or Subclass	Order/Suborder	Family/Subfamily	Genius/Species	Common Name
Insecta	Lepidoptera	Noctuidae	*Chrysnaympha formosa*	
Insecta	Lepidoptera	Noctuidae	*Cirrhophanus triangulifer*	
Insecta	Lepidoptera	Noctuidae	*Coenophila opacifrons*	
Insecta	Lepidoptera	Noctuidae	*Colocasia flavicornis*	
Insecta	Lepidoptera	Noctuidae	*Condica videns*	
Insecta	Lepidoptera	Noctuidae	*Cucullia asteroides*	
Insecta	Lepidoptera	Noctuidae	*Cucullia convexipennis*	
Insecta	Lepidoptera	Noctuidae	*Egira altemans*	
Insecta	Lepidoptera	Noctuidae	*Epigalea decliva*	
Insecta	Lepidoptera	Noctuidae	*Euagrotis illapsa*	
Insecta	Lepidoptera	Noctuidae	*Eudryas grata*	
Insecta	Lepidoptera	Noctuidae	*Eudryas unio*	
Insecta	Lepidoptera	Noctuidae	*Eupsilia devia*	
Insecta	Lepidoptera	Noctuidae	*Eutelia pulcherrima*	
Insecta	Lepidoptera	Noctuidae	*Feltia subgothica*	
Insecta	Lepidoptera	Noctuidae	*Galgula partita*	
Insecta	Lepidoptera	Noctuidae	*Harrisimemna trisignata*	
Insecta	Lepidoptera	Noctuidae	*Heliothis zea*	
Insecta	Lepidoptera	Noctuidae	*Himella intractata*	
Insecta	Lepidoptera	Noctuidae	*Hyppa xylinoides*	
Insecta	Lepidoptera	Noctuidae	*Hypsoropha hormos*	
Insecta	Lepidoptera	Noctuidae	*Idia aemula*	
Insecta	Lepidoptera	Noctuidae	*Idia americalis*	
Insecta	Lepidoptera	Noctuidae	*Idia lubricalis*	
Insecta	Lepidoptera	Noctuidae	*Lacinipolia meditata*	
Insecta	Lepidoptera	Noctuidae	*Lacinipolia renigera*	
Insecta	Lepidoptera	Noctuidae	*Lemmeria digitalis*	
Insecta	Lepidoptera	Noctuidae	*Leucania lapidaria*	
Insecta	Lepidoptera	Noctuidae	*Leucania ursula*	
Insecta	Lepidoptera	Noctuidae	*Leuconycta diphteroides*	
Insecta	Lepidoptera	Noctuidae	*Macrochilo orciferalis*	
Insecta	Lepidoptera	Noctuidae	*Megalographa biloba*	
Insecta	Lepidoptera	Noctuidae	*Meropleon diversicolor*	
Insecta	Lepidoptera	Noctuidae	*Metaxaglaea viatica*	
Insecta	Lepidoptera	Noctuidae	*Morrisonia confusa*	
Insecta	Lepidoptera	Noctuidae	*Nedra ramosula*	
Insecta	Lepidoptera	Noctuidae	*Noctua pronuba*	
Insecta	Lepidoptera	Noctuidae	*Ochropleura implecta*	
Insecta	Lepidoptera	Noctuidae	*Oligia chlorostigma*	
Insecta	Lepidoptera	Noctuidae	*Orthodes cynica*	
Insecta	Lepidoptera	Noctuidae	*Orthosia rubescens*	
Insecta	Lepidoptera	Noctuidae	*Paectes abrostolooides*	
Insecta	Lepidoptera	Noctuidae	*Palthis angulalis*	
Insecta	Lepidoptera	Noctuidae	*Pangrapta decoralis*	
Insecta	Lepidoptera	Noctuidae	*Panopoda rufimargo*	
Insecta	Lepidoptera	Noctuidae	*Papaipema arctivorens*	

Class or Subclass	Order/Suborder	Family/Subfamily	Genius/Species	Common Name
Insecta	Lepidoptera	Noctuidae	*Papaipema baptisiae*	
Insecta	Lepidoptera	Noctuidae	*Papaipema cerussata*	
Insecta	Lepidoptera	Noctuidae	*Papaipema inquaesita*	
Insecta	Lepidoptera	Noctuidae	*Papaipema nelita*	
Insecta	Lepidoptera	Noctuidae	*Pericroma saucia*	
Insecta	Lepidoptera	Noctuidae	*Perigea xanthioides*	
Insecta	Lepidoptera	Noctuidae	*Phosphila miselioides*	
Insecta	Lepidoptera	Noctuidae	*Plagiomimicus pityochromus*	
Insecta	Lepidoptera	Noctuidae	*Plathypena scabra*	
Insecta	Lepidoptera	Noctuidae	*Plusia contexta*	
Insecta	Lepidoptera	Noctuidae	*Polia detracta*	
Insecta	Lepidoptera	Noctuidae	*Psaphida rolandi*	
Insecta	Lepidoptera	Noctuidae	*Pseudaletia unipuncta*	
Insecta	Lepidoptera	Noctuidae	*Pseudeustrotia cameola*	
Insecta	Lepidoptera	Noctuidae	*Raphia frater*	
Insecta	Lepidoptera	Noctuidae	*Schinia arcigera*	
Insecta	Lepidoptera	Noctuidae	*Schina rivulosa*	
Insecta	Lepidoptera	Noctuidae	*Scoliopteryx libatrix*	
Insecta	Lepidoptera	Noctuidae	*Simyra henrici*	
Insecta	Lepidoptera	Noctuidae	*Spodoptera omithogalli*	
Insecta	Lepidoptera	Noctuidae	*Sunira bicolorago*	
Insecta	Lepidoptera	Noctuidae	*Trichoplusia ni*	
Insecta	Lepidoptera	Noctuidae	*Ulolonche culea*	
Insecta	Lepidoptera	Noctuidae	*Xestia dilucida*	
Insecta	Lepidoptera	Noctuidae	*Xestia dolosa*	
Insecta	Lepidoptera	Noctuidae	*Xestia smithii*	
Insecta	Lepidoptera	Noctuidae	*Zale aeruginosa*	
Insecta	Lepidoptera	Noctuidae	*Zale horrida*	
Insecta	Lepidoptera	Noctuidae	*Zale lunata*	
Insecta	Lepidoptera	Notodontidae	*Datana contracta*	
Insecta	Lepidoptera	Notodontidae	*Datana ministra*	
Insecta	Lepidoptera	Notodontidae	*Heterocampa guttivitta*	
Insecta	Lepidoptera	Notodontidae	*Heterocampa obliqua*	
Insecta	Lepidoptera	Notodontidae	*Hyparpax aurora*	
Insecta	Lepidoptera	Notodontidae	*Macrurocampa marthesia*	
Insecta	Lepidoptera	Notodontidae	*Nadata gibbosa*	
Insecta	Lepidoptera	Notodontidae	*Psaphida rolandi*	
Insecta	Lepidoptera	Notodontidae	*Pseudaletia unipuncta*	
Insecta	Lepidoptera	Notodontidae	*Pseudeustrotia cameola*	
Insecta	Lepidoptera	Notodontidae	*Oligcentria lignicolor*	
Insecta	Lepidoptera	Notodontidae	*Peridea angulosa*	
Insecta	Lepidoptera	Notodontidae	*Peridea ferruginea*	
Insecta	Lepidoptera	Notodontidae	*Pheosia rimosa*	
Insecta	Lepidoptera	Notodontidae	*Schizura unicornis*	
Insecta	Lepidoptera	Notodontidae	*Symmerista albifrons*	

Class or Subclass	Order/Suborder	Family/Subfamily	Genius/Species	Common Name
Insecta	Lepidoptera	Oecophoridae	*Agonopterix pulvipennella*	
Insecta	Lepidoptera	Oecophoridae	*Semioscopis inornata*	
Insecta	Lepidoptera	Pyralidae	*Aglossa cuprina*	
Insecta	Lepidoptera	Pyralidae	*Agriphila vulgivagella*	
Insecta	Lepidoptera	Pyralidae	*Desmia funeralis*	
Insecta	Lepidoptera	Pyralidae	*Herculia infimbrialis*	
Insecta	Lepidoptera	Pyralidae	*Herpetogramma aegealis*	
Insecta	Lepidoptera	Pyralidae	*Munroedes futilalis*	
Insecta	Lepidoptera	Pyralidae	*Munroessa icciusalis*	
Insecta	Lepidoptera	Pyralidae	*Nomophila nearctica*	
Insecta	Lepidoptera	Pyralidae	*Parapediasia teterrella*	
Insecta	Lepidoptera	Pyralidae	*Pediasia trisecta*	
Insecta	Lepidoptera	Pyralidae	*Peoria approximella*	
Insecta	Lepidoptera	Pyralidae	*Thaumatopsis pexella*	
Insecta	Lepidoptera	Pyralidae	*Udea rubigalis*	
Insecta	Lepidoptera	Pyralidae	*Urola nivalis*	
Insecta	Lepidoptera	Saturnidae	*Actias luna*	
Insecta	Lepidoptera	Saturnidae	*Antheraea polyphemus*	
Insecta	Lepidoptera	Saturnidae	*Automeris io*	
Insecta	Lepidoptera	Saturnidae	*Callosamia anguifera*	
Insecta	Lepidoptera	Saturnidae	*Callosamia promethea*	
Insecta	Lepidoptera	Saturnidae	*Dryocampa rubicunda*	
Insecta	Lepidoptera	Saturnidae	*Hyalophora cecropia*	
Insecta	Lepidoptera	Saturnidae	*Podosesia syringae*	
Insecta	Lepidoptera	Sesiidae	*Synanthedon acerni*	
Insecta	Lepidoptera	Sesiidae	*Synanthedon exitiosa*	
Insecta	Lepidoptera	Sphingidae	*Ceratomia amyntor*	
Insecta	Lepidoptera	Sphingidae	*Ceratomia undulosa*	
Insecta	Lepidoptera	Sphingidae	*Darapsa myron*	
Insecta	Lepidoptera	Sphingidae	*Darapsa pholus*	
Insecta	Lepidoptera	Sphingidae	*Darapsa versicolor*	
Insecta	Lepidoptera	Sphingidae	*Dolba hyloeus*	
Insecta	Lepidoptera	Sphingidae	*Eumorpha pandorus*	
Insecta	Lepidoptera	Sphingidae	*Laothoe juglandis*	
Insecta	Lepidoptera	Sphingidae	*Manduca quinquemaculata*	
Insecta	Lepidoptera	Sphingidae	*Paonias astylus*	
Insecta	Lepidoptera	Sphingidae	*Paonias excaecatus*	
Insecta	Lepidoptera	Sphingidae	*Smerinthus jamaicensis*	
Insecta	Lepidoptera	Tortricidae	*Acleris logiana*	
Insecta	Lepidoptera	Tortricidae	*Acleris chalybeana*	
Insecta	Lepidoptera	Tortricidae	*Acleris schalleriana vibumana*	
Insecta	Lepidoptera	Tortricidae	*Argyrotaenia velutinana*	
Insecta	Lepidoptera	Tortricidae	*Chimoptesis pennsylvaniana*	
Insecta	Lepidoptera	Tortricidae	*Pandemis limitata*	

Class or Subclass	Order/Suborder	Family/Subfamily	Genius/Species	Common Name
Insecta	Lepidoptera	Noctuidae	*Zale undularis*	
Insecta	Lepidoptera	Noctuidae	*Renia nemoralis*	
Insecta	Lepidoptera	Noctuidae	*Archanara subflava ?*	
Insecta	Lepidoptera	Arctiidae	*Cycnia tenera?*	
Insecta	Lepidoptera	Arctiidae	*Holomelina opella*	
Insecta	Lepidoptera	Geometridae	*Eulithis sp.*	
Insecta	Lepidoptera	Geometridae	*Eupithecia sp.*	
Insecta	Lepidoptera	Geometridae	*Metarranthis sp.*	
Insecta	Lepidoptera	Geometridae	*Nemoria bistriana?*	
Insecta	Lepidoptera	Geometridae	*Pero sp.*	
Insecta	Lepidoptera	Noctuidae	*Eupsilia sp.*	
Insecta	Lepidoptera	Noctuidae	*Leucania*	
Insecta	Lepidoptera	Tortricidae	*Cydia sp.*	
Insecta	Lepidoptera	Tortricidae	*Phaneta sp.*	
Insecta	Lepidoptera	Tortricidae	*Pseudexentera sp.*	
Additional Insects/Myriapods				
Insecta	Hymenoptera	Formicidae spp.		Ants
Insecta	Hymenoptera	Vespidae		Hornets
Insecta	Neuroptera	Chrysopidae		Green lacewing
Insecta	Neoptera	Corydalidae		Dobsonflies
Insecta	Diptera	Lauxaniidae		Lauxanid flies
Insecta	Diptera	Simulidae		Black flies
Insecta	Diptera	Asilidae		Robber flies
Insecta	Diptera	Chironomidae spp (4)		Midges
Insecta	Diptera	Tipulidae spp (3)		Crane flies
Insecta	Diptera	Cucilidae spp (3)		Mosquitoes
Insecta	Diptera	Muscidae		House flies
Insecta	Diptera	Tipulidae	*Muscus* sp.	Crane flies
Insecta	Diptera	Dolichopodiadae		Long legged flies
Insecta	Diptera	Lauxaniidae		Lauxanid flies
Insecta	Diptera	Ichneumoninae		Ichneumous flies
Insecta	Diptera	Tabanidae		Horse-flies
Insecta	Diptera	Tenthredinidae		Common sawflies
Insecta	Trichoptera	Psychomyiidae		Trumpet net/tube making caddisflies
Insecta	Trichoptera	Leptoceridae	*Psychomyia* sp.	Long-horned caddisflies
Insecta	Trichoptera spp. (3)			Caddisflies
Insecta	Trichoptera	Philopotamida		Little black sedges
Insecta	Trichoptera	hydropsychida	*Chimarra* sp.	Great gray-spotted sedges
Insecta	Odonata	Libellulidae	Arctopsyche sp.	Skimmers/pearcher dragonflies
Insecta	Odonata/Zygoptera	Coenagrionidae spp (2)		Damselflies
Insecta	Odonata/Zygoptera	Coenagrionidae		Pond damselflies
Insecta	Diptera/Nematocera	Simuliidae	*Argia* sp.	Black fly
Insecta	Ephemeroptera	Heptageniidae	*Simulium vittatum*	March brown and Cahill mayflies

Class or Subclass	Order/Suborder	Family/Subfamily	Genius/Species	Common Name
Insecta	Ephemeroptera	Heptageniidae	*Stenonema* sp.	Little maryatt
Insecta	Hemiptera/ Homoptera	Membracidae spp.(2)	*Epeorus* sp.	Treehoppers
Insecta	Hemiptera /Homoptera	Cicadellidae spp. (7)		Leafhoppers
Insecta	Hemiptera	Aphididae		Aphids
Insecta	Hemiptera	Pentatonidae		Green stink bug
Insecta	Hemiptera	Pentatonidae sp.	*Acrosternum hilare*	Stink bugs
Insecta	Hemiptera	Miridae spp. (2)		Plant bugs
Insecta	Hemiptera	Mesoveliidae		Water treaders
Insecta	Hemiptera	Lygaeidae spp. (2)		Seed bugs
Insecta	Hemiptera	Reduviidae spp (2)		Assasin bugs
Insecta	Hemiptera	Notonectidae spp (2)		Backswimmers
Insecta	Hemiptera	Belostomatidae		Giant waterbugs
Insecta	Hemiptera	Nepidae		Water scorpions
Insecta	Hemiptera	Corixidae		Water Boatman
Insecta	Hemiptera	Pleidae		Pigmy backswimmers
Insecta	Hemiptera	Saldidae		Shore bugs
Insecta	Coleoptera	Buprestidae		Metallic wood-boring beetles
Insecta	Coleoptera	Staphylinidae		Rove beetles
Insecta	Coleoptera	Silphidae		Sexton beetle
Insecta	Coleoptera	Coccinelidae	*Nicrophorus orbicollis*	Asian multicolored lady bug
Insecta	Coleoptera	Coccinelidae	*Harmonia axyridis*	14-spotted lady beetle
Insecta	Coleoptera	Elateridae	*Propylea quatuordecimpuretata*	Click beetles
Insecta	Coleoptera	Histeridae		Hister beetles
Insecta	Coleoptera	Cicinolelidae		6-spotted tiger beetle
Insecta	Coleoptera	Dyticidae	*Cincinadela sexgutata*	Diving beetles
Insecta	Coleoptera	Halipidae		Crawling water beetles
Insecta	Coleoptera	carabidae		Big headed ground beetle
Insecta	Coleoptera	Carabidae		Bombardier beetle
Insecta	Coleoptera	Carabidae		Ground beetle
Insecta	Coleoptera	Carabidae spp. (9)	*Chlaenius* sp.	Ground beetle
Insecta	Coleoptera	Scarabaeidae		Scarab beetle
Insecta	Coleoptera	Scarabaeinae	*Phyllophaga* sp.	True dung beetles
Insecta	Coleoptera	Cantharidae		Soldier beetles
Insecta	Coleoptera	Curculionidae spp. (5)		True weevils
Insecta	Coleoptera	Hydrophilidae spp (2)		Water scavenger beetles
Insecta	Coleoptera	Hydrophilidae		Water scavenger beetles
Insecta	Coleoptera	Chrysomelidae	*Oculatais*	Lily Pad Leaf Beetle
Insecta	Coleoptera	Chrysomelidae spp. 8	*Donacia* sp.	Leaf beetles
Insecta	Dictyoptera/Blattaria	Blattellidae		Wood roaches

Class or Subclass	Order/Suborder	Family/Subfamily	Genius/Species	Common Name
Insecta	Dictopterya/Isoptera			Termites
Insecta	Dictopterya/ Mantoidea			Mantids
Insecta	Orthoptera	Acrididae		Short horned grasshoppers
Insecta	Orthoptera	Tetrigidae		Pygmy grasshoppers
Insecta	Orthoptera	Tettigoniidae		Long horned grasshoppers
Insecta	Orthoptera	Cercopidae		spittle bugs
Insecta	Orthoptera	Gryllidae		Field crickets
Chilopoda	Lithobiomorpha			Stone centipedes
Arachnids				
Arachnida	Araneae spp.(24)			Typical spiders
Arachnida	Araneae	Pisauridae		Fishing spider
Arachnida	Acariformes	Ixodidae	*Dolomedes* sp.	Deer tick
Arachnida	Acariformes	Ixodidae	*Ixodes scapularis*	Wood tick
Arachnida	Acariformes	Hydrachnidia	*Dermacentor variabilis*	Water mites
Arachnida	Acariformes	Tetranychidae		Spider mite
Crustaceans				
Crustacea	Amphipoda	Gammaridae		Scuds
Crustacea	Amphipoda	Talitridae	*Gammarus* sp.	Landhopper
Crustacea	Isopoda	Porcellionidae		Wood louse
Crustacea	Isopoda	Philosciidae	*Porcellio* sp.	Common striped wood louse
Mollusks				
Mollusca	Bivalva/Unionoida	Unionidae	*Philoscia muscorum*	N. Elliptio mussel
Mollusca	Bivalva	Sphaeriidae	*Elliptio complanata*	Fingernail clam
Mollusca	Gastropoda		*Sphaerium* sp.	Snail
Annelid Worms				
Annelida	Oligochaeta			Earthworm
Annelida	Hirudinea			Leech
SOURCES				
2009 Great Swamp NWR Bioblitz				
North American Butterfly Association Surveys, 1994-2009				
Aquatic Invertebrate Survey, D.Cook and E.Hill, 2001				
Moth data, Ken Bliss, 2001-2003				

Table A-3. PLANT SPECIES DOCUMENTED AT GREAT SWAMP NWR

Family	*Scientific Name*	Common Name
Aceraceae	*Acer rubrum*	red maple
Aceraceae	*Acer saccharum*	sugar maple
Aceraceae	*Acer negundo*	boxelder
Aceraceae	*Acer platenoidies*	Norway maple
Aceraceae	*Acer saccharinum*	slilver maple
Acoraceae	*Acorus calamus*	calamus
Alismataceae	*Alisma sp.*	water plantain
Alismataceae	*Alisma subcordatum*	American water plantain
Alismataceae	*Sagittaria sp.*	arrowhead
Alismataceae	*Sagittaria latifolia*	broadleaf arrowhead
Anacardiaceae	*Rhus glabra*	smooth sumac
Anacardiaceae	*Toxicodendron radicans*	eastern poison ivy
Apiaceae	*Cicuta bulbifera*	bulblet-bearing water hemlock
Apiaceae	*Cicuta maculata*	spotted water hemlock
Apiaceae	*Daucus carota*	Queen Anne's lace
Apiaceae	*Sanicula*	sanicle
Apiaceae	*Sium suave*	hemlock waterparsnip
Apocynaceae	*Apocynum androsaemifolium*	spreading dogbane
Apocynaceae	*Apocynum cannabinum*	Indianhemp
Apocynaceae	*Apocynum sp.*	dogbane
Aquifoliaceae	*Ilex opaca*	American holly
Aquifoliaceae	*Ilex verticillata*	common winterberry
Araceae	*Arisaema triphyllum*	Jack-in-the-pulpit
Araceae	*Calla palustris*	wild calla
Araceae	*Peltandra virginica*	green arrow arum
Araceae	*Symplocarpus foetidus*	skunk cabbage
Araliaceae	*Panax quinquefolius*	American ginseng
Araliaceae	Panax trifoliata	dwarf ginseng
Asclepiadaceae	*Asclepias incarnata*	swamp milkweed
Asclepiadaceae	*Asclepias purpurea*	purple milkweed
Asclepiadaceae	*Asclepias syriaca*	common milkweed
Asclepiadaceae	*Asclepias sp.*	milkweed
Asclepiadaceae	*Cynanchum laeve*	honeyvine
Asteraceae	*Achillea millefolium*	common yarrow
Asteraceae	*Ageratina altissima var. altissima*	white snakeroot
Asteraceae	*Ageratina altissima var. altissima*	white snakeroot
Asteraceae	*Ambrosia artemisiifolia*	annual ragweed
Asteraceae	*Aster divaricatus*	white wood aster
Asteraceae	*Arctium minus*	lesser burdock
Asteraceae	*Ambrosia trifida*	great ragweed
Asteraceae	*Artemisia vulgaris*	common wormwood
Asteraceae	*Aster sp.*	aster
Asteraceae	*Bidens cernua*	nodding beggartick
Asteraceae	*Bidens connata*	purplestem beggarticks
Asteraceae	*Bidens discoidea*	small beggarticks

Family	*Scientific Name*	Common Name
Asteraceae	*Bidens frondosa*	devil's beggartick
Asteraceae	*Bidens sp.*	beggartick
Asteraceae	*Bidens tripartita*	threelobe beggarticks
Asteraceae	*Centaurea stoebe ssp. Micranthos*	spotted knapweed
Asteraceae	*Chrysanthemum leucanthemum*	oxeye daisy
Asteraceae	*Cichorium intybus*	blue chicory
Asteraceae	*Cirsium sp.*	thistle
Asteraceae	*Cirsium arvense*	Canada thistle
Asteraceae	*Conyza canadensis*	Canadian horseweed
Asteraceae	*Coreopsis sp.*	tickseed
Asteraceae	*Erechtites hieraciifolia*	American burnweed
Asteraceae	*Erigeron annuus*	daisy fleabane
Asteraceae	*Erigeron philadelphicus*	Philadelphia fleabane
Asteraceae	*Eupatorium dubium*	coastal plain joe-pyeweed
Asteraceae	*Eupatorium fistulosum*	trumpetweed
Asteraceae	*Eupatorium maculatum*	spotted joepyeweed
Asteraceae	*Eupatorium perfoliatum*	common boneset
Asteraceae	*Eupatorium rugosum*	white snakeroot
Asteraceae	*Eurybia divaricata*	white wood aster
Asteraceae	*Euthamia graminifolia*	flat-top goldentop
Asteraceae	*Galinsoga quadriradiata*	shaggy soldier
Asteraceae	*Gnaphalium obtusifolium*	fragrant cudweed
Asteraceae	*Hieracium caespitosum*	meadow hawkweed
Asteraceae	*Hieracium pilosella*	hawkweed
Asteraceae	*Krigia biflora*	two-flower dwarf dandelion
Asteraceae	*Lactuca cf. canadensis*	Canada lettuce
Asteraceae	*Mikania scandens*	climbing hempweed
Asteraceae	*Packera aurea*	golden ragwort
Asteraceae	Packera (Senecio) paupercula	ragwort
Asteraceae	*Solidago caesia*	wreath goldenrod
Asteraceae	*Solidago canadensis*	Canada goldenrod
Asteraceae	*Solidago gigantea*	giant goldenrod
Asteraceae	*Solidago patula*	rough leaf goldenrod
Asteraceae	*Solidago rugosa*	wrinkleleaf goldenrod
Asteraceae	*Solidago sp.*	goldenrod
Asteraceae	*Symphyotrichum divaricatum*	lawn American-aster
Asteraceae	*Symphyotrichum lateriflorum*	calico aster
Asteraceae	*Symphyotrichum puniceum*	purple-stem aster
Asteraceae	*Symphyotrichum racemosum*	small-head aster
Asteraceae	*Taraxacum officinale*	common dandelion
Asteraceae	*Vernonia noveboracensis*	New York ironweed
Balsaminaceae	*Impatiens sp.*	touch-me-not
Balsaminaceae	*Impatiens capensis*	jewelweed
Berberidaceae	*Berberis thunbergii*	Japanese barberry
Berberidaceae	*Podophyllum peltatum*	mayapple
Betulaceae	*Alnus serrulata*	hazel alder
Betulaceae	*Betula alleghaniensis*	yellow birch

Family	*Scientific Name*	Common Name
Betulaceae	*Betula lenta*	sweet birch
Betulaceae	*Betula populifolia*	gray birch
Betulaceae	*Carpinus caroliniana*	American hornbeam
Betulaceae	*Ostrya virginiana*	hophornbeam
Boraginaceae	*Hackelia virginiana*	beggarslice
Boraginaceae	*Myosotis laxa*	small forget-me-not
Brassicaceae	*Alliaria petiolata*	garlic mustard
Brassicaceae	*Barbarea vulgaris*	garden yellowrocket
Brassicaceae	*Capsella bursa-pastoris*	shepherd's purse
Brassicaceae	*Cardamine bulbosa*	bulbous bittercress
Brassicaceae	*Cardamine hirsuta*	hairy bittercress
Brassicaceae	Cardamine impatiens	
Brassicaceae	*Cardamine pensylvanica*	cuckoo flower
Brassicaceae	*Cardamine pratensis*	cuckoo flower
Brassicaceae	*Lepidium campestre*	field pepperweed
Brassicaceae	*Lepidium virginicum*	Virginia pepperweed
Callitrichaceae	*Callitriche sp.*	water starwort
Callitrichaceae	*Callitriche terrestris*	Callitriche
Campanulaceae	*Lobelia cardinalis*	cardinalflower
Caprifoliaceae	*Lonicera japonica*	Japanese honeysuckle
Caprifoliaceae	*Lonicera morrowii*	Marrow's honeysuckle
Caprifoliaceae	*Sambucus canadensis*	common elderberry
Caprifoliaceae	*Viburnum acerifolium*	mapleleaf viburnum
Caprifoliaceae	*Viburnum dentatum*	southern arrowwood
Caprifoliaceae	*Viburnum prunifolium*	blackhaw
Caryophyllaceae	*Arenaria serpyllifolia*	thymeleaf sandwort
Caryophyllaceae	*Cerastium fontanum ssp. vulgare*	big chickweed
Caryophyllaceae	*Cerastium vulgatum*	mouse-ear chickweed
Caryophyllaceae	*Stellaria graminea*	grass-like starwort
Celastraceae	*Celastrus orbiculatus*	oriental bittersweet
Celastraceae	*Celastrus scandens*	American bittersweet
Celastraceae	*Euonymus alatus*	winged burning bush
Celastraceae	*Euonymus americana*	American strawberry-bush
Ceratophyllaceae	*Ceratophyllum demersum*	coon's tail
Clethraceae	*Clethra alnifolia*	coastal sweet pepperbush
Chenopodiaceae	*Chenopodium album*	goosefoot
Clusiaceae	*Hypericum ascyron*	great St. Johnswort
Clusiaceae	*Hypericum boreale*	northern St. Johnswort
Clusiaceae	*Hypericum sp.*	St. Johnswort
Clusiaceae	*Triadenum virginicum*	Virginia marsh St. Johnswort
Convallariaceae	Uvularia sessilifolia	wild oats
Convolvulaceae	*Convolvulus arvensis*	field bindweed
Convolvulaceae	*Calystegia sepium*	hedge false bindweed
Cornaceae	*Cornus amomum*	silky dogwood
Cornaceae	*Cornus florida*	flowering dogwood
Cornaceae	*Cornus racemosa*	gray dogwood
Cornaceae	*Cornus sericea*	red-osier dogwood

Family	*Scientific Name*	Common Name
Cornaceae	*Cornus sp.*	dogwood
Crassulaceae	*Hylotelephium telephium*	witch's moneybags
Crassulaceae	*Penthorum sedoides*	ditch stonecrop
Cupressaceae	*Juniperus virginiana*	eastern redcedar
Cuscutaceae	*Cuscuta gronovii*	scaldweed
Cuscutaceae	*Cuscuta sp.*	dodders
Cyperaceae	*Carex sp.*	sedge
Cyperaceae	*Carex abscondita*	concealed sedge
Cyperaceae	*Carex albicans var. emmonsii*	Emmon's sedge
Cyperaceae	*Carex amphibola*	eastern narrow leaf sedge
Cyperaceae	*Carex aquatilis*	water sedge
Cyperaceae	*Carex atlantica*	prickly bog sedge
Cyperaceae	*Carex blanda*	Eastern woodland sedge
Cyperaceae	*Carex brunescens*	brown sedge
Cyperaceae	*Carex canescens*	silvery sedge
Cyperaceae	*Carex comosa*	longhair sedge
Cyperaceae	Carex communis	sedge
Cyperaceae	*Carex complanata*	flattened sedge
Cyperaceae	*Carex crinita*	fringed sedge
Cyperaceae	*Carex debilis*	white-edge sedge
Cyperaceae	*Carex exilis*	meager sedge
Cyperaceae	*Carex folliculata*	northern long sedge
Cyperaceae	*Carex gravida*	heavy-fruited sedge
Cyperaceae	*Carex grayi*	Gray's sedge
Cyperaceae	*Carex grisea*	inflated narrow-leaf sedge
Cyperaceae	*Carex intumescens*	greater bladder sedge
Cyperaceae	*Carex lacustris*	hairy sedge
Cyperaceae	*Carex laxiculmis*	spreading sedge
Cyperaceae	*Carex laxiflora*	broad looseflower sedge
Cyperaceae	*Carex lupulina*	hop sedge
Cyperaceae	*Carex lurida*	shallow sedge
Cyperaceae	*Carex obtusata*	blunt sedge
Cyperaceae	*Carex pensylvanica*	Pennsylvania sedge
Cyperaceae	*Carex radiata*	Eastern star sedge
Cyperaceae	*Carex scoparia*	broom sedge
Cyperaceae	*Carex squarrosa*	squarrose sedge
Cyperaceae	*Carex stipata Muhl. ex Willd.*	awlfruit sedge
Cyperaceae	*Carex straminea*	straw sedge
Cyperaceae	*Carex stricta*	upright sedge
Cyperaceae	*Carex swanii*	Swan's sedge
Cyperaceae	*Carex tribuloides*	blunt broom sedge
Cyperaceae	*Carex versicaria*	inlfated sedge
Cyperaceae	*Carex vulpinoidea var. vulpinoidea*	fox sedge
Cyperaceae	*Cyperus esculentus*	yellow nutsedge
Cyperaceae	*Cyperus sp.*	flatsedge
Cyperaceae	*Cyperus strigosus*	strawcolored flatsedge
Cyperaceae	*Dulichium arundinaceum*	threeway sedge

Family	*Scientific Name*	Common Name
Cyperaceae	*Eleocharis sp.*	spikerush
Cyperaceae	Eleocharis erythropoda	
Cyperaceae	*Eleocharis ovata*	ovate spikerush
Cyperaceae	*Eleocharis palustris*	marsh spikerush
Cyperaceae	*Eleocharis sp.*	spikerush
Cyperaceae	*Eleocharis tenuis var. pseudoptera*	slender spikerush
Cyperaceae	*Eleocharis tenuis var. tenuis*	slender spikerush
Cyperaceae	*Scirpus atrovirens*	black bulrush
Cyperaceae	*Scirpus cyperinus*	woolgrass
Cyperaceae	*Scirpus sp.*	bulrush
Cyperaceae	*Schoenoplectus fluviatilis*	river bulrush
Dennstaedtiaceae	*Dennstaedtia punctilobula*	eastern hayscented fern
Dicranaceae	*Dicranum sp.*	broom moss
Dioscoreaceae	*Dioscorea quaternata*	fourleaf yam
Dioscoreaceae	*Dioscorea villosa*	yellow yarn
Dipsacaceae	Dipsacus fullonum	teasel
Dryopteridaceae	*Athyrium filix-femina*	lady fern
Dryopteridaceae	*Dryopteris carthusiana*	spinulose shieldfern
Dryopteridaceae	*Dryopteris cristata*	crested woodfern
Dryopteridaceae	*Dryopteris marginalis*	marginal woodfern
Dryopteridaceae	*Onoclea sensibilis*	sensitive fern
Dryopteridaceae	*Polystichum acrostichoides*	Christmas fern
Elaeagnaceae	*Elaeagnus umbellata*	autumn olive
Elaeagnaceae	*Eleagnus angustifolia*	Russian-olive
Equisetaceae	*Equisetum sp.*	horsetail
Equisetaceae	*Equisetum arvense*	field horsetail
Ericaceae	*Gaylussacia baccata*	black huckleberry
Ericaceae	*Gaylussacia frondosa*	dangleberry
Ericaceae	*Gaylussacia sp.*	huckleberry
Ericaceae	*Kalmia angustifolia*	sheep laurel
Ericaceae	*Kalmia latifolia*	mountain laurel
Ericaceae	*Lyonia ligustrina*	maleberry
Ericaceae	*Rhododendron periclymenoides*	pink azalea
Ericaceae	*Rhododendron sp.*	rhododendron
Ericaceae	*Rhododendron viscosum*	swamp azalea
Ericaceae	Vaccinium angustifolium	Low-bush blueberry
Ericaceae	*Vaccinium corymbosum*	highbush blueberry
Ericaceae	*Vaccinium pallidum*	hillside blueberry
Ericaceae	*Vaccinium sp.*	blueberry
Ericaceae	*Vaccinium stamineum*	deerberry
Euphorbiaceae	*Acalypha rhomboidea*	Three-seeded mercury
Fabaceae	*Amphicarpaea bracteata*	American hog peanut
Fabaceae	*Apios americana*	groundnut
Fabaceae	*Gymnocladus dioicus*	Kentucky coffeetree
Fabaceae	*Lotus corniculatus*	bird's-foot trefoil
Fabaceae	*Medicago lupulina*	black medick
Fabaceae	*Melilotus alba*	yellow sweetclover

Family	*Scientific Name*	Common Name
Fabaceae	*Robinia pseudoacacia*	black locust
Fabaceae	*Securigera varia*	crownvetch
Fabacae	*Trifolium campestre*	low hop-clover
Fabacae	*Trifolium pratense*	red clover
Fabaceae	*Trifolium repens*	white clover
Fabaceae	*Vicia cracca*	Canada pea
Fabaceae	*Vicia tetrasperma*	lentil vetch
Fagaceae	*Fagus grandifolia*	American beech
Fagaceae	*Quercus alba*	white oak
Fagaceae	*Quercus bicolor*	swamp white oak
Fagaceae	*Quercus coccinea*	scarlet oak
Fagaceae	*Quercus palustris*	pin oak
Fagaceae	*Quercus prinus*	chestnut oak
Fagaceae	*Quercus rubra*	northern red oak
Fagaceae	*Quercus velutina*	black oak
Gentianaceae	*Bartonia virginica*	yellow screwstem
Geraniaceae	*Geranium maculatum*	spotted geranium
Haloragaceae	*Myriophyllum spicatum*	Eurasian water milfoil
Haloragaceae	*Proserpinaca palustris*	marsh mermaidweed
Hamamelidaceae	*Hamamelis virginiana*	American witchhazel
Hamamelidaceae	*Liquidambar styraciflua*	sweetgum
Hydrocharitaceae	*Vallisneria americana*	Eel-grass
Iridaceae	*Iris sp.*	iris
Iridaceae	*Iris pseudacorus*	paleyellow iris
Iridaceae	*Iris versicolor*	harlequin blueflag
Iridaceae	*Sisyrinchium angustifolium*	pointed blue eyed grass
Iridaceae	Sisyrinchium montanum	Blue-eyed grass
Isoetaceae	*Isoetes sp.*	quillwort
Juglandaceae	Carya alba	mockernut
Juglandaceae	*Carya sp.*	hickory
Juglandaceae	*Carya cordiformis*	bitternut hickory
Juglandaceae	*Carya glabra*	pignut hickory
Juglandaceae	*Carya ovalis*	red hickory
Juglandaceae	*Carya ovata*	shagbark hickory
Juglandaceae	*Juglans cinerea*	butternut
Juglandaceae	*Juglans nigra*	black walnut
Juncaceae	*Juncus sp.*	rush
Juncaceae	*Juncus acuminatus*	sharp fruit rush
Juncaceae	*Juncus effusus*	soft rush
Juncaceae	*Juncus militaris*	bayonet rush
Juncaceae	*Juncus tenuis*	poverty rush
Juncaceae	Luzula multiflora	path rush
Lamiaceae	*Glechoma hederacea*	ground ivy
Lamiaceae	*Lycopus americanus*	water-horehound
Lamiaceae	*Lycopus sp.*	water-horehound
Lamiaceae	*Lycopus uniflorus*	northern bugleweed
Lamiaceae	*Lycopus virginicus*	Virginia water-horehound

Family	*Scientific Name*	Common Name
Lamiaceae	*Mentha sp.*	mint
Lamiaceae	*Mentha arvensis*	field mint
Lamiaceae	*Physostegia virginiana*	false dragon-head
Lamiaceae	*Prunella vulgaris*	common selfheal
Lamiaceae	*Pycnanthemum Michx.*	mountainmint
Lamiaceae	*Pycnanthemum tenuifolium*	narrowleaf mountainmint
Lamiaceae	*Pycnanthemum virginianum*	mountain-mint
Lamiaceae	*Scutellaria lateriflora*	blue skullcap
Lamiaceae	*Stachys tenuifolia*	smooth hedgenettle
Lauraceae	*Lindera benzoin*	northern spicebush
Lauraceae	*Sassafras albidum*	sassafras
Lemnaceae	*Lemna sp.*	duckweed
Lemnaceae	*Lemna minor*	lesser duckweed
Lemnaceae	*Spirodela polyrhiza*	common duckmeat
Lemnaceae	*Wolffia sp.*	watermeal
Lemnaceae	*Wolffia columbiana*	Columbian watermeal
Lemnaceae	Wolfiella brasiliensis	pond scum
Lentibulariaceae	*Utricularia macrorhiza*	common bladderwort
Lentibulariaceae	*Utricularia vulgaris*	greater bladderwort
Leucobryaceae	*Leucobryum sp.*	moss
Liliaceae	*Allium vineale*	wild garlic
Liliaceae	Erythronium americanum	dogtooth violet
Liliaceae	*Maianthemum canadense*	Canada mayflower
Liliaceae	*Medeola virginiana*	Indian cucumber
Liliaceae	*Uvularia sessilifolia*	sessile leaf bellwort
Lycopodiaceae	*Lycopodium digitatum*	fan clubmoss
Lycopodiaceae	*Lycopodium obscurum*	princess pine
Lythraceae	*Decodon verticillatus*	hairy swamp loosestrife
Lythraceae	*Lythrum salicaria*	purple loosestrife
Magnoliaceae	*Liriodendron tulipifera*	tuliptree
Malvaceae	*Hibiscus moscheutos ssp. moscheutos*	crimsoneyed rosemallow
Monotropaceae	*Monotropa uniflora*	indian pipe
Moraceae	*Morus alba*	white mulberry
Myricaceae	Comptonia peregrina	sweet-fern
Myricaceae	*Morella pensylvanica*	northern bayberry
Nymphaeaceae	*Nuphar lutea ssp. advena*	broad-leaf pond-lily
Nyssaceae	*Nyssa sylvatica*	blackgum
Nyssaceae	*Nyssa aquatica*	tupelo
Oleaceae	*Fraxinus sp.*	ash
Oleaceae	*Fraxinus americana*	white ash
Oleaceae	*Fraxinus nigra*	black ash
Oleaceae	*Fraxinus pennsylvanica*	green ash
Onagraceae	*Circaea quadrisulcata*	enchanter's nightshade
Onagraceae	*Epilobium ciliatum ssp. glandulosum*	fringed willowherb
Onagraceae	*Epilobium coloratum*	purpleleaf willowherb
Onagraceae	*Epilobium leptophyllum*	narrowleaf willowherb
Onagraceae	*Ludwigia palustris*	marsh seedbox

Family	*Scientific Name*	Common Name
Onagraceae	*Oenothera biennis*	common evening primrose
Orobanchaceae	*Epifagus virginiana*	beechdrops
Osmundaceae	*Osmunda cinnamomea*	cinnamon fern
Osmundaceae	*Osmunda regalis*	royal fern
Oxalidaceae	*Oxalis europea*	wood sorrel
Oxalidaceae	*Oxalis stricta*	upright yellow wood sorrel
Plantaginaceae	*Plantago lanceolata*	narrowleaf plantain
Plantaginaceae	*Plantago major*	common plantain
Poaceae	*Agrostis sp.*	bentgrass
Poaceae	*Agrostis capillaris*	common bentgrass or browntop
Poaceae	*Agrostis gigantea*	redtop
Poaceae	*Agrostis hymenalis*	winter bentgrass
Poaceae	*Agrostis perennans*	upland bentgrass
Poaceae	*Agrostis stolonifera*	creeping bentgrass
Poaceae	*Andropogon glomeratus*	bushy bluestem
Poaceae	*Andropogon virginicus*	common broom-sedge
Poaceae	*Andropogon virginicus var. abbreviatus*	common broom-sedge
Poaceae	*Anthoxanthum odoratum*	sweet vernalgrass
Poaceae	*Arthraxon hispidus*	carpgrass
Poaceae	*Brachyelytrum septentrionale*	northern shorthusk
Poaceae	*Calamagrostis canadensis*	blue-joint reedgrass
Poaceae	*Cinna arundinacea*	sweet woodreed
Poaceae	*Cinna latifolia*	drooping woodreed
Poaceae	*Dactylis glomerata*	orchard grass
Poaceae	*Danthonia spicata*	poverty oat grass
Poaceae	*Dichanthelium acuminatum*	tapered rosette grass
Poaceae	*Dichanthelium clandestinum*	deertongue
Poaceae	*Dichanthelium leucothrix*	roughish witchgrass
Poaceae	*Digitaria sp.*	crabgrass
Poaceae	*Echinochloa crus-gallii*	barnyard grass
Poaceae	*Echinochloa muricata*	rough barnyard grass
Poaceae	*Echinochloa walteri*	long-awn cock's-spur grass
Poaceae	Elymus hystrix	bottlebrush grass
Poaceae	*Elymus villosus*	hairy wildrye
Poaceae	*Elymus virginicus*	Virginia wild rye
Poaceae	*Elytrigia repens*	quackgrass
Poaceae	*Eragrostis spectabilis*	purple lovegrass
Poaceae	*Festuca filiformis*	fine-leaf sheep fescue
Poaceae	*Festuca pratensis*	meadow fescue
Poaceae	*Glyceria sp.*	mannagrass
Poaceae	*Glyceria canadensis*	rattlesnake mannagrass
Poaceae	*Glyceria striata*	fowl mannagrass
Poaceae	*Holcus lanatus*	velvetgrass
Poaceae	*Hordeum vulgare*	common barley
Poaceae	*Leersia oryzoides*	rice cutgrass
Poaceae	*Leersia sp.*	cutgrass

Family	*Scientific Name*	Common Name
Poaceae	*Leersia virginica*	whitegrass
Poaceae	*Lolium perenne*	perennial ryegrass
Poaceae	*Microstegium vimineum*	Japanese stiltgrass
Poaceae	*Panicum sp.*	panicgrass
Poaceae	*Panicum virgatum*	switchgrass
Poaceae	*Phalaris arundinacea*	reed canarygrass
Poaceae	*Phleum pratense*	timothy
Poaceae	*Phragmites australis*	common reed
Poaceae	*Poa nemoralis*	wood bluegrass
Poaceae	*Poa palustris*	fowl bluegrass
Poaceae	*Poa pratensis*	Kentucky bluegrass
Poaceae	*Schedonorus pratensis*	meadow fescue
Poaceae	*Schizachyrium scoparium*	little bluestem
Poaceae	*Sorghastrum nutans*	Indiangrass
Poaceae	*Tridens flavus*	purpletop tridens
Polygonaceae	*Polygonum amphibium*	water smartweed
Polygonaceae	*Polygonum arifolium*	halberdleaf tearthumb
Polygonaceae	*Polygonum caespitosum*	Oriental lady's thumb
Polygonaceae	*Polygonum hydropiper*	marshpepper knotweed
Polygonaceae	*Polygonum hydropiperoides*	swamp smartweed
Polygonaceae	*Polygonum lapathifolium*	curlytop knotweed
Polygonaceae	*Polygonum pensylvanicum*	Pennsylvania smartweed
Polygonaceae	*Polygonum persicaria*	spotted ladysthumb
Polygonaceae	*Polygonum punctatum*	dotted smartweed
Polygonaceae	*Polygonum robustius*	stout smartweed
Polygonaceae	*Polygonum sagittatum*	arrowleaf tearthumb
Polygonaceae	*Polygonum scandens*	climbing false buckwheat
Polygonaceae	*Polygonum sp.*	smartweed
Polygonaceae	*Polygonum virginianum*	jumpseed
Polygonaceae	*Rumex acetosella*	common sheep sorrel
Polygonaceae	*Rumex crispus*	curly dock
Polytrichaceae	*Polytrichum commune*	haircap moss
Pontederiaceae	*Heteranthera reniformis*	kidneyleaf mud-plantain
Pontederiaceae	*Pontederia cordata*	pickerelweed
Portulacaceae	*Claytonia virginica*	Virginia springbeauty
Potamogetonaceae	*Potamogeton pusillus*	lesser pondweed
Primulaceae	*Anagallis arvensis*	scarlet pimpernel
Primulaceae	*Hottonia inflata*	American featherfoil
Primulaceae	*Lysimachia ciliata*	fringed loosestrife
Primulaceae	*Lysimachia nummularia*	creeping jenny
Primulaceae	*Lysimachia terristris*	swamp candles
Primulaceae	*Trientalis borealis*	starflower
Pyrolaceae	*Chimaphila maculata*	striped prince's pine
Pyrolaceae	*Pyrola sp.*	wintergreen
Pyrolaceae	*Pyrola rotundifolia*	roundleaf wintergreen
Ranunculaceae	*Anemone quinquefolia*	wood anenome
Ranunculaceae	*Clematis virginiana*	devil's darning needles

Family	*Scientific Name*	Common Name
Ranunculaceae	*Enemion biternatum*	false rue anenome
Ranunculaceae	*Ranunculus abortivus*	kidneyleaf buttercup
Ranunculaceae	*Ranunculus acris*	tall buttercup
Ranunculaceae	Ranunculus alleghaniensis	
Ranunculaceae	*Ranunculus pusillus*	low spearwort
Ranunculaceae	Ranunculus recurvatus	hooked buttercup
Ranunculaceae	*Ranunculus repens*	creeping buttercup
Ranunculaceae	*Ranunculus sp.*	buttercup
Ranunculaceae	Thalictrum dioicum	
Ranunculaceae	*Thalictrum pubescens*	king of the meadow
Ranunculaceae	*Thalictrum sp.*	meadowrue
Rhamnaceae	*Frangula alnus*	glossy buckthorn
Rhamnaceae	*Rhamnus cahtartica*	buckthorn
Rosaceae	*Agrimonia parviflora*	Many-flowered agrimony
Rosaceae	*Amelanchier arborea*	common serviceberry
Rosaceae	*Amelanchier canadensis*	Canada serviceberry
Rosaceae	*Amelanchier sp.*	serviceberry
Rosaceae	Aronia melanocarpa	
Rosaceae	*Crataegus sp.*	hawthorn
Rosaceae	*Fragaria virginiana*	Virginia strawberry
Rosaceae	*Geum canadense*	Canada avens
Rosaceae	*Geum laciniatum*	rough avens
Rosaceae	Malus communis	apple
Rosaceae	*Malus sp.*	apple
Rosaceae	*Photinia pyrifolia*	red chokeberry
Rosaceae	*Potentilla arguta*	tall cinquefoil
Rosaceae	*Potentilla canadensis*	dwarf cinquefoil
Rosaceae	*Potentilla simplex*	old-field cinquefoil
Rosaceae	*Potentilla sp.*	cinquefoil
Rosaceae	*Potentilla sterilis*	barren strawberry
Rosaceae	*Prunus serotina*	black cherry
Rosaceae	*Rosa multiflora*	multiflora rose
Rosaceae	*Rosa nitida*	shining rose
Rosaceae	*Rosa palustris*	swamp rose
Rosaceae	*Rosa sp.*	rose
Rosaceae	*Rosa virginiana*	Virginia rose
Rosaceae	*Rubus allegheniensis*	Allegheny blackberry
Rosaceae	*Rubus hispidus*	bristly dewberry
Rosaceae	*Rubus occidentalis*	black raspberry
Rosaceae	*Rubus pensilvanicus*	Pennsylvania blackberry
Rosaceae	*Rubus phoenicolasius*	wine raspberry
Rosaceae	*Rubus sp.*	blackberry
Rosaceae	Sanguisorba canadensis	burnet
Rosaceae	*Spiraea alba var. latifolia*	white meadowsweet
Rosaceae	*Spiraea tomentosa*	steeplebush
Rubiaceae	*Cephalanthus occidentalis*	common buttonbush
Rubiaceae	*Cruciata pedemontana*	Piedmont bedstraw

Family	*Scientific Name*	Common Name
Rubiaceae	*Galium aparine*	stickywilly
Rubiaceae	*Galium asprellum*	rough bedstraw
Rubiaceae	*Galium cf trifidum*	three petal bedstraw
Rubiaceae	*Galium mollugo*	great hedge bedstraw
Rubiaceae	*Galium obtusum*	bluntleaf bedstraw
Rubiaceae	*Galium palustre*	common marsh bedstraw
Rubiaceae	*Galium sp.*	bedstraw
Rubiaceae	*Galium uniflorum*	one flower bedstraw
Rubiaceae	*Mitchella repens*	partridgeberry
Salicaceae	Populus balsamifera	balsam poplar
Salicaceae	*Populus deltoides*	Eastern cottonwood
Salicaceae	*Populus grandidentata*	bigtooth aspen
Salicaceae	*Populus tremuloides*	quaking aspen
Salicaceae	*Salix sp.*	willow
Salicaceae	*Salix atrocinerea*	large gray willow
Salicaceae	*Salix eriocephala*	Missouri River willow
Salicaceae	*Salix fragilis*	crack willow
Salicaceae	*Salix nigra*	black willow
Salicaceae	*Salix petiolaris*	meadow willow
Salicaceae	*Salix sericea*	silky willow
Saururaceae	*Saururus cernuus*	lizard's tail
Scrophulariaceae	*Agalinis tenuifolia var. tenuifolia*	slenderleaf false foxglove
Scrophulariaceae	*Lindernia dubia*	yellowseed false pimpernel
Scrophulariaceae	*Mimulus alatus*	sharp-wing monkey flower
Scrophulariaceae	*Mimulus ringens*	Allegheny monkeyflower
Scrophulariaceae	*Penstemon digitalis*	talus slope penstemon
Scrophulariaceae	*Verbascum thapsus*	common mullein
Scrophulariaceae	*Veronica arvensis*	corn speedwell
Scrophulariaceae	*Veronica peregrina*	neckweed
Scrophulariaceae	*Veronica persica*	bird's eye speedwell
Simaroubaceae	*Ailanthus altissima*	tree of heaven
Smilacaceae	*Smilax glauca*	cat greenbrier
Smilacaceae	*Smilax herbacea*	smooth carrion flower
Smilacaceae	*Smilax rotundifolia*	roundleaf greenbrier
Solanaceae	*Physalis heterophylla*	clammy ground-cherry
Solanaceae	*Solanum carolinense*	horse-nettle
Solanaceae	*Solanum dulcamera*	climbing nightshade
Solanaceae	*Solanum nigrum*	black nightshade
Sparganiaceae	*Sparganium sp.*	bur-reed
Sparganiaceae	*Sparganium americanum*	American bur-reed
Sparganiaceae	*Sparganium androcladum*	branched bur-reed
Sparganiaceae	*Sparganium angustifolium*	greenfruit bur-reed
Sparganiaceae	*Sparganium eurycarpum*	broadfruit bur-reed
Sphagnaceae	*Sphagnum sp.*	sphagnum
Thelypteridaceae	*Thelypteris noveboracensis*	New York fern
Thelypteridaceae	*Thelypteris palustris*	eastern marsh fern
Tiliaceae	Tilia americana	linden

Family	*Scientific Name*	Common Name
Typhaceae	*Typha angustifolia*	narrowleaf cattail
Typhaceae	*Typha latifolia*	broadleaf cattail
Ulmaceae	*Ulmus americana*	American elm
Ulmaceae	*Ulmus rubra*	slippery elm
Urticaceae	*Boehmeria cylindrica*	smallspike false nettle
Urticaceae	*Laportea canadensis*	Canadian woodnettle
Urticaceae	*Pilea pumila*	Canadian clearweed
Verbenaceae	*Verbena hastata*	swamp verbena
Verbenaceae	*Verbena urticifolia*	white vervain
Violaceae	*Viola cucullata*	marsh blue violet
Violaceae	*Viola lanceolata*	bog white violet
Violaceae	*Viola sororia*	common blue violet
Violaceae	*Viola sp.*	violet
Vitaceae	*Parthenocissus quinquefolia*	Virginia creeper
Vitaceae	Vinca minor	vinca
Vitaceae	Vitis aestivalis	spring grape
Vitaceae	*Vitis labrusca*	fox grape
Vitaceae	*Vitis sp.*	grape
Bryophyta (Mosses)		
Amblystegiaceae	*Amblystegium riparium*	
Anomodontaceae	*Anomodon attenuatus*	tree skirt
Aulacomniaceae	*Aulacomnium palustre*	club moss
Bryaceae	*Leptobryum pyriforme*	
Climaciaceae	*Climacium americanum*	tree moss
Dicranaceae	*Dicranum scoparium*	eyelash moss
Entodontaceae	*Entodon cladorrhizans*	
Hypnaceae	*Homomallium adnatum*	
Hypnaceae	*Hypnum curvifolium*	
Hypnaceae	*Hypnum imponens*	
Leucobryaceae	*Leucbyrum glaucum*	white moss
Leucobryaceae	*Leucobryum albidum*	cushion moss
Mniaceae	*Plagiomnium cuspidatum*	
Orthotrichaceae	*Orthotrichum ohioense*	
Plagiotheciaceae	*Plagiothecium laetum*	
Polytrichaceae	*Atrichum altecristatum*	
Polytrichaceae	*Polytrichum ohioense*	Hairy-cap moss
Sphagnaceae	*Sphagnum cuspidatum*	peat moss
Sphagnaceae	*Sphagnum fimbriatum*	peat moss
Sphagnaceae	*Sphagnum inundatum*	peat moss
Sphagnaceae	*Sphagnum palustre*	peat moss
Sphagnaceae	*Sphagnum squarrosum*	pear moss
Sphagnaceae	*Sphagnum subsecundum*	peat moss
Thuidiaceae	*Thuidium delicatulum*	fern moss
Lycopodiophyta (Clubmosses)		
Lycopodiaceae	*Lycopodium clavatum*	club-moss
Lycopodiaceae	*Lycopodium dendroideum*	ground-pine
Lycopodiaceae	*Lycopodium digitatum*	running cedar

Table A-4. FUNGI SPECIES DOCUMENTED AT GREAT SWAMP NWR

Family	Genus and Species
Amanitaceae	*Amanita brunnescens*
Amanitaceae	*Amanita citrina*
Amanitaceae	*Amanita flavoconia*
Amanitaceae	*Amanita gallica*
Amanitaceae	*Amanita rubescens*
Amanitaceae	*Amanita vaginata*
Atheliaceae	*Plicaturopsis crispa*
Bankeraceae	*Sarcodon atriviridis*
Bankeraceae	*Hydnellum scrobiculatum*
Bolbitiaceae	*Agrocybe erebia*
Bolbitiaceae	*Agrocybe pediades*
Bolbitiaceae	*Agrocybe praecox*
Bolbitiaceae	*Concybe lactea*
Boletaceae	*Boletus bicolor*
Boletaceae	*Boletus frostii*
Boletaceae	*Boletus hortonii*
Boletaceae	*Boletus pallidus*
Boletaceae	*Boletus spacidiceus*
Boletaceae	*Tylopilus alboater*
Boletaceae	*Tyoplius felleus*
Cephaloziaceae	*Odontoschisma denudatum*
Ceratiomyxaceae	*Ceratiomyxa fruticulosa*
Ceratiomyxaceae	*Fuligo septica*
Ceratiomyxaceae	*Lycogala epidendrum*
Chanthatellaceae	*Cantharellus cinnabarinus*
Chanthatellaceae	*Cantharellus minor*
Clavariaceae	*Clavulinopsis fusiformis*
Clavariaceae	*Ramariopsis kunzei*
Coprinaceae	*Psathyrella candolleana*
Coprinaceae	*Psathyrella conissans*
Coprinaceae	*Psathyrella velutina*
Cortinariaceae	*Inocybe geophylla*
Cortinariaceae	*Phaeomarasmius erinoceellus*
Cortinariaceae	*Rozites caperata*
Deuteromycete	*Chromelosporium carneum*
Entolomataceae	*Entoloma stricticus*
Entolomataceae	*Leptonia caesiocincta*
Entolomataceae	*Nolanea murraii*
Entolomataceae	*Nolanea verna*
Fomitopsidaceae	*Daedalea quercina*
Fomitopsidaceae	*Fomitopsis spraguei*
Fomitopsidaceae	*Piptoporus betulinus*
Ganodermataceae	*Ganoderma applanatum*
Geocalycaceae	*Chiloscyphus profundus*

Family	Genus and Species
Gloeophyllaceae	*Gloeophyllum sepiarium*
Gyroporaceae	*Gyroporus castaneus*
Hapalopilaceae	*Hapalopilus nidulans*
Hapalopilaceae	*Ischnoderma resinosum*
Helotiaceae	*Bisporella citrina*
Hymenochaetaceae	*Hydrochaete olivaceum*
Hymenochaetaceae	*Ionotus hispidus*
Hymenochaetaceae	*Phellinus everhartii*
Hymenochaetaceae	*Phellinus gilvus*
Hymenochaetaceae	*Phellinus sp*
Jubulaceae	*Frullania eboracensis*
Leotiaceae	*Leotia lubrica*
Lycoperdaceae	*Calvatia cyanthiformis*
Lycoperdaceae	*Lycoperdon perlatum*
Marasimus	*Marasmius pyrrhocephalus*
Marasmiaceae	*Armillaria gallica*
Marasmiaceae	*Armillaria mellea*
Marasmiaceae	*Armillaria tabescens*
Meripilaceae	*Grifola frondosa*
Meruliaceae	*Phlebia radiata*
Nectriaceae	*Leucogloea compressa*
Nidulariaceae	*Cyathus stercoreus*
Pezizaceae	*Peziza badioconfusa*
Phallaceae	*Mutinus elegans*
Pleurotaceae	*Hohenbuehelia mastrucata*
Pleurotaceae	*Hypsizygus tessulatus*
Pleurotaceae	*Pleurotus ostreatus*
Pluteaceae	*Pluteus cervinus*
Polyporaceae	*Daedaliopsis confragosa*
Polyporaceae	*Laetiporus sulfureus*
Polyporaceae	*Lenzites betulinus*
Polyporaceae	*Lenzites betulinus*
Polyporaceae	*Oligoporus caesius*
Polyporaceae	*Polyporus alveolaris*
Polyporaceae	*Polyporus craterellus*
Polyporaceae	*Polyporus elegans*
Polyporaceae	*Trametes conchifer*
Polyporaceae	*Trametes mesenterica*
Polyporaceae	*Trametes versicolor*
Polyporaceae	*Trichaptum biforme*
Polyporaceae	*Trichaptum biforme*
Polyporaceae	*Tyromyces chioneus*
Pyronemataceae	*Scutellina scutellata*
Reticulariaceae	*Lycogala epidendrum*
Russulaceae	*Lactarius aquifluus*
Russulaceae	*Lactarius chrysorheus*
Russulaceae	*Lactarius gerardi*

Family	Genus and Species
Russulaceae	*Lactarius subvellerus*
Russulaceae	*Russula compacta*
Russulaceae	*Russula nigricans*
Russulaceae	*Russula ochroleucoides*
Russulaceae	*Russula virescens*
Schizoporaceae	*Oxyporus populinus*
Sclerodermataceae	*Scleroderma areolatum*
Stemonitidaceae	*Stemonitis sp.*
Stereaceae	*Stereum striatum*
Stereaceae	*Stereum complicatum*
Stereaceae	*Stereum ostrea*
Stereaceae	*Xylobolus frustulatus*
Strophariaceae	*Hypholoma sublateritium*
Tremellaceae	*Tremella mesenterica*
Tricholomataceae	*Gymnopus biformis*
Tricholomataceae	*Gymnopus castaneus*
Tricholomataceae	*Gymnopus dryophilus*
Tricholomataceae	*Gymnopus iocephalus*
Tricholomataceae	*Gymnopus subnudus*
Tricholomataceae	*Hygrophorus borealis*
Tricholomataceae	*Hygrophorus conicus*
Tricholomataceae	*Hygrophorus miniatus*
Tricholomataceae	*Hygrophorus parvulus cf.*
Tricholomataceae	*Laccaria amethystea*
Tricholomataceae	*Mycena epipterygia*
Tricholomataceae	*Mycena pura*
Tricholomataceae	*Trichloloma resplendens*
Tricholomataceae	*Trichloloma sejunctum*
Tricholomataceae	*Trichloloma subluteum*
Tricholomataceae	*Panellus stipticus*
Lichens	
Parmeliaceae	*Parmotrema hypotropum*
Parmaliaceae	*Flavoparmelia caperata*
Parmaliaceae	*Parmelia sulcata*
Parmeliaceae	*Punctelia rudecta*
Physciaceae	*Physia millegrana*
Cladoniaceae	*Cladonia cristatella*
SOURCE:	
Dorothy Smellen	
2009 Great Swamp NWR BioBlitz	

Appendix B

Wilderness Review

WILDERNESS REVIEW PROCESS

The purpose of a wilderness review is to identify and recommend for Congressional designation National Wildlife Refuge System (Refuge System) lands and waters that merit inclusion in the National Wilderness Preservation System (NWPS). Wilderness reviews are a required element of Comprehensive Conservation Plans (CCPs). They are conducted in accordance with the U.S. Fish and Wildlife Service's (Service) wilderness review and evaluation policy guidance (610 FW 4) and according to the refuge planning process outlined in 602 FW 1 and 3, including public involvement and National Environmental Policy Act (NEPA) compliance.

There are three phases to the wilderness review process:

1) Wilderness Inventory. The wilderness inventory identifies lands and waters that meet the minimum criteria for wilderness. These areas are called wilderness study areas (WSAs).
2) Wilderness Study. The wilderness study evaluates a range of management alternatives to determine if a WSA is suitable for wilderness designation or management under an alternate set of goals and objectives that do not involve wilderness designation. The findings of the study determine whether we will recommend an area for wilderness designation in the final CCP.
3) Wilderness Recommendation. The recommendation phase consists of reporting recommendations for wilderness designation from the Director of the Service through the Secretary of the Interior and the President to Congress in a wilderness study report. The study report is prepared following completion of the CCP. Congress has reserved the authority to make final decisions on wilderness designation.

This appendix summarizes the inventory and study phases of the wilderness review for the Great Swamp National Wildlife Refuge (refuge).

Wilderness Inventory

The wilderness inventory consists of identifying areas that minimally meet the requirements for wilderness as defined in the Wilderness Act of 1964 (Wilderness Act). It represents a broad look at the planning area to identify WSAs.

The definition of wilderness is found in section 2(c) of the Wilderness Act: "A wilderness, in contrast with 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. In this act, an area of wilderness is further defined to mean an area of undeveloped federal land 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 the 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 of sufficient 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 historic value."

Wilderness Study

During the study phase, lands and waters qualifying for wilderness as a result of the inventory are studied in greater detail to analyze values (e.g., ecological, recreational, cultural, economic, and symbolic), resources (e.g., wildlife, water, vegetation, minerals, and soils), public uses, and refuge management activities within the area. The analysis includes an evaluation of whether the WSA can be effectively managed to preserve its wilderness character.

An "All Wilderness Alternative" and a "No Wilderness Alternative" are analyzed for each WSA to compare the benefits and impacts of managing the area as wilderness as opposed to managing the area under an alternate set of goals, objectives, and strategies that do not involve wilderness designation. The environmental analysis addresses

benefits and impacts to wilderness values and other resources under each management alternative. The study evaluates how each alternate will:

- Achieve the purposes of the Wilderness Act and the NWPS;
- Affect achieving refuge or planning unit purpose(s);
- Affect the refuge's contribution toward achieving the Refuge System mission;
- Affect maintaining and, where appropriate, restoring biological integrity, diversity, and environmental health at various landscape scales; and
- Meet other legal and policy mandates.

The findings of the study help determine the WSAs suitability for management and preservation as wilderness with regard to its primary purposes as a refuge. The information, analysis, and decisions in the CCP and associated NEPA document provide the rationale for wilderness suitability determinations and the basic source of information throughout the public, executive, and legislative review processes that follow.

Wilderness Recommendation

There is no requirement to recommend a WSA for congressional designation as wilderness. The final CCP and record of decision document the Service's determination on a WSA's suitability (or unsuitability) for wilderness and decision to recommend (or not recommend) an area for designation.

For a WSA recommended suitable for designation, additional steps will be required including preparing a wilderness study report that presents the results of the wilderness review, documentation of opportunities for public review, a copy of the final CCP, and a legislative Environmental Impact Statement (LEIS). Once these documents are prepared, they are transmitted from the Service Director to the Secretary of the Interior to the President, and ultimately to Congress for approval.

WSAs recommended as suitable for wilderness designation are managed according to the management direction provided in the final CCP. Recommended wilderness areas (RWAs) have been approved by the Director and forwarded to the Secretary for consideration. RWAs are managed to maintain their wilderness character. Proposed Wilderness Areas (PWAs) have been approved by the Secretary and forwarded to the President for consideration. PWAs are managed consistent with Service Wilderness Stewardship policy 610 FW 1-3 and sections 4.22B and C. Areas will be managed at their respective level of approval until either Congress legislatively designates the area as wilderness or the CCP is amended to modify or remove the wilderness proposal.

WILDERNESS INVENTORY OF GREAT SWAMP NWR

The wilderness inventory is a broad look at the CCP planning area to identify WSAs. WSAs are roadless areas within the refuge boundaries that meet the minimum criteria for wilderness identified in Section 2(c) of the Wilderness Act. A WSA must meet the minimum size requirement (or be a roadless island), appear natural, and provide outstanding opportunities for solitude or primitive recreation. Other supplemental values are evaluated, but not required. Our inventory of potentially eligible lands and waters and the application of the wilderness criteria are described in the following sections and summarized in Table B-1.

Identification Lands of Potentially Eligible for Consideration as Wilderness

Identification of potentially eligible lands and waters required gathering land status maps, land acquisition documents including pre-acquisition surveys where available, land use and road inventory data, and aerial imagery of existing refuge tracts. First-hand knowledge by staff of the current and past history of tracts was also important in refining the analysis. Only roadless lands currently owned by the refuge were evaluated. "Roadless" refers to the absence of improved roads suitable and maintained for public travel by means of motorized vehicles primarily intended for highway use. Additionally, only lands and waters currently owned by the Service in fee title were included in the

evaluation. These lands and waters are included in five WSAs all contiguous with the existing Wilderness Area. Each unit is listed in Table B-1 and shown in Map B-1. WSAs are described in greater detail in the Wilderness Study section of this review.

Evaluation of Size Criteria

An inventory unit meets the size criteria for a WSA if any one of the following standards applies (610 FW 4.8):

- An area with over 5,000 contiguous acres. State and private lands are not included in making this acreage determination.
- A roadless island of any size. A roadless island is defined as an area surrounded by permanent waters or that is markedly distinguished from the surrounding lands by topographical or ecological features.
- An area of less than 5,000 contiguous Federal acres that is of sufficient size as to make practicable its preservation and use in an unimpaired condition, and of a size suitable for wilderness management.
- An area of less than 5,000 contiguous Federal acres that is contiguous with a designated wilderness, recommended wilderness, or area under wilderness review by another Federal wilderness managing agency such as the Forest Service, National Park Service, or Bureau of Land Management.

1. Discussion

Great Swamp NWR encompasses 7,768 acres and has an approved acquisition boundary that would allow for expansion to a maximum of 9,429 acres. Great Swamp NWR is located 26 miles from New York City within the Townships of Chatham, Harding, and Long Hill of Morris County in north-central New Jersey. The surrounding area is heavily suburbanized and, as a result, the refuge has become an island of wildlife habitat in a sea of development. The Great Swamp NWR Wilderness Area (GSWA) is 3,660 acres in size and encompasses roughly the eastern half of the refuge with all designated wilderness lands lying east of New Vernon and Long Hill Roads. The GSWA was established by Congress on September 28, 1968 (Public Law 90-352) and has the distinction of being the first Wilderness Area within the Department of the Interior.

Lands and waters west of New Vernon and Long Hill Roads lie within the “Management Area” of the refuge. These lands are not contiguous with the GSWA, being separated by paved, heavily travelled county roads. They are managed intensively for wildlife, habitat, and public use to facilitate the accomplishment of refuge purposes and the mission of the Service. They are also heavily encumbered with permanent road and structures. Since these lands and waters are not contiguous with federally designated or proposed wilderness, do not exceed 5,000 acres in total, contain significant permanent roads and structures, and must be managed in ways inconsistent with the preservation of their character as wilderness, they do not meet the criteria for WSAs and were not evaluated further.

Most, but not all, refuge lands and waters east of New Vernon and Long Hill Roads lie within the GSWA. Approximately 654 acres east of this dividing line are either contiguous with or in close proximity to the GSWA. These non-wilderness tracts were either excluded from the original 1968 wilderness designation or were acquired subsequent to designation. The GSWA is bounded by a perimeter of major utility rights-of-way (ROW; gas and electric) along its southeastern and northeastern borders. The northern border below Pleasantville Road is also bounded in large part by a ROW. All of these ROWs pre-date the establishment of the GSWA. Approximately 206 acres comprised of 33 different tracts are either partially or completely separated from the GSWA by these ROWs. Given the significant infrastructure present and the intensive management and maintenance requirements of these ROWs, they effectively serve as barriers separating the refuge lands and waters that lie beyond the ROW from the wilderness lands that lie within its perimeter. Tracts beyond the ROW can therefore not be considered contiguous with the GSWA, are far smaller than 5,000 acres, and cannot be managed in a way that preserves wilderness character and maintains unimpaired conditions. Given that, refuge lands and waters lying beyond ROWs do not meet the criteria for WSAs and were not evaluated further.

The following five areas were identified for further evaluation as potential WSAs. All lie east of New Vernon and Long Hill Roads, are already owned by the refuge, are contiguous with the GSWA, and lie inside ROWs (see Map B-1).

The Meyersville A WSA encompasses 247.0 acres contiguous with the southwest corner of the GSWA (see Map B-2). It is located east of New Vernon Road and north of Meyersville Road. Tracts 122 and 343 are separated by the eastern terminus of White Bridge Road. Tracts 122a and 122m front New Vernon Road while tract 122q is bounded to the north by White Bridge Road. The southeast border of tracts 189 and 290 are bounded by a utility ROW. Several private properties are adjacent to the WSA and lie within the acquisition boundary of the refuge.

The Meyersville B WSA encompasses 156.7 acres also contiguous with the southwest corner of the GSWA (see Map B-3). It is located east of New Vernon Road and north of Meyersville Road. Tract 343 is bounded to the south by the eastern terminus of White Bridge Road. Several private properties are adjacent to the WSA and lie within the acquisition boundary of the refuge.

The Long Hill Lane WSA encompasses 3.9 acres contiguous with the southeastern boundary of the GSWA (see Map B-4). It is located north of Long Hill Lane. Several private properties are adjacent to the WSA and lie within the acquisition boundary of the refuge.

The Ferber WSA encompasses 39.4 acres contiguous with the boundary of the GSWA between Woodland and Meyersville Roads (see Map B-5). Several private properties are adjacent to the WSA and lie within the acquisition boundary of the refuge. Tract 276R (0.8 acres) is a small finger of refuge land a short distance to the west of the main WSA tracts that was acquired to provide access from Woodland Road to the GSWA. The tract follows a paved driveway between a residence to the east and a mowed field to the west before intersecting with the corner of wilderness tract 215.

The Britten WSA encompasses 2.0 acres contiguous with the northeast boundary of the GSWA (see Map B-6). Tract #269R extends from the wilderness boundary to Britten Road. The Britten WSA is a small finger of refuge land acquired to provide access from Britten Road to the GSWA. The WSA passes closely between two residences and landscaped yards and becomes increasingly impacted by human development as it nears the road. Despite connecting directly to the GSWA, the narrow, linear shape of the WSA combined with its small size and closely proximity to human habitation makes its management as wilderness impractical.

2. Conclusion

Four of the five WSAs described above meet the wilderness size criteria of a roadless area of less than 5,000 contiguous Federal acres that is contiguous with a designated wilderness. The Britten WSA, while technically meeting the wilderness size criteria, is of such a size, shape, and location as to make its management as wilderness impractical and it has been excluded from further evaluation as a WSA. The size evaluation for each WSA is summarized in Table B-1.

Evaluation of the Naturalness Criteria

To qualify as a WSA, an area must meet the naturalness criterion (610 FW 4.9). Section 2(c) of the Wilderness Act defines wilderness as an area that "…generally appears to have been affected primarily by the forces of nature with the imprint of man's work substantially unnoticeable." The area must appear "natural" to the average visitor rather than "pristine." The presence of ecologically intact, historic landscape conditions is not required. An area may include some man-made features and human impacts provided they are substantially unnoticeable in the unit overall. In the inventory phase, the naturalness evaluation focuses on the existing physical impacts of refuge management activities, refuge uses, or human-caused hazards. At this stage, we do not disqualify an area from further study solely on the basis of established or proposed activities or 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. In addition, an area may not be considered unnatural in appearance solely on the basis of "sights and sounds" of human impacts and activities outside the boundary of the unit.

1. Discussion

The wilderness inventory documented the following man-made features and evidence of human impact related to historic and existing uses and management activities and uses in the proposed WSAs.

The Meyersville A WSA has a long history of human use, predominantly agricultural use. The area was farmed and drainage ditches were dug for mosquito control and other purposes. These practices altered the hydrology of the landscape. After the refuge was established, the Service plugged drainage ditches to restore drained wetlands. Survey records show an old "woods road" leading south from historic Meyersville Road to a site containing "old cabins and a well" in the north-central portion of tract 122. The remains of an "old plank bridge" spanning Black Brook were also noted in the same area. Over time through intentional clean-up and natural decomposition, the landscape has largely reverted back to natural conditions and evidence of past human activity is substantially unnoticeable with the exceptions noted below. Land cover within the WSA is primarily wooded swamp and bottomland forest with occasional marshy areas, vernal pools, and knolls of upland hardwood forest. The WSA is an uninhabited place appearing to be subject to natural processes. In several locations, the boundary of the WSA fronts a road or ROW or abuts residential property. The sounds of the area vary depending on the proximity to roads and residential properties outside the refuge boundary. Additionally, frequent air traffic noise also impacts the soundscape of the WSA. The "sights and sounds" of human impacts and activities outside the boundary of the WSA do not disqualify the unit from being considered natural in appearance. Following acquisition, the refuge installed water control structures in the northern portion of tract 122 primarily to improve habitat management capabilities for waterfowl. Continued maintenance and use of these structures is necessary to meet the refuge's wildlife and habitat objectives. Tract 122q lies between a remediated asbestos Superfund site to the west and a potential remediation site to the east. Asbestos was removed from the tract during clean-up operations and the slope of the western boundary was armored with rock riprap to prevent erosion from the remediated site. Tracts 122a, 122m, and 290 front busy municipal roads and/or abut private residential properties. Tract 189 spans a utility ROW and contains a 3-foot diameter culvert within a 15-foot drainage easement running north-south along its eastern edge. The refuge currently manages four grassland fields (20.5 acres) and one brushland field (2.6 acres) within the WSA using motorized equipment. These treatments are being phased out and are proposed to cease in the CCP's preferred alternative. All fields will be allowed to revert to natural conditions.

The Meyersville B WSA has a long history of human use, predominantly agricultural use. The area was farmed and drainage ditches were dug for mosquito control and other purposes. These practices altered the hydrology of the landscape. After the refuge was established, the Service plugged drainage ditches to restore drained wetlands. Over time through intentional clean-up and natural decomposition, the landscape has largely reverted back to natural conditions and evidence of past human activity is substantially unnoticeable. Land cover within the WSA is primarily wooded swamp and bottomland forest with occasional marshy areas, vernal pools, and knolls of upland hardwood forest. The WSA is an uninhabited place appearing to be subject to natural processes. In two locations, the boundary of the WSA fronts a road or ROW. In only one location does the WSA abut a residential property (refuge-owned quarters). The sounds of the area vary depending on the proximity to roads and residential properties outside the refuge boundary. Additionally, frequent air traffic noise also impacts the soundscape of the WSA. The "sights and sounds" of human impacts and activities outside the boundary of the WSA do not disqualify the unit from being considered natural in appearance. This WSA configuration eliminates the northern portion of tract 122, tracts 122a, m, and q, and tracts 189 and 290. Removing these tracts from this WSA eliminates many of the concerns discussed under option "A" but reduces the size of the WSA by 90.3 acres. The refuge currently manages one grassland field (6.2 acres) and one brushland field (2.6 acres) within the WSA using motorized equipment. These treatments are being phased out and are proposed to cease in the CCP's preferred alternative. Both fields will be allowed to revert to natural conditions.

The Long Hill Lane WSA is characterized by saturated to seasonally-flooded soils supporting broad-leaf deciduous forest with a scrub-shrub understory. The land has a history of minor timber extraction but the evidence of past human activity is substantially unnoticeable. The WSA is an uninhabited place appearing to be subject to natural processes. An undeveloped gas pipeline easement cuts from southwest to northeast across the bottom third of tract

122b. In order to avoid potential future complications, only that portion of the tract not crossed by the easement is included in the WSA. An easement also crosses the southwest corner of tract 10Aa creating a small area that is unsuitable for wilderness designation. Tract 401g is developed with a house, shed, barn, and driveway and is being used as a government quarters for refuge staff. Tracts 66 and 71 are crossed by a ROW and lie partially or completely outside the ROW and have therefore been excluded. The sounds of the area vary depending on the proximity to roads and residential properties outside the refuge boundary. This area is lightly settled on the rural side of suburban. Additionally, frequent air traffic noise also impacts the soundscape of the WSA. The "sights and sounds" of human impacts and activities outside the boundary of the WSA do not disqualify the unit from being considered natural in appearance.

The Ferber WSA has had a long history of intensive human use for agriculture and, more recently, horseback riding. The remnants of an old riding track and gravel access roads are still clearly visible. The property is dominated by old field habitat with a significant invasive species component. Great Brook crosses the northern portion of the WSA dividing tract 227b from tract 401f. Riparian forest lines the banks of the brook while upland broad-leaf deciduous forest covers the western portion of the area. In two locations, the boundary of the WSA reaches out to a municipal road for access. The WSA is nearly completely surrounded by residential development. The sounds of the area vary depending on the proximity to roads and residential properties outside the refuge boundary. Additionally, frequent air traffic noise also impacts the soundscape of the WSA. The "sights and sounds" of human impacts and activities outside the boundary of the WSA do not disqualify the unit from being considered natural in appearance. In the late-2000s the refuge made earthwork improvements to the site to facilitate the management of priority wildlife species. Such management requires the frequent use of motorized equipment and other uses generally prohibited in wilderness. Tract 276R a short distance to the west follows a paved driveway between a residence to the east and a mowed field to the west before intersecting the GSWA boundary. The small size and narrow configuration of this tract combined with its close proximity to occupied residences significantly reduces its natural value.

2. Conclusion

Two of the four WSAs described above satisfy the wilderness naturalness criteria. The Meyersville A WSA does not meet the criteria due to the presence of water control structures, a culvert, an easement, a ROW, and landfill remediation infrastructure that must continue to be maintained and operated. Such operation and maintenance may require the use of generally prohibited uses. The Meyersville B WSA, on the other hand, eliminates the tracts (or portions thereof) that contain substantially noticeable structures resulting in a WSA that sufficiently satisfies the naturalness criteria to merit further consideration. Mechanical grassland and brushland treatments are being phased out in favor of natural habitat regeneration. The Long Hill Lane WSA satisfies the naturalness criteria and merits further consideration. The Ferber WSA does not meet the naturalness criteria due extensive and obvious evidence of human disturbance, the continued need for artificial structures, and the necessity to use generally prohibited uses to manage priority wildlife resources. The naturalness evaluation for these WSAs is summarized in Table B-1.

Evaluation of Outstanding Opportunities for Solitude or Primitive and Unconfined Recreation Criteria

In addition to meeting the size and naturalness criteria to qualify as WSA, an area must provide outstanding opportunities for solitude or primitive recreation (610 FW 4.10). The area does not have to possess outstanding opportunities for both solitude and primitive recreation, and does not need to have outstanding opportunities on every acre. Further, an area does not have to be open to public use and access to qualify under these criteria. Congress has designated a number of Refuge System Wilderness Areas that are closed to public access to protect ecological resource values.

Opportunity for solitude refers to the ability of a visitor to be alone and secluded from other visitors in the area. Primitive and unconfined recreation means non-motorized, dispersed outdoor recreation activities that do not require developed facilities or mechanical transport. These primitive recreation activities may provide opportunities to experience challenge and risk, self-reliance, and adventure.

These two opportunity "elements" are not well defined by the Wilderness Act but in most cases can be expected to occur together. 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 recreation use that experiencing solitude is not an option.

1. Discussion

The Meyersville B WSA is currently closed to the public but possesses ample opportunities for solitude or primitive and unconfined recreation, especially in the more interior areas. If designated, the WSA would be open to the public from dawn until dusk like the contiguous GSWA. One tract within the WSA abuts a road and another touches the corner of a ROW. The presence of vegetative screening, however, provides opportunities for seclusion and dispersed recreation even in these areas. The vast majority of the WSA abuts, and is buffered by, existing refuge lands, including designated wilderness. The wet, swampy habitat and presence of abundant mosquitoes and ticks during the warmer months will serve to naturally limit the number of people visiting the WSA thereby enhancing opportunities for solitude. The area is more accessible during the colder months when the ground is frozen and noxious insects have waned, however, fewer people are generally interested in visiting such areas under those conditions. Additionally, the WSA does not require developed facilities or mechanical transport for accessibility or recreational purposes. There is a great potential for primitive recreation activities that provide opportunities to experience challenge and risk, self-reliance, and adventure.

The Long Hill Lane WSA is also currently closed to the public but possesses ample opportunities for solitude or primitive and unconfined recreation, especially in the more interior areas. If designated, the WSA would be open to the public from dawn until dusk like the contiguous GSWA. The WSA abuts developed and undeveloped private lands and refuge lands, including designated wilderness. The lack of nearby access points and presence of abundant mosquitoes and ticks during the warmer months will serve to naturally limit the number of people visiting the WSA thereby enhancing opportunities for solitude. The area is more accessible during the colder months when the ground is frozen and noxious insects have waned however fewer people are generally interested in visiting such areas under those conditions. Additionally, the WSA does not require developed facilities or mechanical transport for accessibility or recreational purposes. There is a great potential for primitive recreation activities that provide opportunities to experience challenge and risk, self-reliance, and adventure.

2. Conclusion

Both WSAs described above satisfy the wilderness solitude or primitive and unconfined recreation criteria. The Meyersville B and Long Hill Lane WSAs would open an additional 160.6 acres of refuge lands to the public. While not far from human development, both have the potential to provide visitors with an outstanding wilderness experience. Neither WSA currently has a trail system and the wilderness lands they abut are also largely without trails. The lack of recreational infrastructure makes these areas particularly attractive to those seeking solitude or wilderness recreation in the midst of this densely settled, heavily populated region. Since both WSAs abut the GSWA they can also serve as gateways to enjoyment of the larger wilderness area. The solitude or primitive and unconfined recreation evaluation for these WSAs is summarized in Table B-1.

Supplemental Values

Supplemental values are defined by the Wilderness Act as "ecological, geological, or other features of scientific, educational, scenic, or historic value." These values are not required for consideration as a WSA but their presence is documented.

1. Discussion

Both the Meyersville B and Long Hill Lane WSAs offer outstanding ecological values with features of scientific and educational interest. Land cover within the WSAs is broadly wetland, dominated by bottomland forest and marsh interspersed with occasional vernal pools and scrub-shrub and broad-leaf deciduous forest in areas of slightly higher

elevation. These habitat types are increasingly rare in heavily developed New Jersey and provide important habitat for Federal- and State-listed rare plant and wildlife species. The WSAs have the potential to provide scientific and educational value to the larger community, since they located in the heart of one of the most highly developed, densely populated areas in the country. A unique opportunity exists to establish wilderness-compatible field research and education for scientists as well as students at the numerous neighboring schools and universities. There is potential for broader outreach to educate the public about the importance of wilderness, wetland habitat, and wildlife conservation in general.

2. Conclusion

Both the Meyersville B and Long Hill Lane WSAs satisfy the supplemental values criteria. These values are not required but their presence complements the requirements for wilderness designation. The supplemental values evaluation for these WSAs is summarized in Table B-1.

Inventory Findings and Wilderness Study Areas

Two areas of the five evaluated satisfy the minimum criteria for a WSA. Both the Meyersville B and Long Hill Lane WSAs are refuge-owned roadless lands contiguous with designated wilderness; appear to be primarily affected by the forces of nature; and offer outstanding opportunities for solitude or primitive and unconfined recreation. These WSAs are presented in Table B-1 and Maps B-1, B-3, and B-4.

Table C-1 Wilderness Inventory						
Criteria Satisfied - Yes/No & Comments						
Refuge Unit and Acreage	(1) Has at least 5,000 acres of land or is of sufficient size to make practicable its preservation and use in an unimpaired condition, or is less than 5,000 acres and contiguous with a designated wilderness area;	(2) generally appears to have been affected primarily by the forces of nature, with the imprint of man's work substantially unnoticeable;	(3a) has outstanding opportunities for solitud	OR	(3b) has outstanding opportunities for a primitive and unconfined type of recreation;	(4) contains ecological, geological, or other features of scientific, educational, scenic, or historical value.	Parcel qualifies as a Wilderness Study Area (meets criteria 1, 2, and 3a or 3b).
Meyersville A 247.0 acres	Yes, unit is contiguous with a designated wilderness area.	No	--		--	--	No
Meyersville B 156.7 acres	Yes, unit is contiguous with a designated wilderness area.	Yes	Yes		Yes	Yes, State and Federally-listed species habitat, important wetland, vernal pool, and upland habitat, scientific and educational values.	Yes
Long Hill Lane 3.9 acres	Yes, unit is contiguous with a designated wilderness area.	Yes	Yes		Yes	Yes, State and Federally-listed species habitat, important wetland,	Yes

					vernal pool, and upland habitat, scientific and educational values.	
Ferber WSA 39.4 acres	Yes, unit is contiguous with a designated wilderness area.	No	--	--	--	No
Britten WSA 2.0 acres	No, unit is contiguous with a designated wilderness area however is of such a size and shape as to make its management as wilderness impractical.	--	--	--	--	No

WILDERNESS STUDY OF GREAT SWAMP NWR

The two WSAs found to possess the required wilderness characteristics defined by the Wilderness Act were each further evaluated through the refuge planning process to determine their suitability for designation, management, and preservation as wilderness (610 FW 4.13). Considerations in this evaluation included:

- Quality of wilderness values;
- Evaluation of resource values, public uses, and associated management concerns, and;
- Capability for management as wilderness or "manageability/"

This information provides a basis to compare the impacts of a range of management alternatives and determine the most appropriate management direction for the WSA.

Evaluation of Wilderness Values

The following information considers the quality of the WSA's mandatory and supplemental wilderness characteristics.

1. Size

The Meyersville B WSA is a 156.7-acre roadless area contiguous with designated wilderness and meets the minimum size criteria.

The Long Hill Lane WSA is a 3.9-acre roadless area contiguous with designated wilderness and meets the minimum size criteria.

2. Naturalness

The Meyersville B WSA generally appears to have been affected primarily by the forces of nature. The imprint of human uses and activities is substantially unnoticeable (i.e., old drainage ditches dug for agriculture and mosquito control, periodically mowed grassland and brushland fields) and does not affect the overall apparent naturalness of the WSA.

The Long Hill Lane WSA generally appears to have been affected primarily by the forces of nature, with the imprint of human uses and activities substantially unnoticeable. The impacts of human presence are minimal in terms of human-made features and do not affect the overall apparent naturalness of the WSA.

3. Outstanding Opportunities for Solitude or Primitive and Unconfined Recreation

The Meyersville B WSA possesses outstanding opportunities for both solitude or primitive and unconfined recreation. The WSA is contiguous with 3,660 acres of designated wilderness. Although the WSA fronts a municipal road and ROW in two locations, vegetative screening provides sufficient cover to preserve these values. The interior of the WSA is especially well suited for solitude or wilderness-appropriate recreation.

The Long Hill Lane WSA possesses outstanding opportunities for both solitude or primitive and unconfined recreation. The WSA is contiguous with 3,660 acres of designated wilderness. Although the WSA is in proximity to residential properties, vegetative screening provides sufficient cover to preserve these values. The interior of the WSA is especially well suited for solitude or wilderness-appropriate recreation.

4. Supplemental Values

Both WSAs offer outstanding ecological values with features of scientific and educational interest. The WSAs have the potential to provide scientific and educational value to the larger community, since they are located in the heart of one of the most highly developed, densely populated areas in the country. A unique opportunity exists to establish

wilderness-compatible field research and education for scientists as well as students at the numerous neighboring schools and universities. There is potential for broader outreach to educate the public about the importance of wilderness, wetland habitat, and wildlife conservation in general.

5. Evaluation of Manageability and Other Resource Values and Uses

Both WSAs can be managed to preserve their wilderness character in perpetuity, recognizing that a "minimum requirements analysis" and "minimum tool" approach will be required. There are no valid existing private rights or mineral rights in the WSAs. Private lands, easements, and ROWs have been specifically excluded to avoid conflicts with pre-existing rights.

The refuge lands and waters comprising both WSAs are currently closed to public use. Should these areas be designated as WSAs, appropriate administrative processes would be followed to open them to wilderness-compatible public uses such as hiking, wildlife observation, outdoor photography, and hunting.

Existing refuge management activities within the Meyersville B WSA (Tract 122d) include periodic (once every 4-8 years) motorized mechanical treatment of two fields, one grassland (6.2 acres), and one brushland (2.6 acres). These treatments are being phased out and are proposed to cease in the CCP's preferred alternative. Both fields will be allowed to revert to natural conditions. Invasive species control and/or re-vegetation using wilderness-compatible methods (backpack sprayers, hand pulling, hand tools, etc.) may be required to facilitate the reestablishment of native plant communities. The WSA would be managed in ways that would not diminish the wilderness character of the area or make impractical its preservation as wilderness. There are no plans to construct permanent roads, facilities, or structures within the Meyersville B WSA. A minimal system of low-impact hiking trails similar to that which currently exists within the GSWA might be developed to facilitate public use.

Existing refuge management activities within the Long Hill Lane WSA are minimal and consistent with management direction in the Wilderness Act and current Service wilderness stewardship policy. None of the current or expected refuge management activities would diminish the wilderness character of the WSA or make impractical its preservation as wilderness. There are no plans to construct permanent roads, facilities, or structures within the Long Hill Lane WSA.

Study Findings and Wilderness Study Areas

Wilderness designation and management of the Meyersville B and Long Hill Lane WSAs would be fully compatible with current and proposed refuge management. None of the values identified above would be forgone or adversely affected as a result of designation.

Development of CCP Alternatives

After evaluating the quality of wilderness values, manageability, and other resource values and uses, the following alternatives were developed and analyzed in the draft CCP/EA.

1. Alternative A (Current Management)

This alternative is the "No Action" alternative required by NEPA. Alternative A defines our current management activities and serves as the baseline against which to compare the other alternatives. Under this alternative no additional lands would be proposed for wilderness designation. The lands under consideration as WSAs would remain closed to the public and continue to be managed as they have been in the past to accomplish refuge purposes and the mission of the Service in accordance with legal and policy guidance.

2. Alternative B (Enhance Biological Diversity and Public Use Opportunties)

Under this alternative, both WSAs (160.6 acres) would be recommended as suitable for wilderness designation. Since Congress has reserved the authority to make final decisions on wilderness designation, the wilderness recommendations are preliminary administrative determinations that will receive further review and possible modification by the Director of the Service, the Secretary of the Interior, or the President of the United States. However, analysis of the environmental consequences of this alternative in chapter 4 is based on the assumption that Congress would accept the recommendation and designate both WSAs as wilderness.

If the two WSAs are designated as wilderness, they would be managed according to the provisions of the Wilderness Act and Service wilderness management regulations (50 CFR 35) and wilderness stewardship policy (610 FW 1-4). The areas would be managed to accomplish refuge purposes and the Refuge System mission, while also preserving wilderness character and values for future generations. The use of motorized vehicles, motorized equipment, mechanical transport, or the placement of any structure or installation may only be allowed to respond to emergencies involving the health and safety of persons within the wilderness area or when necessary to meet the minimum requirements for the administration of the area as wilderness and to accomplish refuge purposes. Proposed or new refuge management activities or refuge uses would be evaluated through a minimum requirements analysis and NEPA compliance to assess potential impacts and identify mitigating measures to preserve wilderness character. As required by law and policy, another wilderness review would be conducted 15 years from the approval of the CCP, if not sooner. Refuge lands and waters, including any new acquisitions, would be evaluated for suitability as wilderness at that time.

3. Alternative C (Emphasis on Maximizing Natural Vegetation)

Same as Alternative B.

4. Alternative D (Emphasis on Expanding Priority Public Uses)

Same as Alternative B.

Alternatives Considered but Eliminated from Detailed Study

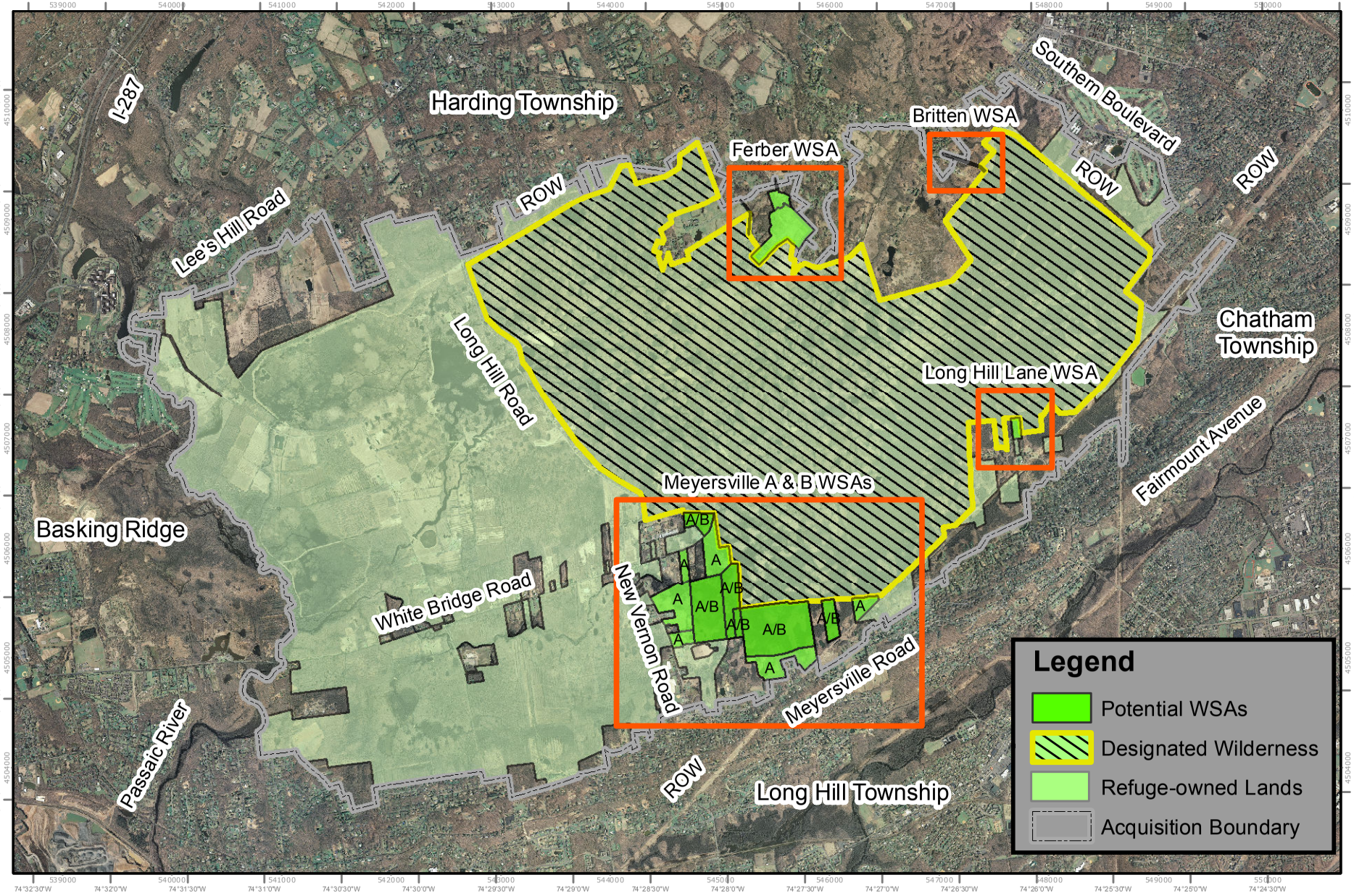
Federal agencies are required by NEPA to rigorously explore and objectively evaluate all reasonable alternatives and to briefly discuss the reasons for eliminating any alternatives that were not developed in detail (40 CFR 1502.14). All reasonable alternatives consistent with law and policy were considered in this review. Of the five areas identified as having potential for wilderness designation, three were excluded from further evaluation for reasons detailed in the inventory and study sections of the review. The two remaining WSAs do appear suitable for wilderness designation and are being proposed for such designation as a result of this review.

GREAT SWAMP NWR RECOMMENDATIONS FOR WSA

In total, Great Swamp NWR recommends 160.6 acres to be designated by Congress as wilderness as defined by the Wilderness Act of 1964 and added to the existing GSWA.

Both the Meyersville B and Long Hill Lane WSAs contain valuable wilderness qualities and resources and have been effectively managed since the land was acquired to meet the purposes of the refuge and the mission of the Refuge System. Both WSAs are of such quality and character as to meet the purposes of the Wilderness Act and the Great Swamp NWR Wilderness Act of 1968. Great Swamp NWR has determined that the WSAs are substantially similar to contiguous designated wilderness lands both in terms of resource values, wilderness qualities, and management requirements. Therefore, Great Swamp NWR recommends these WSAs for wilderness designation.

Map B-1 Great Swamp NWR Potential Wilderness Study Areas (WSAs)

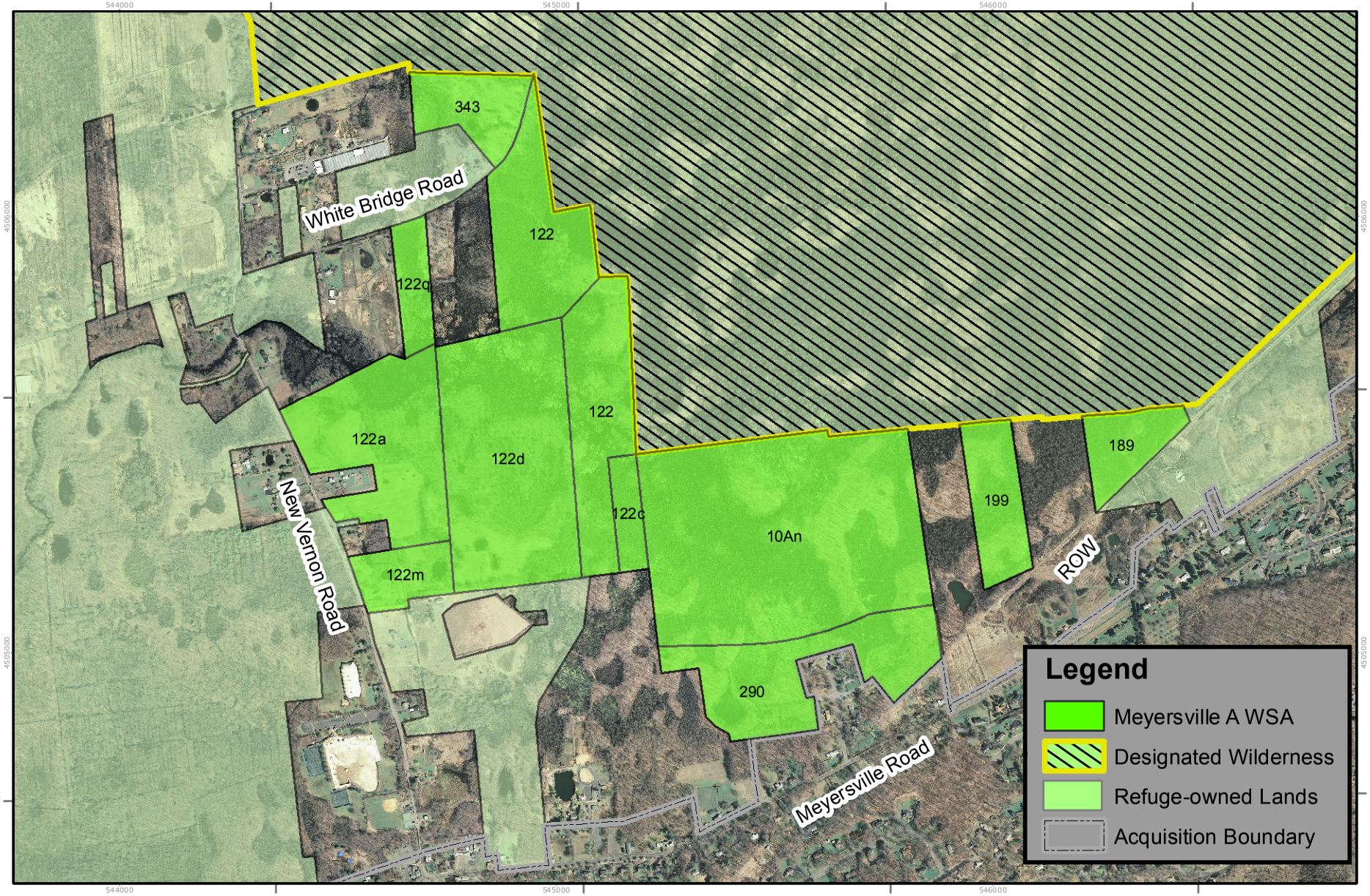


Map Projection: NAD_1983_UTM_Zone_18N
Graticule Units: degrees, minutes, seconds
Map Grid Unit: Meter
C:\GIS\Steve\W Review\W Review Map - Final.mxd 9-2013

0 600 1,200 2,400 3,600 4,800 6,000 Meters
0 0.275 0.55 1.1 1.65 2.2 2.75 Miles
1 = 50,000

N

Map B-2 Meyersville A WSA - 247.0 acres



Map Projection: NAD_1983_UTM_Zone_18N
Graticule Units: degrees, minutes, seconds
Map Grid Unit: Meter
C:\GIS\Steve\W Review\W Review Map - Final.mxd 9-2013

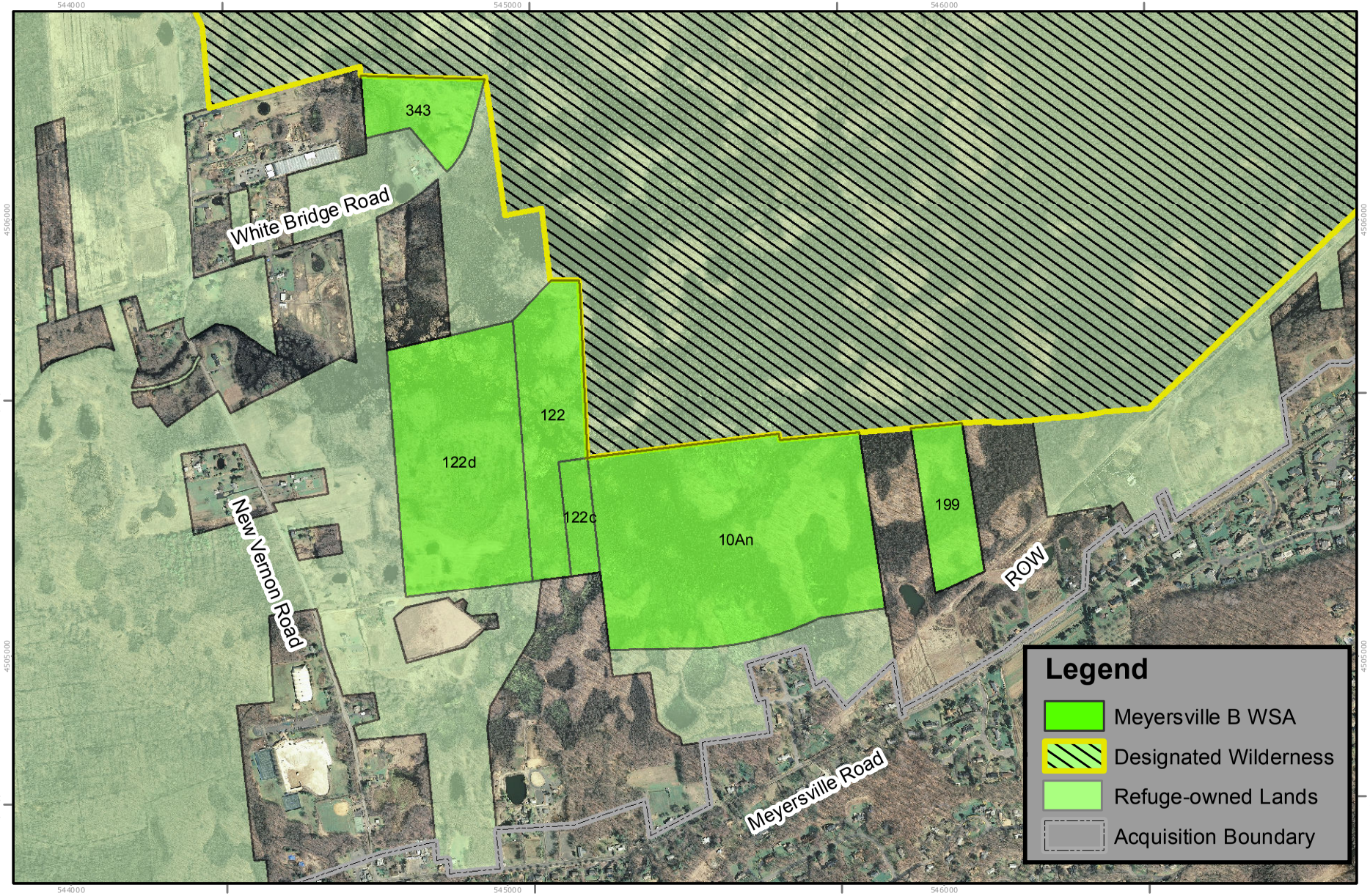
0 150 300 600 900 1,200 1,500 Meters

0 0.075 0.15 0.3 0.45 0.6 0.75 Miles

1 = 12,702

N

Map B-3 Meyersville B WSA - 156.7 acres



Map Projection: NAD_1983_UTM_Zone_18N
Graticule Units: degrees, minutes, seconds
Map Grid Unit: Meter
C:\GIS\Steve\W Review\W Review Map - Final.mxd 9-2013

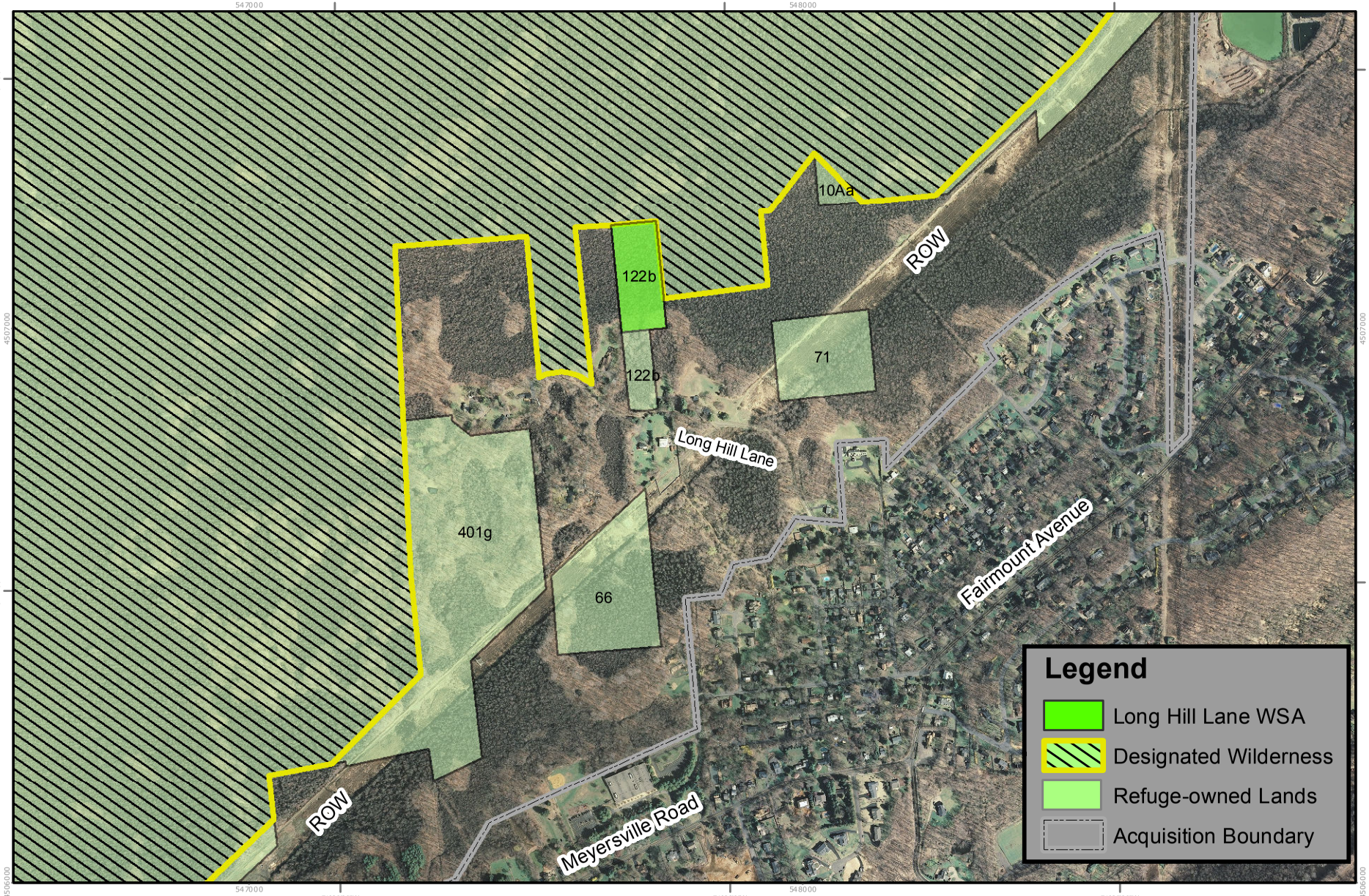
0 150 300 600 900 1,200 1,500 Meters

0 0.075 0.15 0.3 0.45 0.6 0.75 Miles

1 = 12,702

N

Map B-4 Long Hill Lane WSA - 3.9 acres



Map Projection: NAD_1983_UTM_Zone_18N
Graticule Units: degrees, minutes, seconds
Map Grid Unit: Meter
C:\GIS\Steve\W Review\W Review Map - Final.mxd 9-2013

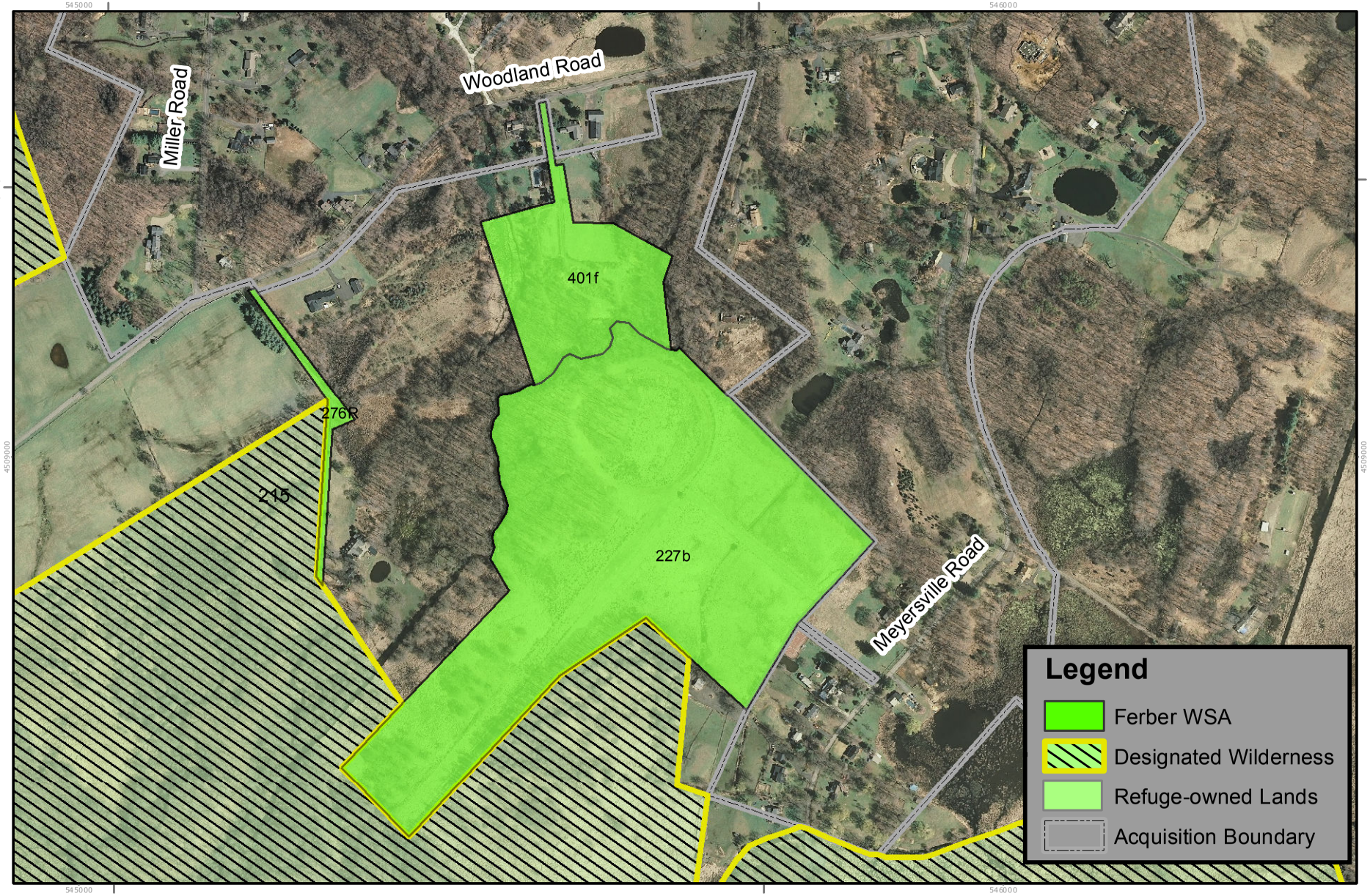
0 120 240 480 720 960 1,200 Meters

0 0.05 0.1 0.2 0.3 0.4 0.5 Miles

1 = 10,000

N

Map B-5 Ferber WSA - 39.4 acres



Map Projection: NAD_1983_UTM_Zone_18N
Graticule Units: degrees, minutes, seconds
Map Grid Unit: Meter
C:\GIS\Steve\W Review\W Review Map - Final.mxd 9-2013

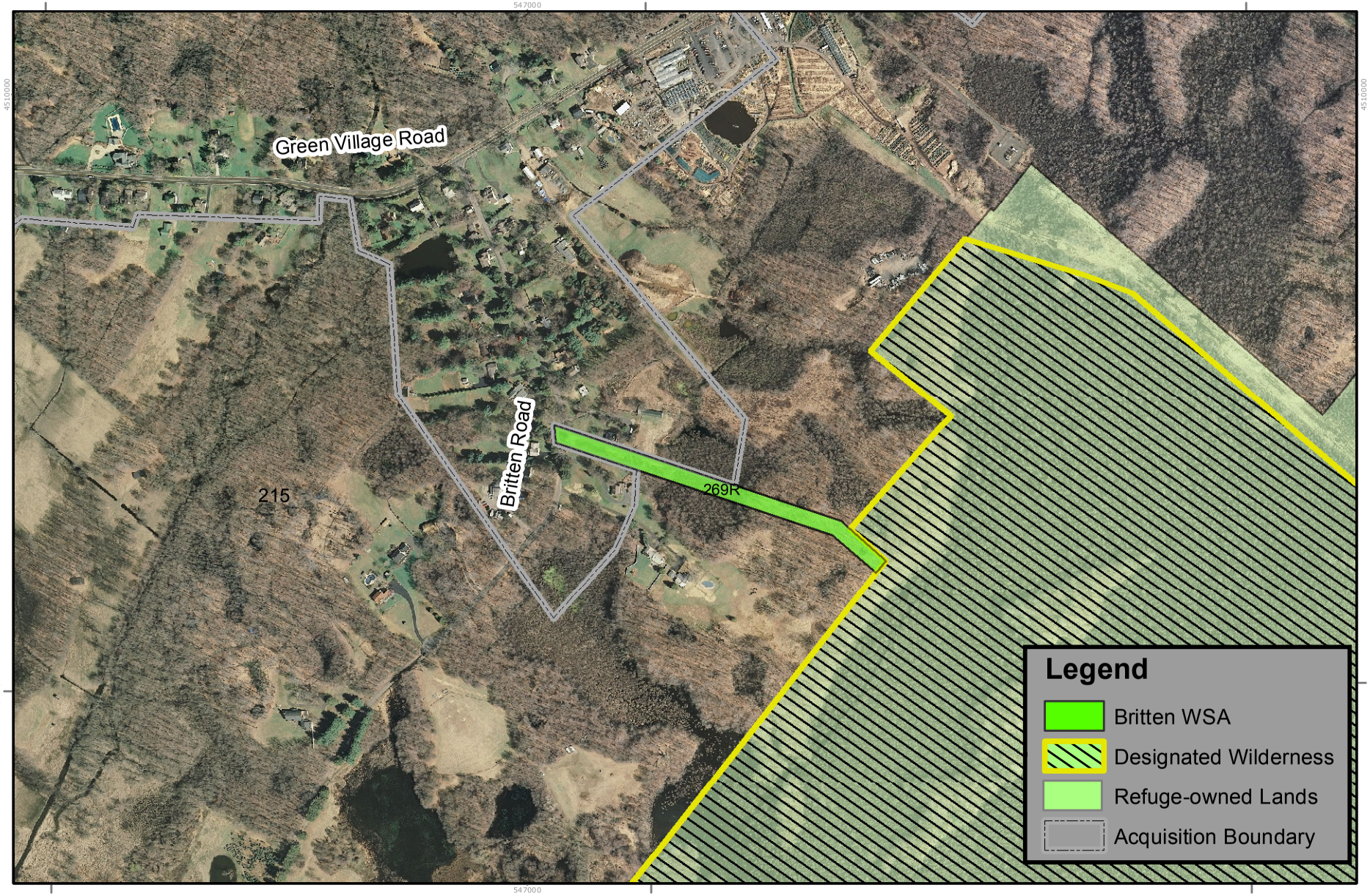
0 70 140 280 420 560 700 Meters

0 0.035 0.07 0.14 0.21 0.28 0.35 Miles

1 = 6,000

N

Map B-6 Britten WSA - 2.0 acres



Map Projection: NAD_1983_UTM_Zone_18N
Graticule Units: degrees, minutes, seconds
Map Grid Unit: Meter
C:\GIS\Steve\W Review\W Review Map - Final.mxd 9-2013

0 75 150 300 450 600 750 Meters

0 0.0375 0.075 0.15 0.225 0.3 0.375 Miles

1 = 6,500

N

Appendix C

Compatibility Determinations

- Wildlife Observation and Photography, Environmental Education and Interpretation
- Deer Hunting
- Turkey Hunting
- Special Birding Events
- Alternative Forms of Transportation
- Snowshoeing and Cross-Country Skiing
- Dog Walking
- Educational and Commercial Photography and Filming
- Wildlife Research
- Police and Fire Training
- National Weather Service Sensor

COMPATIBILITY DETERMINATION

USE

Wildlife Observation, Photography, Environmental Education, and Interpretation

REFUGE NAME

Great Swamp National Wildlife Refuge

DATE ESTABLISHED

1960

ESTABLISHING AND ACQUISITION AUTHORITY

Great Swamp National Wildlife Refuge (refuge) was established primarily under the authorities of the Migratory Bird Treaty Act of 1918 (16 U.S.C. 703-711, 40 Stat. 755) and the Migratory Bird Conservation Act of 1929 (16 U.S.C. 715-715r, 45 Stat. 1222), as amended, by transfer of approximately 2,900 acres of land donated to the Federal Government by the Great Swamp Committee of the North American Wildlife Foundation.

REFUGE PURPOSES

Based upon land acquisition documents and authorities, refuge purposes were identified as follows:

> *"…for use as an inviolate sanctuary, or for any other management purpose, for migratory birds.*" (Migratory Bird Conservation Act of 1929; 16 U.S.C. 715d)
>
> *"...suitable for (1) incidental fish and wildlife-oriented recreational development, (2) the protection of natural resources, (3) the conservation of endangered species or threatened species ..."* (Refuge Recreation Act; 16 U.S.C. 460k-1) *"the Secretary…may accept and use…real…property. Such acceptance may be accomplished under the terms and conditions of restrictive covenants imposed by donors"*…(Refuge Recreation Act; 16 U.S.C. 460k-2, as amended)
>
> *"...for the conservation of the wetlands of the Nation in order to maintain the public benefits they provide and to help fulfill international obligations contained in various migratory bird treaties and conventions ..."* (Emergency Wetlands Resources Act of 1986; 16 U.S.C. 3901(b)); and,

"... to conserve (A) fish or wildlife which are listed as endangered species or threatened species .... or (B) plants ..." (Endangered Species Act of 1973; 16 U.S.C. 1534).

"…to secure for the American people of present and future generations the benefits of an enduring resource of wilderness… wilderness areas ... shall be administered for the use and enjoyment of the American people in such manner as will leave them unimpaired for future use and enjoyment as wilderness, and so as to provide for the protection of these areas, the preservation of their wilderness character, and for the gathering and dissemination of information regarding their use and enjoyment as wilderness: …" (Wilderness Act of 1964; Public Law 88-577; 16 U.S.C. 1131-1136)

NATIONAL WILDLIFE REFUGE SYSTEM MISSION

The Mission of the National Wildlife Refuge System (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 (National Wildlife Refuge System Improvement Act (Improvement Act); 16 U.S.C. 668dd(a)(2)).

DESCRIPTION OF PROPOSED USE

(a) What is the use? Is the use a priority public use?

The uses are wildlife observation and photography, environmental education and interpretation. We are also allowing painting as part of wildlife observation. Wildlife observation, photography, environmental education, and interpretation are priority uses 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 (Public Law 105-57).

(b) Where would the use be conducted?

These uses have been allowed and will continue to be allowed on designated roads and trails in all U.S. Fish and Wildlife Service-owned (Service) areas open to the public. These areas include, but are not limited to, the 12 miles of existing designated roads and trails listed below.

Wilderness area Trails

Ivory	0.8 miles
Yellow	0.9 miles
Blue	2.4 miles
Red	0.5 miles
Orange	1.6 miles

Silver	0.4 miles
Green	0.7 miles
Beige	0.5 miles
White	0.7 miles
Wildlife Observation Center	1.5 miles
Nature Detective Trail	0.3 miles
Bockhoven Trail	0.5 miles
Pleasant Plains Road	2.5 miles (vehicle use allowed)
Morris County Outdoor Edu. Center	0.1 miles

In addition, the Wilderness Area is open to off-trail use but due to seasonal changes some areas become difficult to traverse due to water levels.

(c) When would the use be conducted?

These uses occur throughout the year from sunrise to sunset when the refuge is open to the general public.

(d) How would the use be conducted?

Visitors enter the refuge at public entry points, designated parking areas or the north and south ends of Pleasant Plains Rd.

Wildlife observation, painting, and photography occur on an individual or group basis. Groups larger than 10 should contact the refuge to plan their visit so staff or volunteers can direct or lead groups to an appropriate area. Visitors that will be participating in painting will occur in a way to not inhibit pedestrian or vehicle traffic.

Information kiosks and refuge brochures identify the roads and trails that are open.

(e) Why is this use being proposed?

The Improvement Act defines wildlife observation, photography, environmental education, and interpretation as public uses that, if compatible, are to receive our enhanced consideration over other general public uses. Authorizing these uses will provide opportunities for the public to enjoy wildlife and plants on the refuge in accordance with law, and it will produce better-informed public advocates for Service programs.

These uses will provide opportunities for visitors to observe and learn about wildlife and wild lands at their own pace in both structured and unstructured environments, and observe wildlife in their natural habitats firsthand. These four priority uses provide visitors with opportunities to enjoy refuge resources and gain a better understanding and appreciation of fish and wildlife, wild lands ecology, the relationships of plant and animal populations in an ecosystem, and wildlife management. These activities will enhance public understanding of natural resource management programs and ecological concepts, enable the public to better understand the problems facing our wildlife and wild lands resources, help visitors to better

understand how they affect wildlife and other natural resources, and learn about the Service's role in conservation and restoration.

Photographers and artists will gain opportunities to photograph, sketch or paint landscapes and wildlife in its natural habitat. These opportunities will increase the publicity and advocacy of Service programs. Photography and painting provides wholesome, safe, outdoor recreation in a scenic setting, and entices those who come strictly for recreational enjoyment to participate in the educational facets of our public use program and become advocates for the refuge and the Service.

Visitors need a way to access these priority uses. By allowing visitors to walk, hike, and use motorized vehicles in designated areas of the refuge, we are providing access to these important priority public uses with minimal impacts to sensitive wildlife and habitat.

AVAILABILITY OF RESOURCES

The resources necessary to provide and administer this use are available within current and anticipated refuge budgets. Staff time associated with administration of this use is related to assessing the need for road and trail maintenance and repair, maintaining kiosks, gates and recording collected data, sign-posting roads and trails, analyzing visitor use patterns, monitoring the effects of public uses on refuge resources and visitors, and providing information to the public about the use.

Providing information to the public and Administration needs	=	$10,000
Resource impact monitoring	=	$10,000
Maintenance needs	=	$9,000
Total	=	$29,000

- FY 2012 Budget Allocations:
  - Employee salaries and benefits = $913,000
  - Fixed costs (utilities, fuel, administrative) = $110,000
  - Discretionary funds (management capability) = $344,000
  - Total available funds for FY 2012 = $1,367,000

The use would be manageable with existing resources.

ANTICIPATED IMPACTS OF THE USE

Access in the Wilderness Area is limited to mainly the designated trails due to the wet soil conditions. The highest numbers of visitors are during the spring and fall which coincides with the wettest soil conditions. Users are limited to mainly the designated trails. The summer is a drier time in the Wilderness Area but numbers of visitors is limited due to the high number of nuisance insects, low numbers of migratory birds, and dense vegetation that limits wildlife observation. During deep freeze in the winter, access is also improved in the Wilderness Area

but numbers of visitors again is limited due to the cold temperatures, minimal wildlife, and dormant vegetation. The number of one-time users in the Wilderness Area is regulated by the distribution, size and total number of access parking areas. This maintains a quality wilderness experience for the user while also reducing the resource impacts.

Following are descriptions of potential adverse effects on natural resources of wildlife observation, painting, photography, environmental education, and interpretation accessed by walking, hiking, and motorized vehicles in authorized areas within the refuge. Effects of other modes of access (e.g., snow-shoeing, cross-country skiing) are addressed in separate documents.

Effects on Hydrology and Water Quality: The refuge minimizes adverse effects on water resources in a variety of ways. The refuge has developed the trails to minimize erosion and adverse impacts to hydrology and water quality through planning and placement in areas that are not subject to high levels of erosion and that are not adjacent to sensitive areas. The refuge will monitor the amount of use on trails to prevent over use and erosion and degradation of trails. One way the refuge minimized the impacts has been to construct boardwalks on some of our heavily visited areas to prevent impacts to hydrology. Also the Wildlife Observation Center and wilderness trail parking lots are graveled and are, therefore, more porous than impervious surfaces such as asphalt or concrete. This allows precipitation to absorb into the ground and preventing storm runoff into the brooks and streams causing sediment loading and pollution run off.

Effects on Vegetation: To facilitate wildlife observation, photography, and environmental education, and interpretation, we allow hiking access on designed trails and access throughout the Wilderness Area. We will also allow vehicle access on Pleasant Plains Road. Short-term effects consist of the deterioration of plant material, whereas long-term effects of trampling include direct and indirect effects on vegetation and soils like diminishing soil porosity, aeration, and nutrient availability through soil compaction (Roovers et al. 2004). Compaction of soils thus limits the ability of plants, particularly rare and sensitive species, to re-vegetate affected areas (Hammitt and Cole 1998). Where adverse impacts to vegetation are observed, the refuge will take necessary measures, such as remediation and trail closures, to restore plant communities.

We anticipate that allowing use on designated routes will cause some vegetation loss. Foot travel may increase root exposure and trampling effects, however we anticipate that under current and projected use the incidence of these problems will be minor. Routes for pedestrian travel consist of existing trails and boardwalks that have been used for many years. Designated routes do not have any known occurrences of rare plant species on their surface or soils subject to compaction that will be impacted by this use. Users leaving designated trails could have impacts to adjacent vegetation. Trails will be monitored, problem areas will be identified, and appropriate restoration and protection efforts will be made.

Highly traveled trails such as the ones at the Wildlife Observation Center have had boardwalks built to lessen the impacts on vegetation and wildlife disturbance. This allows visitors to quietly walk through these areas with minimal disturbance to the surrounding wildlife. Boardwalks have also been observed to be used as cover by some of the common species of turtles, fox, frogs, snakes, and salamanders present in this area.

Effects on Soil: Under current levels of use, impacts to soils (erosion, compaction) are not likely to be significant. In addition, pedestrian travel is not likely to significantly increase erosion or stream alteration. Soils throughout Great Swamp are predominantly poor to poorly drained silt loam, stratified lacustrine sand, silt and clay. These soils by nature allow vegetation such as grasses, legumes, wild herbaceous plants, hardwoods and coniferous trees to recover rather quickly. (NRCS 1976) These naturally compact soils will have little change from pedestrian traffic. Years of observation from staff of ground impacts by foot traffic has revealed little to no change. Therefore, no significant hydrologic impacts are anticipated from this use subject to the stipulations in this compatibility determination.

Effects on Wildlife: We anticipate that there will be temporal disturbances to wildlife species using habitat on or directly adjacent to the designated trails and Pleasant Plains Road. Based on current levels of use these disturbances are likely to be short term as wildlife will be able to return during hours the refuge is closed to the public or on days of low use (week days). With current use there are still frequent sighting of wildlife along designated routs. Designated routes were selected based on refuge staff's long time observations and best available information concerning wildlife species and sensitive habitats on the refuge. Long-term impacts may include certain wildlife species avoiding trail corridors as a result of this use over time. These impacts are not likely to significantly affect wildlife populations along these routes based on the current use pattern.

Short-term and long-term adverse impacts will be expected for wildlife populations. Disturbances will vary by wildlife species involved and the type, level, frequency, duration, and the time of year activities occur. Beale and Monaghan (2004) found that adverse effects to wildlife increase as number of users increase. The study found that an animal's response to one visitor walking down a trail is entirely different than its response to a group of users walking down a trail. The refuge recognizes that large group sizes may amplify negative effects to wildlife; therefore, groups larger than 10 are required to notify the refuge prior to visiting. This will enable the refuge to understand which trails are preferred by large groups, and to monitor any potential excessive wildlife disturbance created by large groups. Having the ability to monitor these kinds of disturbances will also enable the refuge to mitigate impacts associated with large groups. Examples of mitigation may include directing large groups to less sensitive habitats during breeding seasons, assigning refuge staff to lead or meet with the group while on refuge lands to better monitor the group and/or limit over all group size.

Human disturbance can cause an animal to vacate an area or habitat due to the amount or frequency of disturbance. In a study done by Gill et al. (2001), the decision of whether or not to move away from disturbed areas will be determined by factors such as the quality of the site currently being occupied, the distance to and quality of other suitable habitats, the relative risk of predation or density of competitors in different sites, and the investment that an individual has made in a site (for example, in establishing a territory, gaining dominance status or acquiring information).

There is evidence to suggest that species most likely to be adversely affected are those where available habitat is limited, thus constraining them to stay in disturbed areas and suffer the costs

of reduced survival or reproductive success (Gill et al. 2001). Because of the diversity of habitats represented on the refuge any population level effects to wildlife species from trail use might be minimized by the abundance of habitat on the refuge and adjacent lands. Wildlife disturbance may be compounded by seasonal needs. For example, causing mammals to flee during winter months would consume stored fat reserves that are necessary to survive the winter. Hammitt and Cole (1998) found white-tailed deer females with young are more likely to flee from disturbance than those without young. Some species, like warblers, would be negatively affected by disturbance associated with bird watching particularly during the breeding season.

For songbirds, physiological changes in response to environmental stressors can reveal cryptic effects of disturbance that can potentially lead to species decline. However, such responses may vary with life history. In findings from (Bisson 2011) suggest that some song birds quickly acclimate to a limited amount of human disturbance during the breeding season. This response may be an adaptive response for any 'fast-living' species with a short life span and a short and synchronized breeding season.

We will take all necessary measures to minimize all of these impacts, particularly where group educational activities are involved. We will evaluate the sites and programs periodically to assess whether they are meeting the objectives, and to prevent site degradation. If evidence of unacceptable adverse impacts appears, we will rotate the activities to secondary sites, or curtail or discontinue them. We will post and enforce refuge regulations, and establish, post, and enforce closed areas.

Effects on Threatened and Endangered Species:
There are two Federal-listed species known to occur on the refuge. Indiana bats (*Myotis sodalis*), listed as endangered, are known to use the refuge's forested areas for foraging, roosting, and may have a summer maternity colony on refuge lands as well. There are also locations on the refuge that contain bog turtles (*Glyptemys muhlenbergii)* and other areas where the bog turtle was historically found.

Based on the research done on the refuge using radio-telemetry tracking and bat acoustic surveys, the refuge provides foraging and roosting habitat for Indiana bats. We are planning to continue mist net surveys to assess the status of Indiana bats within the refuge. Currently roost sites are in closed areas of the refuge or off trails. Indiana bat will continue to be monitored with cooperation of many of our partners and with New Jersey USFWS Ecological Field Office throughout the state and if they are found to use public areas or trail corridors on the refuge public use in those areas will be re-evaluated. We anticipate that these uses are not likely to adversely affect Indiana bats because these activities do not coincide with the area where this species is known to occur.

Based on radio-telemetry tracking the refuge provides foraging, nesting, and hibernation habitat for the bog turtle. The bog turtles will continue to be tracked and trapping will continue in areas that have historically had bog turtles to find all areas this species occurs on the refuge. All known and historical bog turtle sites are closed to the public and not located near trails. We anticipate that these uses are not likely to adversely affect bog turtles.

Since all known threatened or endangered animals utilizes areas of the refuge that are closed to the public, we anticipate no adverse effects on the populations.

PUBLIC REVIEW AND COMMENT

This compatibility determination is being released concurrent with the draft Comprehensive Conservation Plan/Environmental Assessment for a 45-day review and comment period.

DETERMINATION (CHECK ONE BELOW):

____ Use is not compatible

__X__ Use is compatible with the following stipulations

STIPULATIONS NECESSARY TO ENSURE COMPATIBILITY

The refuge has developed a list of criteria for determining whether any given route would be appropriate for public wildlife observation, wildlife photography, environmental education or interpretation. These criteria apply to current and future trails. Criteria are as follows:

Checklist for Existing Routes to Be Eligible for Compatibility Consideration*
**(Routes must meet all criteria)*
1. Route provides an opportunity to view a variety of habitats and wildlife.
2. Route is safe for the access proposed at current use levels.
3. Route requires minimal annual maintenance to ensure safe access and to prevent further habitat degradation.
4. Route has a low potential for fragmenting habitat or disturbing wildlife populations.
5. Any route crossing of sensitive or hydric soils occupies the shortest possible distance.
6. Continued use of the existing route is not likely to cause further wetland alteration or degradation. There is low risk that hydrology, soil stability, sensitive plant communities, riparian zones, and wildlife habitats would be adversely affected.

Additional stipulations that will apply to ensure compatibility include:
— Refuge regulations will be posted and enforced. Closed areas will be established as needed, posted, and enforced. Signs necessary for visitor information, safety, and traffic control will be kept up to date.
— The known presence of a threatened or endangered species will preclude any new use of an area until the refuge manager determines otherwise.
— Locations for public uses will be chosen to minimize impacts to wildlife and habitat. We will periodically evaluate sites and programs to assess whether objectives are being met and to prevent site degradation. If evidence of unacceptable adverse impacts appears, the location(s) of activities will be rotated with secondary sites, curtailed, or discontinued.
— Walking and hiking are restricted to hours open to the general public.(Sunrise to sunset).
— The refuge conducts an outreach program to promote public awareness and compliance with public use regulations on the refuge.

— Group size is encouraged to be no more than 10 persons to promote public safety, accommodate other users, and reduce wildlife disturbance. Groups larger than 10 persons must contact the refuge office prior to visiting the trail system so the refuge can determine if the group will require a Special Use Permit (SUP). Groups traveling only on roads shared with vehicles are not required to contact the refuge office or obtain a SUP.
— All routes designated for public access are annually inspected for maintenance needs. Prompt action is taken to correct any conditions that risk public safety. Roads and trails are maintained at a level that reasonably accounts for safe travel.
— Guidelines to ensure the safety of all participants will be issued in writing to any special use permit holder for the activities and will be reviewed before the activity begins.
— Routes designated for public access are monitored periodically to determine if they continue to meet the compatibility criteria (listed above) established by the refuge. Should monitoring and evaluation of the use(s) indicate that the compatibility criteria are or will be exceeded, appropriate action will be taken to ensure continued compatibility, including modifying or discontinuing the use.
— Routine law enforcement patrols are conducted throughout the year. The patrols promote education and compliance with refuge regulations, monitor public use patterns and public safety, and document visitor interaction.

JUSTIFICATION

Environmental education, interpretation, wildlife observation, and photography are all priority public uses and are to receive enhanced consideration on refuges, according to the Improvement Act. Providing increased wildlife-dependent recreational opportunities promotes visitor appreciation and support for refuge programs as well as habitat conservation efforts in New York metropolitan area and elsewhere.

Environmental education and interpretation activities generally support refuge purposes and impacts can largely be minimized. Environmental education and interpretation are public use management tools used to develop a resource protection ethic within society. These tools allow us to educate refuge visitors about endangered and threatened species management, wildlife management, ecological principles and ecological communities. Environmental education and interpretation also instill an ‘ownership’ or ‘stewardship’ ethic in visitors. They strengthen Service visibility in the local community.

The majority of visitors to the refuge are there to view and/or photograph the wildlife and upland, wetland, and grassland habitat areas. Some visit to develop an understanding of natural or cultural history. This purpose is in accordance with a wildlife-oriented activity and is an acceptable secondary use. There will be some visitor impacts from this activity, such as trampling vegetation (Kuss and Hall 1991) and disturbance to wildlife near trails (Burger 1981, Klein, 1989); however, stipulations to ensure compatibility will make these impacts minimal. For example, wildlife disturbance will be limited to the parts of the refuge that are open to the public

which represents a fraction of the total wildlife habitat available at Great Swamp leaving the remaining area un-disturbed.

By allowing these uses on trails which have been evaluated by refuge staff to meet the criteria presented in this document, physical impacts to vegetation, soils, hydrology, wetland communities and ecological integrity of Great Swamp will be minimized. Through proper trail maintenance these impacts will be further reduced. Hydrologic and soil impacts were generally inherited with refuge lands and are being remediated through routine maintenance operations. These uses will not affect the refuge's ability to restore impacted lands nor will they materially increase sedimentation, erosion or hydrologic impacts on refuge lands.

By limiting the uses to designated trails on a small percentage of the refuge and within the most common habitat type, disturbance will be limited and manageable. For this reason disturbance effects will not prevent the refuge from fulfilling the purposes of the Fish and Wildlife Act (1956) or the mission of the Refuge System for conserving, managing, restoring, and protecting wildlife resources. Through these measures the refuge still fulfills its obligations to ensure the biological integrity of the refuge's wildlife, plant and habitat resources.

These uses will not have an effect on threatened or endangered species. No public use trails are open on lands which are occupied by the threatened bog turtle. The endangered Indiana bat is nocturnal and therefore these uses will not affect their foraging activities.

For the reasons discussed above, these uses will not affect the refuge's ability to conserve wetlands or protect, manage, and restore the wildlife and plant resources, as mandated through the Emergency Wetlands Resources Act (1986) and the Fish and Wildlife Act (1956), or the mission of the Refuge System. These uses will help add to the public's understanding of Wilderness through their engagement and not detract from our abilities to manage Wilderness as we are mandated to through the Wilderness Act of 1964. Based on this information, we have determined that environmental education and interpretation and wildlife observation and photography will not materially interfere with or detract from the mission of the Refuge System or the purposes for which the refuge was established.

SIGNATURE:

Refuge Manager: _____ _____
(Signature) (Date)

CONCURRENCE:

Regional Chief: _____ _____
(Signature) (Date)

MANDATORY 15-YEAR REEVALUATION DATE: _____

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COMPATIBILITY DETERMINATION

USE

White-tailed Deer Hunt (firearm and archery)

REFUGE NAME

Great Swamp National Wildlife Refuge

DATE ESTABLISHED

1960

ESTABLISHING AND ACQUISITION AUTHORITY

Great Swamp National Wildlife Refuge (refuge) was established primarily under the authorities of the Migratory Bird Treaty Act of 1918 (16 U.S.C. 703-711, 40 Stat. 755) and the Migratory Bird Conservation Act of 1929 (16 U.S.C. 715-715r, 45 Stat. 1222), as amended, by transfer of approximately 2,900 acres of land donated to the Federal Government by the Great Swamp Committee of the North American Wildlife Foundation.

REFUGE PURPOSES

Based upon land acquisition documents and legal authorities, refuge purposes were identified as follows:

> *"…for use as an inviolate sanctuary, or for any other management purpose, for migratory birds*". (Migratory Bird Conservation Act of 1929; 16 U.S.C. 715d)
>
> *"...suitable for (1) incidental fish and wildlife-oriented recreational development, (2) the protection of natural resources, (3) the conservation of endangered species or threatened species ..."* (Refuge Recreation Act; 16 U.S.C. 460k-1) *"the Secretary…may accept and use…real…property. Such acceptance may be accomplished under the terms and conditions of restrictive covenants imposed by donors"…* (Refuge Recreation Act; 16 U.S.C. 460k-2, as amended)
>
> *"...for the conservation of the wetlands of the Nation in order to maintain the public benefits they provide and to help fulfill international obligations contained in various migratory bird treaties and conventions ..."* (Emergency Wetlands Resources Act of 1986; 16 U.S.C. 3901(b)); and,
>
> *"... to conserve (A) fish or wildlife which are listed as endangered species or threatened species ... or (B) plants ..."* (Endangered Species Act of 1973; 16 U.S.C. 1534).

> *"…to secure for the American people of present and future generations the benefits of an enduring resource of wilderness… wilderness areas ... shall be administered for the use and enjoyment of the American people in such manner as will leave them unimpaired for future use and enjoyment as wilderness, and so as to provide for the protection of these areas, the preservation of their wilderness character, and for the gathering and dissemination of information regarding their use and enjoyment as wilderness: …"* (Wilderness Act of 1964; Public Law 88-577; 16 U.S.C. 1131-1136)

NATIONAL WILDLIFE REFUGE SYSTEM MISSION

The Mission of the National Wildlife Refuge System (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 (National Wildlife Refuge System Improvement Act; 16 U.S.C. 668dd (a) (2)).

DESCRIPTION OF PROPOSED USE

(a) What is the use? Is the use a priority public use?

The use is an annual white-tailed deer hunt with two separate and distinct hunting seasons. Firearm season each November and fall archery (bow) season each October. Hunting is one of the six priority public uses identified by the National Wildlife Administration Act of 1966, as amended by the National Wildlife Refuge System Improvement Act of 1997.

(b) Where the use would be conducted?

Firearm hunting will be allowed on approximately 6,376 acres of the refuge [about 82 percent of the total area (7,735 acres)], which includes the Wilderness and Management Areas, with the exception of land designated as "Safety Zone" or "No-Entry" (Bitler 2011). Fall bow hunting will be allowed on approximately 5,000 acres of the refuge (about 65 percent of the total area), which includes the Wilderness Area east of Long Hill Road and Management Area south of White Bridge Road, with the exception of land designated as "Safety Zone" or "No Entry."

The 3,660-acre Wilderness Area forms most of the eastern side of the refuge, and is comprised of bottomland red maple floodplain forest, small upland "islands" of American beech and chestnut oak-dominated hardwood forest, and a small amount of open water. The Management Area forms the western side, and is characterized by stands of bottomland and upland forest types (i.e., pin oak – swamp white oak and mesic beech – oak) interspersed among about 840 acres of scrub-shrub habitat, 460 acres of early successional fields, and five impoundments (570 acres). Additionally, Black Brook, Great Brook, Loantaka Brook, and Primrose Brook flow through the refuge and drain into the Passaic River that runs along portions of the western refuge boundary [U.S. Fish & Wildlife Service (Service) 2009].

Two federally listed species occur on the refuge, the endangered Indiana bat (*Myotis sodalis*) and the threatened bog turtle (*Glyptemys muhlenbergii*). Indiana bats are known to forage and roost throughout the Wilderness and Management Areas during the summer maternity period (Kitchell 2008). Bats arrive in April and remain on the refuge into October, after which they migrate to winter hibernacula (USFWS 2007). A small population of bog turtles occurs in a few acres of emergent wetland habitat in a refuge Safety Zone area. Additionally, several wetlands associated with seeps that historically have supported bog turtles are scattered throughout the refuge; in the recent past, single occurrences of the species have been documented in two of these areas. State-listed species that have been documented on the refuge include the State-endangered peregrine falcon (*Falco peregrinus*), red-shouldered hawk (*Buteo lineatus*), bald eagle (*Haliaeetus leucocephalus*), vesper sparrow (*Pooecetes gramineus*), blue-spotted salamander (*Ambystoma laterale*) and bobcat (*Lynx rufus*), and the State-threatened barred owl (*Strix varia*), long-eared owl (*Asio otus*), red-headed woodpecker (*Melanerpes erythrocephalus*), and wood turtle (*Glyptemys insculpta)* [Bitler 2011, New Jersey Division of Fish & Wildlife (NJDFW) 2012a]. The refuge also contains about 31 acres of the globally rare herbaceous community called the Floodplain Pool Association along portions of the Passaic River, Black Brook, and Great Brook. Additionally, rare wetland plants documented on, or adjacent to, the refuge include featherfoil (*Hottonia inflata*), water-plaintain spearwort (*Ranunculus ambigens*), black-girdle woolgrass (*Scirpus atrocinctus*), and water horehound (*Lycopus americanus*) (USFWS 2009).

Much of the land adjacent to the refuge is residential, with the exception of four Farmland Preservation properties, a New Jersey Natural Lands Trust property, Somerset County Lord Stirling Park (along the western boundary), and Morris County Great Swamp Outdoor Education Center (along the eastern boundary) (USFWS 2009). Safety Zones (1,329 acres) include refuge lands within about 450 feet of all residences, buildings, parking areas, and equipment storage facilities. Carrying a loaded firearm within 450 feet of a building or within 450 feet of a playground (whether or not occupied) is prohibited. Carrying a bow with an arrow in place within 150 feet of a building or within 450 feet of a playground (whether occupied or not) is prohibited. The refuge also has a 64-acre No Entry area, which cannot be entered by hunters due to acquisition deed restrictions. Designated hunter parking lots will be distributed throughout the Management Area and around the perimeter of the Wilderness Area to provide access. A Deer Check Station (located by the refuge headquarters) will be open from 7:00 a.m. – 7:00 p.m. during the days of the firearm hunt (Bitler 2011). During the bow hunt, a Check Station may be established, or hunters will be required to report information on their harvested deer using the NJDFW Automated Harvest Report System.

(c) When would the use be conducted?

The annual firearm deer hunt will be conducted during the fall season. In recent years, the hunt has occurred over a 5-day period in November, beginning with a 1-day youth hunt on a Saturday, and followed by a 4-day regular hunt the following Wednesday through Saturday.

Currently, the regular hunt dates coincide with school closings associated with the annual New Jersey Teacher Convention to maximize youth hunting opportunities (Bitler 2011). In addition to the hunting days, during daylight hours, scouting will be permitted 2days in the Management Area (the Saturday prior to, and the Sunday following, the day of the youth firearm hunt). The fall bow hunt will be conducted during the fall season over a 5-day period in October (Monday through Friday). In addition to the hunting days, during daylight hours, scouting will be permitted in the Management Area, south of White Bridge Road, the Saturday prior to the day of the hunt. For both the firearm and bow hunting seasons, as population surveys are conducted and biological data are collected from harvested deer and assessed annually, season dates may change and the season length be extended or reduced. Additionally, once the bow hunt is established, we will consider adding a 1-day youth bow hunt prior to the regular bow hunt. Hunting hours will be from one-half hour before sunrise to one-half hour after sunset.

(d) How would the use be conducted?

Firearm and fall bow deer hunting will be conducted within the framework of New Jersey State regulations. The New Jersey Division of Fish and Wildlife (NJDFW) oversees the Statewide deer hunting program. The State is sub-divided into 70 Deer Management Zones and deer hunting opportunities and bag limits in most of the Zones are governed by eight State hunting regulation sets (NJDFW 2012b). The refuge comprises Deer Management Zone 38 and the refuge deer hunt is administered by the Service in cooperation with NJDFW. The NJDFW will issue up to 450 (maximum of 200 shotgun, 200 muzzleloader, and 50 bow) Zone 38 permits. In addition to a State hunting license and a Zone 38 permit, hunters who wish to hunt on the refuge must also purchase a Federal permit and follow refuge-specific regulations. Regulations and information are mailed to hunters who purchase refuge hunting permits and are published in the New Jersey's annual hunting digest (Bitler 2011). The hunt, as currently proposed, complies with the Final Environmental Impact Statement (USFWS 1987), revised 2010 Environmental Assessment, and 2013 CCP/EA.

During the firearm deer hunt, the entire refuge will be closed to all other public use activities, except that during the 1-day youth hunt, only the western half (Management Area) of the refuge will be closed. Signs will be posted at public access points and the closure will be publicized in local newspapers. The refuge will establish season dates and annual bag limits annually. For example, from 2007 – 2011, the bag limit was two deer, with a limit of one antlered buck per hunter. Shotgun hunters could take either two antlerless deer or one antlerless followed by one antlered deer, whereas muzzleloader hunters could take, in any order, two antlerless or one antlered and one antlerless deer. Further, shotgun hunters could hunt in the Management Area, but hunters using muzzleloaders could hunt in both the Management and Wilderness Areas. During the youth hunt, the bag limit was one deer of either sex (Bitler 2011). In 2012, changes in refuge

regulations included limiting the bag limit for all hunters to one deer of either sex. Hunters will be required to bring their harvested deer to the refuge Deer Check Station where biological data on the animals will be collected by refuge staff.

During the fall bow and arrow season the refuge will remain open to the public. The refuge will establish an annual bag limit similar to that of the firearm season. Weapons include long bow, recurve bow, compound bow, and crossbow. Hunters, upon harvesting any deer, must complete all information requested on the State of New Jersey Harvest Report System. A Check Station may be established, or hunters will be required to report information on their harvested deer using the NJDFW Automated Harvest Report System.

(e) Why is this use being proposed?

An annual white-tailed deer firearm hunt has been conducted on the refuge since 1974 to maintain the refuge deer population at (or below) a level that will not negatively impact wildlife habitat and the integrity of ecological communities (about 20 deer/mi^2; Tilghman 1989), while providing a safe, high-quality outdoor experience for refuge hunters. Deer are an integral part of the wildlife resources found at the refuge and serve important ecological functions. For example, deer browsing reduces the dominance of shrubs that form dense thickets, facilitating growth of other species, and thus, promoting ecological diversity (Royo et al. 2010). Deer also represent a significant vector of seed dispersal via ingestion and subsequent defecation (Myers et al. 2004), and serve as important seasonal prey to coyotes, bobcats, black bears (Miller et al., 2003, Turner et al. 2011, Northeast Deer Technical Committee 2009). However, in the absence of the intense predation pressure in which deer populations evolved, the species has the potential to grow beyond its biological carrying capacity (BCC) at a local and regional scale (Northeast Deer Technical Committee 2009). Overabundance of deer populations is one of the most challenging problems facing wildlife managers (Warren 1997).

While deer at moderate densities serve critical ecological functions, deer at high densities are known to significantly and negatively impact forest health. Over-browsing can eliminate the woody and herbaceous understory layer in forest stands, including seedlings and saplings of canopy trees. Rare plants may be lost entirely and the understory vegetation may become dominated by unpalatable plants [e.g., ferns, grasses, and sedges (Horsley et al. 2003); striped maple, American beech (Kain et al. 2011); and sugar maple (Anderson and Katz 1993)]. Less palatable, invasive plants (e.g., Japanese barberry) also may become established, outcompete native regenerating plants and become pervasive in the understory (Tilghman 1989, Miller et al. 1992). Ultimately, overbrowsing reduces habitat quality and results in the decline of many species that depend on well-developed, native understory. Long-term, forest composition changes, succession is altered, and the result is a loss of ecological diversity (Warren 1991, Rooney 2001, Horsley et al. 2003, Cote and Rooney 2004, Crimmins et al. 2010, Kain et al. 2011, Tanentzap et al. 2011).

In addition to reducing forest health, overpopulated herds exhibit reduced herd health, manifested by increased prevalence of parasites and disease, reduced body weights, and lower reproductive and winter survival rates (Miller et al. 2003, Northeast Deer Technical Committee 2009). High deer densities also increase the extent that human-wildlife conflicts occur, such as a greater number of deer/vehicle collisions, increased damage to landscape plants and agricultural crops, and an increased abundance of deer ticks (*Ixodes dammini*) that spread lyme disease (Miller et al. 2003; Northeast Deer Technical Committee 2009). In the early 1970s the refuge documented severe "browse lines" in forested habitat due to excessive deer herbivory, as well as reduced herd health, attributed to disease and starvation problems (Roscoe and Howard 1974); the first refuge deer hunt was initiated in 1974.

Deer populations are managed primarily by State agencies through regulated hunting seasons, and currently, hunting remains the only practical available option (Palmer et al. 1980, Northeast Deer Technical Committee 2009). Other techniques including: (1) trapping and transferring excess deer to other locations, (2) using fencing and repellents to manage conflicts, (3) using fertility control agents, (4) providing supplemental food, (5) controlling deer herds with sharpshooters, and (6) reintroducing large predators are all limited in applicability, prohibitively expensive, logistically impractical and technically infeasible (Conover 2000, Northeast Deer Technical Committee 2009).

While similar hunting opportunities exist outside refuge boundaries at the county level, at the township level, hunting activity is limited due to all of the development that surrounds the refuge. At the county level, the refuge is bordered by State Deer Management Zone 13, which includes portions of Morris, Somerset, and Union Counties. State regulations in Zone 13 are liberal. For example, during the 2011-12 State deer harvest, a total of 1,706 deer were harvested from Zone 13. Currently, the archery season spans 135 days over three seasons, with a bag limit of three bucks and an unlimited number of antlerless deer per hunter; the muzzloader season spans 62 days, with a bag limit of one buck and unlimited antlerless deer; and the shotgun season spans 50 days over two seasons, with a bag limit of two bucks and unlimited antlerless deer. Additionally, there is a 1-day youth archery hunt, and 1-day youth firearm hunt, with bag limits of one deer of either sex (NJDFW 2012b).

At the township level, while a huntable deer population exists, there are limited public hunting opportunities as the majority of land surrounding the refuge is developed and privately owned. Because there are few large public places open for hunting, the refuge is providing a large contribution of deer control, which is not only benefiting refuge lands, but also the adjacent communities. Additionally, refuge regulations are more conservative that those of NJDFW, as one of the goals of the refuge deer hunt program is to provide a high-quality outdoor experience for refuge hunters, which includes increasing the likelihood of harvesting an older male (≥3.5 years; Bitler 2011). This coincides with USFWS policy, which emphasizes the need to consider age class distribution when managing wildlife populations (USFWS 2000). To attempt to maintain a buck age structure where at least 30

percent of the bucks are ≥3 years old, in 1999, the refuge instituted an Earn-a-Buck Program for shotgun hunters and limited all hunters to one antlered buck per year (Bitler 2011). The refuge's Comprehensive Conservation Plan also calls for adding an archery season to the Deer Hunting Program to provide archery hunters an opportunity to hunt on the refuge.

AVAILABILITY OF RESOURCES

The annual Deer Hunting Program is administered by the Deputy Refuge Manager through Administrative, Biological, Maintenance, and Visitor Services staff. The Heavy Equipment Operator maintains 31 Hunter Parking Lots, many of which are gated and/or grass lots open only on the days of the hunt. Resource impacts are monitored by a Wildlife Biologist and resource protection is provided by a Federal Wildlife Officer. In addition to staff, volunteers contribute approximately 200 hours per year to the hunt program. Volunteers assist staff with carrying out pre-season deer spotlight surveys, marking Safety Zone and No Entry areas, and collecting information on harvested deer at the Deer Check Station.

Annual costs associated with the administration of the annual deer hunt on the refuge are estimated below:

■ Review annual deer hunting program, meet with staff, and conduct administrative tasks

GS 13 Refuge Manager:	2 days = $716.73
GS 12 Deputy Refuge Manager:	5 days = $1,734.80
GS 12 Visitor Services Manager:	7 days = $1,512.00

■ Organize and conduct annual pre-season deer spotlight survey, analyze data, and prepare report

GS 12 Deputy Refuge Manager:	1 day = $346.96
GS 12 Visitor Services Manager:	7 days = $1,512.00
GS 11 Wildlife Biologist:	15 days = $3,846.00
GS 9 Visitor Services Specialist:	3 days = $519.00
GS 9 Federal Wildlife Officer:	3 days = $615.12

■ Issue hunting permits and maintain a hunter database

GS 4 Administrative Assistant:	45 days = $1,746

■ Provide information to the public about the deer hunt

GS 12 Visitor Services Manager:	1 day = $216.00
GS 9 Visitor Services Specialist:	2 days = $346.00
GS 4 Administrative Assistant:	12 days = $455.00

■ Maintain and/or prepare (mowing) hunter parking lots, maintain pink flagging to designate "Safety Zone" and "No Entry" areas, open and close gates, place "Refuge Closed" and hunter lot number (1-31) signs

GS 10 Engineering Equipment Operator:	5 days = $1,017.20
GS 7 Maintenance Worker:	5 days = $838.40
GS 11 Wildlife Biologist:	5 days = $1,282.00
GS 12 Visitor Services Manager:	1 day = $216.00
GS 9 Visitor Services Specialist:	2 days = $346.00

■ Operate Deer Check Station

GS 12 Visitor Services Manager:	4 days = $864.00
GS 11 Wildlife Biologist:	5 days = $1,282.00
GS 9 Visitor Services Specialist:	3 days = $519.00

■ Monitor hunting activities pre-hunt, during the hunt, and post-hunt to ensure hunters and visitors are in compliance with all applicable laws and regulations. Law Enforcement also is available to assist with search and rescue and emergency response.

GS 9 Federal Wildlife Officer:	14 days = $2,870.56

■ Analyze harvest data and prepare annual Deer Hunting Program report

GS 11 Wildlife Biologist:	15 days = $3,846

Total cost of approximately $26,000.

FY 2012 Budget Allocations:

- Employee salaries and benefits = $913,000.00
- Fixed costs (utilities, fuel, administrative) = $110,000.00
- Discretionary funds (management capability) =$344,000.00
- Total available funds for FY 2012 = $1,367,000.00

Upon analysis, the refuge has adequate resources to manage deer hunting on Great Swamp NWR.

ANTICIPATED IMPACTS OF THE USE

Effects on Target Species Populations: Hunting activities will occur in the fall during deer mating season. It is possible that mature male deer may get harvested before they have had a chance to breed. This should not impact pregnancy rates, as does that fail to conceive are capable of coming into estrous every 21-30 days, from two to seven times. However, it could

extend the breeding season (Miller et al. 2003). During the days of the hunt, individual deer will be exposed to some level of disturbance that could affect their daily activities. Hammitt and Cole (1998) found that white-tailed deer females with young are more likely to flee from disturbance than those without young. Deer that are disturbed repeatedly but not harvested could lose stored fat reserves, which are important for winter survival. However, long-term impacts from hunters to deer populations are believed to be minimal due to the limited number of hunters (maximum 450 permits) and the short duration of the hunt (5 days). Overall, the refuge deer hunting program will not impair the local or regional population of deer. In fact, the use of hunting as a management tool for controlling deer populations directly benefits the health and quality of the remaining deer.

Safety is a major consideration related to deer hunting on the refuge. Much of the land adjacent to the refuge is residential and some area residents have expressed concern over the use of firearms to hunt deer. To address these concerns, the refuge is closed to all other public uses on the scheduled days of the regular hunt, and the western half of the refuge is closed during the youth hunt. Additionally, "Safety Zones" are delineated, within which hunting will not be permitted. Closing the refuge may be an inconvenience to regular visitors of the refuge (i.e., visitors who view and photograph wildlife on Pleasant Plains Road, walk their dog, bicycle, jog, ride horseback, etc.) as well as visitors who are not aware that the refuge is closed. It is anticipated that this issue could be resolved with outreach and education by, for example, explaining to the public that managing the white-tailed deer population helps to prevent over-browsing of refuge habitats.

Effects on Wildlife: In addition to disturbing deer, hunter disturbance to resident wildlife likely will occur at some level and has the potential to negatively impact wildlife populations on the refuge. Direct impacts on wildlife from disturbance can be expected wherever humans have access to an area, and the degree varies depending on a number of factors (e.g. habitat type, species, degree, and duration of disturbance, etc.). In general, human presence disturbs most wildlife, which typically results in a temporary displacement with no long-term effects on individuals or populations. Responses of wildlife to human activities include avoidance or departure from the site, the use of sub-optimal habitat, altered behavior or habituation, or in some cases, attraction (Owen 1973, Erwin 1980, Williams and Forbes 1980, Burger 1981, Kaiser and Fritzell 1984, Morton et al. 1989, Ward and Stehn 1989, Belanger and Bedard 1990, Kahl 1991, Klein 1993, Whittaker and Knight 1998). Disturbance can have other effects on wildlife including shifts in habitat use, abandonment of habitat, and an increase in energy expenditure (Knight and Cole 1991). While temporary disturbance to wildlife may occur on the refuge due to the hunt, long-term negative effects are unlikely because of the timing and duration of the deer hunt, and the limited number of hunters using the refuge.

The hunt will occur during the fall, a time of year when small mammals, reptiles, amphibians, and invertebrates are not breeding, and are less active or inactive. Thus, the likelihood of hunter

interaction with these animals will be rare, and any isolated encounters should not negatively impact these populations. State-listed bird species that possibly could be present and active on the refuge during the deer hunt include the State-endangered peregrine falcon, bald eagle, red-shouldered hawk, and vesper sparrow, and the State-threatened barred owl, long-eared owl, and red-headed woodpecker. In general, fall is the season for bird migration, and hunting could cause some level of disturbance to migrating birds during this time. Hunting activity may cause birds that are feeding and roosting in upland and wetland habitats to unnecessarily take flight, expending energy resources at a time when food resources are limited. While disturbance to the daily migrating and wintering activities of birds may occur, cumulative negative impacts should be negligible, because the hunting season does not coincide with the nesting season, which would impact reproduction, and the period of disturbance is short (5 days), reducing the likelihood that disturbance associated with the hunt would deplete important fat reserves.

Effects on Threatened and Endangered Species: Two federally listed species occur on the refuge, the endangered Indiana bat and the threatened bog turtle. Indiana bats are known to forage and roost throughout the Wilderness and Management Areas during the summer maternity period (Kitchell 2008). Bats arrive in April and remain on the refuge into October, after which they migrate to winter hibernacula (USFWS 2007). Disturbance by deer hunting to Indiana bats is unlikely because bats are gone from the refuge during the time of the hunt. The refuge also provides foraging, nesting, and hibernation habitat for the bog turtle. A small population occurs in a few acres of emergent wetland habitat in a refuge Safety Zone area. Additionally, several wetlands associated with seeps that historically have supported bog turtles are scattered throughout the refuge; in the recent past, single occurrences of the species have been documented in two of these areas. In general, activity of bog turtles during fall is limited as the animals reduce their movements and enter hibernacula (e.g., ground water-washed root systems of woody plants). Also, it is very unlikely that a hunter will encounter a bog turtle, as the primary population falls within a Safety Zone and much of the area is protected by fencing.

Effects on Vegetation: Short term trampling of vegetation by hunters will occur to some degree throughout the refuge during the firearm and bow deer hunting season. Additionally, vegetation in designated grass parking lots temporarily will be compressed from vehicles. Plant species vary in their resistance to trampling, which can lead to changes in plant communities. In general, plant diversity has been shown to increase with slight use and to decrease as use intensifies (Liddle 1997). Regardless, the overall physical effects of deer hunting on refuge plant communities are expected to be minimal. The number of hunters (maximum 450 permits) and duration of the hunt (5 days) are limited by refuge staff, use of all-terrain vehicles (ATVs) and permanent tree stands are prohibited, and the hunt takes place during the dormant season. Finally, potential impacts to vegetation from an overabundant deer population far outweigh the limited impacts on vegetation that could occur from trampling by deer hunters. In fact, positive, indirect effects on the vegetation (i.e., increased ecological diversity) will result from continued management of the refuge's white-tailed deer population.

Effects on Soil: Soils can become compacted and eroded as a result of continued foot traffic, and soils associated with wetland habitats have been rated as either high or very high in their potential for compaction (Bell 2002). However, impacts on soils from hunters during the deer hunt likely will be minimal. The use of ATVs, which can cause soil erosion, is not permitted. The increased foot traffic prior to entering off-road hunting sites should not significantly impact soils because the trails in the Wilderness Area were constructed in areas that are not subject to high levels of erosion, and the boardwalks and gravel roads in the Management Area provide low impact travel routes. Additionally, impacts from off-trail foot-traffic by hunters also are expected to be minimal due to the low number of hunters allowed on the refuge and the short duration of the hunt. Hunters going off-trail often follow existing deer trails, but in areas where new vegetation is trampled, effects likely will be temporary. The soils throughout the refuge (predominantly poor, to poorly drained silt loam, stratified lacustrine sand, silt, and clay) by nature allow vegetation such as grasses, legumes, wild herbaceous plants, hardwoods and coniferous trees to recover rather quickly (NRCS 1976). Additionally, the hunt will occur during the dormant season; in general, impacts to soils are greater during the growing season than the dormant period due to the greater soil moisture content at that time of year. Also, during the November hunt, the soils may be frozen or covered in snow, further reducing any short-term impacts on soils by hunters.

Effects on Hydrology and Water Quality: In general, the refuge minimizes adverse effects on water resources in a variety of ways. Trails are placed in areas that are not subject to high levels of erosion or adjacent to sensitive areas, to minimize erosion and adverse impacts to hydrology and water quality. Additionally, refuge has constructed boardwalks on some of the heavily visited areas to prevent impacts to hydrology. Further, the Wildlife Observation Center and wilderness trail parking lots are graveled and are therefore more porous than impervious surfaces such as asphalt or concrete. This allows precipitation to absorb into the ground and preventing storm runoff into the brooks and streams causing sediment loading and pollution run off. The refuge also does not permit the public to drive off designated refuge roads or to use ATVs, which can cause depressions in the soil and divert water from original drainage patterns.

Activities associated with hunting could impact refuge water resources. Because hunters are not restricted to using only trails designed for other public use activities, they may travel through areas that are susceptible to erosion and subsequent sedimentation. In such areas, concentrated off-trail foot traffic can affect the hydrology of an area by removing vegetation, compacting the soil, and causing water to channel and pool. Long-term, this can result in some drainages becoming dry while others accelerate erosion by being forced to carrying more water. However, impacts of hunters on the hydrology and water quality should be negligible. Hunter numbers are limited and hunters will be dispersed across the refuge, which will reduce repeated erosive actions on soils. Additionally, the soils may be frozen during the November hunting season, further reducing the potential for erosion and downstream sedimentation.

PUBLIC REVIEW AND COMMENT

This compatibility determination is being released concurrent with the draft Comprehensive Conservation Plan/Environmental Assessment for a 45-day review and comment period.

DETERMINATION (CHECK ONE BELOW):

____ Use is not compatible

__X__ Use is compatible with the following stipulations

STIPULATIONS NECESSARY TO ENSURE COMPATIBILITY

To minimize inconvenience to the non-hunting public who use the refuge, signs that the refuge will be closed on the scheduled days of the regular firearm hunt and the western half of the refuge will be closed during the youth hunt will be posted at public access points, and the closure publicized in local newspapers. The refuge will remain open during the Fall Bow hunt.

To maintain a safe hunt, Safety Zones (lands within about 450 feet of all residences, buildings, parking areas, and equipment storage facilities, in which hunters are not permitted to carry a loaded firearm) will be established and delineated with pink flagging. Carrying a loaded firearm within 450 feet of building, within 450 feet of a playground (whether occupied or not), on public roads and in parking areas is prohibited. Carrying a bow with an arrow in place within 150 feet of a building or within 450 feet of a playground (whether occupied or not) is prohibited. Additionally, hunters must wear a minimum of 400 square inches of solid-color hunter orange clothing or material in a conspicuous manner on the head, chest, and back.

To reduce the level of disturbance to wildlife, the number of hunters on the refuge will be limited to a maximum of 400 (200 shotgun and 200 muzzleloader NJDFW permits) and target practice will be prohibited. Additionally, 31 hunter parking lots will be established to help distribute hunters across the refuge. Vehicles will be restricted to public roads and in designated parking areas, use of ATVs will be prohibited, and fires and camping will not be permitted. Hunters will be allowed to set up temporary tree stands. It will be unlawful to hammer nails, spikes, or other metal objects into any tree.

To assess herd health as it relates to BCC, firearm hunters will be required to bring their harvested deer to the refuge Deer Check Station so that biological data can be collected [i.e., age class, body weight, antler beam diameter, disease and parasite prevalence (Miller et al. 2003, Northeast Deer Technical Committee 2009)]. Bow hunters may be required to check their deer or report information on their harvested deer using the NJDFW Automated Harvest Report System.

In the event that the population density falls below desired levels, as evidenced by an annual evaluation of harvest data and pre-hunt spotlight surveys, bag limits and harvest strategies are

adjusted to reduce harvest pressure on the herd. For the 2009 deer season, 113 deer were harvested, including 48 bucks and 65 antlerless animals (does and fawns). For the 2010 deer season, a total of 121 deer were harvested, including 56 bucks and 65 antlerless animals. For the 2011 deer season, a total of 42 deer were harvested, including 22 bucks and 18 antlerless animals. The significant decline in harvested deer was due to an outbreak of Epizootic hemorrhagic disease (EHD) in the summer of 2011 resulting in a significant deer die-off (refer to section 3.1.16 for information regarding EHD). Similar temporary declines were also evident in 2007 and 2008 deer harvest numbers following an EHD outbreak in 2007. In general, this level of harvest in both cases, bag limits and harvest strategies were adjusted to reduce the number of adult does harvested. For example, rather than allowing an unlimited number of antlerless deer and one antlered buck per hunter as had been the case from 2002 to 2006, from 2007 to 2011, the bag limit was reduced to two deer total, with a limit of one antlered buck per hunter; to help maintain a more natural buck age-class distribution, shotgun hunters were required to shoot an antlerles deer first, before harvesting a buck. However, following the 2011 season, the bag limit was further reduced to one deer of either sex per hunter. In general, recent levels of harvest are expected to maintain deer populations within the refuge to a density that reduces impacts to the forest understory and allows for forest regeneration.

JUSTIFICATION

A deer hunt is necessary to fulfill one of the refuge's purposes; "the protection of natural resources." Deer population control will help maintain good health in the refuge deer herd and will help prevent ecosystem damage from over browsing and thus prevent adverse impacts on other wildlife species. Ecological benefits derived from regulated hunting include protection of the environment from over browsing, protection of flora and fauna that may be negatively impacted by deer overpopulation and the maintenance of healthy, viable deer populations for our benefit and that of future generations (Warren 1991, Rooney 2001, Horsley et al. 2003, Cote and Rooney 2004, Northeast Deer Technical Committee 2009, Crimmins et al. 2010, Kain et al. 2011, Tanentzap et al. 2011).

In addition to the ecological and biological reasons for continuing the annual deer hunt on the refuge, hunting is one of the six priority public uses as defined by the National Wildlife Administration Act of 1966, as amended by the National Wildlife Refuge System Improvement Act of 1997. The Act states that hunting, if compatible, is to receive enhanced consideration over other general public uses in refuge planning and management.

The Service's policy is to provide expanded opportunities for recreational, public hunting when it is compatible with the Refuge System mission and specific refuge purposes, and consistent with sound wildlife management and public safety. We ensure that this use receives enhanced attention during planning and management. As listed in the purposes section of this compatibility determination, the refuge was established and subsequently land was acquired for a total of six purposes. Hunting will not materially interfere with or detract from the purposes related to

wildlife conservation, because hunting seasons reduce deer populations to levels that reduce the intensity of grazing which provides improved wildlife habitat, a healthier deer population, and increased plant diversity. Hunting will not materially interfere with or detract from the purposes related to migratory bird conservation because deer hunting will reduce the deer herd which will improve forest interior habitat for migratory landbirds. Additionally, the number of hunters, and timing and duration of the hunt is regulated to minimize impacts associated with human disturbance on migrating birds. Hunting will not materially interfere with or detract from the mission of the Service, because providing hunting opportunities is a focus of the Refuge System.

SIGNATURE:

Refuge Manager: _____ _____
(Signature) (Date)

CONCURRENCE:

Regional Chief:_____ _____
(Signature) (Date)

MANDATORY 15-YEAR REEVALUATION DATE: _____

LITERATURE CITED

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COMPATIBILITY DETERMINATION

USE

Spring Wild Turkey Hunt

REFUGE NAME

Great Swamp National Wildlife Refuge

DATE ESTABLISHED

1960

ESTABLISHING AND ACQUISITION AUTHORITY

Great Swamp National Wildlife Refuge (NWR, refuge) was established primarily under the authorities of the Migratory Bird Treaty Act of 1918 (16 U.S.C. 703-711, 40 Stat. 755) and the Migratory Bird Conservation Act of 1929 (16 U.S.C. 715-715r, 45 Stat. 1222), as amended, by transfer of approximately 2,900 acres of land donated to the Federal Government by the Great Swamp Committee of the North American Wildlife Foundation.

REFUGE PURPOSES

Based upon land acquisition documents and legal authorities, refuge purposes were identified as follows:

> *"…for use as an inviolate sanctuary, or for any other management purpose, for migratory birds*". (Migratory Bird Conservation Act of 1929; 16 U.S.C. 715d)
>
> *"...suitable for (1) incidental fish and wildlife-oriented recreational development, (2) the protection of natural resources, (3) the conservation of endangered species or threatened species ..."* (Refuge Recreation Act; 16 U.S.C. 460k-1) *"the Secretary…may accept and use…real…property. Such acceptance may be accomplished under the terms and conditions of restrictive covenants imposed by donors"*…(Refuge Recreation Act; 16 U.S.C. 460k-2, as amended)
>
> *"...for the conservation of the wetlands of the Nation in order to maintain the public benefits they provide and to help fulfill international obligations contained in various migratory bird treaties and conventions ..."* (Emergency Wetlands Resources Act of 1986; 16 U.S.C. 3901(b)); and,
>
> *"... to conserve (A) fish or wildlife which are listed as endangered species or threatened species ... or (B) plants ..."* (Endangered Species Act of 1973; 16 U.S.C. 1534).

> *"…to secure for the American people of present and future generations the benefits of an enduring resource of wilderness… wilderness areas ... shall be administered for the use and enjoyment of the American people in such manner as will leave them unimpaired for future use and enjoyment as wilderness, and so as to provide for the protection of these areas, the preservation of their wilderness character, and for the gathering and dissemination of information regarding their use and enjoyment as wilderness: …"* (Wilderness Act of 1964; Public Law 88-577; 16 U.S.C. 1131-1136)

NATIONAL WILDLIFE REFUGE SYSTEM MISSION

The Mission of the National Wildlife Refuge System (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 (National Wildlife Refuge System Improvement Act; 16 U.S.C. 668dd (a) (2)).

DESCRIPTION OF PROPOSED USE

(a) What is the use? Is the use a priority public use? The use is a spring wild turkey (*Meleagris gallopavo silvestris*) hunt. Hunting is one of the six priority public uses identified by the National Wildlife Administration Act of 1966, as amended by the National Wildlife Refuge System Improvement Act of 1997.

(b) Where the use would be conducted? Turkey hunting would be allowed on approximately 5,000 acres of the refuge [about 65 percent of the total area (7,735acres)], which includes the Wilderness Area east of Long Hill Road and Management Area south of White Bridge Road, with the exception of land designated as "Safety Zone." Currently, turkey populations are found throughout New Jersey where suitable habitat exists [contiguous forest or woodland areas (>10 acres) and associated field edge habitat (Erikson et al. 2009)]. The refuge falls within New Jersey Turkey Hunting Area 10, which maintains viable turkey populations and an annual spring turkey hunt (NJDFW 2012a). The refuge also supports a healthy turkey population.

The 3,660-acre Wilderness Area forms the eastern side of the refuge, and is comprised of bottomland red maple floodplain forest, small upland "islands" of American beech and chestnut oak-dominated hardwood forest, and about 247 acres of open water. The Management Area forms the western side, and is characterized by stands of bottomland and upland forest types (i.e., pin oak – swamp white oak and mesic beech – oak) interspersed among about 840 acres of scrub-shrub habitat, 460 acres of early succession fields, and five impoundments (570 acres). Additionally, Black Brook, Great Brook, Loantaka Brook, and Primrose Brook flow through the refuge and drain into the Passaic River that runs along portions of the western refuge boundary (USFWS 2009). The refuge also has a 64-acre No Entry area, in which hunters are not allowed due to acquisition deed restrictions.

Much of the land adjacent to the refuge is residential, with the exception of four Farmland Preservation properties, a New Jersey Natural Lands Trust property, Somerset County Lord Stirling Park (along the western boundary), and Morris County Great Swamp Outdoor Education Center (along the eastern boundary) (USFWS 2009). Safety Zones (1,329 acres) have been established (marked with pink flagging), and include refuge lands within 450 feet of a building or within 450 feet of any school playground (whether or not occupied). Designated hunter parking lots will be distributed throughout the Management Area and around the perimeter of the Wilderness Area to provide access. A Turkey Check Station (located by the refuge headquarters) will be open during the days of the hunt.

(c) When would the use be conducted? The turkey hunt will occur during the spring season, in April and May. The hunt will consist of a 1-day youth hunt at the end of April, followed by a regular hunt during a 1-week period in late May. This regular hunt will be a single 1-week hunting period, as described in the NJDFW regulations for spring turkey hunting season (NJDFW 2012a). Hunting hours will be from one-half hour before sunrise to noon. However, as population surveys are conducted and biological data are collected from harvested birds and assessed annually, season dates may change and the season length may be extended or reduced. Additionally, the refuge manager may, upon annual review of the turkey hunting program, impose further restrictions on hunting, recommend that the refuge be closed to hunting, or further liberalize hunting regulations within the limits of state law. Hunting duration will be reviewed each year as part of the annual hunt plan meeting and are subject to reduction in length at the discretion of the refuge manager.

(d) How would the use be conducted? Spring turkey hunting will be conducted within the framework of New Jersey State regulations, Federal regulations in 50 CFR pertaining to the upland game hunting, and refuge-specific regulations. Season dates and bag limits will be managed to ensure that refuge hunts are compatible with the principles of sound wildlife management and otherwise in the public interest, and will be modified, as needed, on an annual basis.

The NJDFW oversees the Statewide turkey hunting program. Hunter numbers and bag limits are based on amount of land open to hunting, hunter densities, and anticipated hunter success ratios. The State is divided into 22 Turkey Hunting Areas; the refuge falls within Turkey Hunting Area 10 (Morris, Union, Essex, Hudson, and Bergen Counties). For each Hunting Area, a lottery system is used to issue hunting permits for five hunting periods and weekly permit quotas determined. Currently, the weekly spring quota for Hunting Area 10 is 160 male birds (NJDFW 2012a). The refuge will work in cooperation with NJDFW to design and carry out a spring turkey hunt. For example, not including the youth hunt, based on 5,000 acres (~8 mi^2) of suitable turkey habitat on the refuge and a hunter density of two hunters/mi^2, a total of 16 hunters would be allowed on the refuge over a 1-week hunting segment (16 hunters per week). Hunters would be allowed to harvest male turkeys with a

shotgun using non-toxic shot or bow and the bag limit would be one male turkey per permit. Total hunters would be 16 at 5 days, equaling 80 hunter half days. The hunter success ratio in New Jersey typically is about 16 percent. However, for a population that is legally being hunted for the first time, harvest rates around 30 percent can be expected (T. McBride, NJDFW Turkey Project Leader, Personal Communication). Based on a 30 percent hunter success ratio, only five male turkeys would be anticipated to be harvested the first season. After the first season, hunter success ratios likely would drop to 16 percent. Hunters would be required to bring harvested turkeys to the refuge Turkey Check Station where biological data on the animals would be collected by refuge staff. Regulations consistent with a Turkey Hunting Plan will be enforced.

(e) Why is this use being proposed? The U.S. Fish and Wildlife Service (Service) has long recognized that hunting is an integral part of a comprehensive management program, and that significant positive benefits can be attributed to a well-managed hunt and a quality public hunting experience. Under current Service policy, hunting is an acceptable and traditional form of recreation, particularly in areas where it historically has been practiced. One of the refuge strategic goals as well as a Visitor Services goal is to provide quality wildlife dependent recreational opportunities in the "Big Six," which includes hunting. When it is done responsibly, the introduction of a spring wild turkey hunt on the refuge is consistent with this goal.

Wild turkeys currently are common throughout New Jersey, but this was not always the case. For more than 100 years (mid-1800s – 1970s) turkeys were gone from the State due to unregulated killing for food and habitat changes. In 1977, the NJDFW, in cooperation with the New Jersey Chapter of the National Wild Turkey Federation, reintroduced turkeys to New Jersey, beginning with an initial release of 23 birds from Vermont, and additional birds from Arkansas (Hahn and Penkala 1977, Penkala and Erickson 1978). In 1979, biologists and technicians began live-trapping and relocating birds to establish populations throughout the State. By 1981, the population was able to support a spring hunting season, and in December 1997, a limited fall season was initiated. In 1986, the NJDFW released wild turkeys into the Great Swamp NWR. The birds were from the in-state trap and transfer program. Historically, 4 years after an area had received trap and transfer birds, the population was considered stable and able to sustain a limited spring turkey hunting season (Robert Erickson, Regional Biologist, NWTF, Personal Communication). Currently, the New Jersey's turkey population is estimated at more than 20,000 birds, with an annual harvest of more than 3,000 birds Statewide (T. McBride, NJDFW Turkey Project Leader, Personal Communication). Allowing a limited wild turkey hunt on the refuge is not likely to negatively impact the local or regional turkey population.

AVAILABILITY OF RESOURCES

The Wild Turkey Hunting Program will be administered by the Deputy Refuge Manager through Administrative, Biological, Maintenance, and Visitor Services staff. The Heavy Equipment Operator will maintain Hunter Parking Lots, open only on the days of the hunt. Resource impacts will be monitored by a Wildlife Biologist and resource protection will be provided by a Federal Wildlife Officer. Volunteers will assist staff with carrying out population surveys, marking Safety Zone and No Entry areas, and collecting information on harvested turkeys at the Turkey Check Station.

Annual costs associated with the administration of the annual turkey hunt on the refuge are estimated below:

■ Review annual turkey hunting program, meet with staff, and conduct administrative tasks

GS 13 Refuge Manager:	1 day = $358.36
GS 12 Deputy Refuge Manager:	3 days = $1,040.88
GS 12 Visitor Services Manager:	4 days = $864.00

■ Organize and conduct annual turkey polt survey, analyze data, and prepare report

GS 12 Deputy Refuge Manager:	1 day = $346.96
GS 12 Visitor Services Manager:	4 days = $1,040.88
GS 11 Wildlife Biologist:	8 days = $2,051.20
GS 9 Visitor Services Specialist:	3 days = $519.00
GS 9 Federal Wildlife Officer:	3 days = $615.12

■ Issue hunting permits and maintain a hunter database

GS 4 Administrative Assistant:	22 days = $873.00

■ Provide information to the public about the turkey hunt

GS 12 Visitor Services Manager	1 day = $216.00
GS 9 Visitor Services Specialist:	2 days = $346.00
GS 4 Administrative Assistant:	12 days = $455.00

■ Maintain and/or prepare (mowing) hunter parking lots, maintain pink flagging to designate "Safety Zone", open and close gates, place hunter lot number signs.

GS 10 Engineering Equipment Operator:	3 days = $610.32
GS 7 Maintenance Worker:	3 days = $503.04
GS 11 Wildlife Biologist:	3 days:= $769.20

GS 12 Visitor Services Manager:	1 day = $216.00
GS 9 Visitor Services Specialist:	2 days = $346.00

■ Operate Turkey Check Station

GS 12 Visitor Services Manager:	4 days = $864.00
GS 11 Wildlife Biologist:	5 days = $1,282.00
GS 9 Visitor Services Specialist:	3 days = $519.00

■ Monitor hunting activities pre-hunt, during the hunt, and post-hunt to ensure hunters and visitors are in compliance with all applicable laws and regulations. Law Enforcement also is available to assist with search and rescue and emergency response.

GS 9 Federal Wildlife Officer:	7 days = $1,435.28

■ Analyze harvest data and prepare annual Turkey Hunting Program report

GS 11 Wildlife Biologist:	7 days = $1,794.80

Total cost of approximately $17,000.00

FY 2012 Budget Allocations:

- Employee salaries and benefits = $913,000.00
- Fixed costs (utilities, fuel, administrative) = $110,000.00
- Discretionary funds (management capability) =$344,000.00
- Total available funds for FY 2012 = $1,367,000.00

ANTICIPATED IMPACTS OF THE USE

Effects on Target Species Populations: Since male turkeys will mate with more than one hen, a limited spring gobbler season should have little impact on breeding success and size of the turkey population. However, other factors such as wet spring seasons that reduce polt survival, predation by avian and mammalian predators, additional human-caused mortality, and disease, also influence mortality rates, and under certain conditions harvest-related mortality could be additive (Diefenbach et al. 2011). Thus, impacts of hunting when combined with other natural sources of mortality could negatively impact the refuge turkey population. There are many factors that can contribute to changes in the turkey population, and very few of these factors (i.e. spring rainfall) can be controlled by wildlife managers. One factor that wildlife managers can control is the length and timing of hunting seasons. Spring gobbler (males) seasons are set to coincide with the time when hens begin to incubate their eggs. In New Jersey, this occurs in late April. Starting a spring season too early can be detrimental to turkey populations because hens abandon nests more readily if they are disturbed before they start to incubate. Additionally, illegal take of hens occurs more frequently if a spring season starts before incubation, when hens

are still mobile. The second peak of gobbling activity occurs at the start of incubation, when nesting hens are no longer available to gobblers. The spring season is timed to better coincide with this peak in gobbling activity (2012-13 NJ Hunting and Trapping Digest)

If not accounted for in planning, high hunter success ratios could further impact the population. Based on State hunter success ratios, the estimated first-year harvest for the refuge would be five male birds. Harvest should decrease in subsequent years if the hunt period and hunter density remain the same due to a more "educated" turkey population. Close monitoring will be necessary to document factors impacting the refuge turkeys to ensure a viable population and sustainable harvest.

Safety is a major consideration related to turkey hunting on the refuge. Much of the land adjacent to the refuge is residential and some area residents have expressed concern over the use of firearms for hunting. To address these concerns, those portions of the refuge in which turkey hunting will occur will be closed to all other public uses on the scheduled days of the 5-day hunt. Additionally, "Safety Zones" are delineated, within which hunting will not be permitted.

Effects on Wildlife: Direct impacts on wildlife from disturbance can be expected wherever humans have access to an area, and the degree varies depending on a number of factors (e.g. habitat type, species, degree and duration of disturbance, etc.). In general, human presence disturbs most wildlife, which typically results in a temporary displacement with no long-term effects on individuals or populations. Responses of wildlife to human activities include avoidance or departure from the site, the use of sub-optimal habitat, altered behavior or habituation, or in some cases, attraction (Owen 1973, Erwin 1980, Williams and Forbes 1980, Burger 1981, Kaiser and Fritzell 1984, Morton et al. 1989, Ward and Stehn 1989, Belanger and Bedard 1990, Kahl 1991, Klein 1993, Whittaker and Knight 1998). Disturbance can have other effects on wildlife including shifts in habitat use, abandonment of habitat, and an increase in energy expenditure (Knight and Cole 1991). The hunt will cause some level of disturbance to non-target species as hunters walk to their hunting locations and discharge shotguns.

Hunters may temporarily disrupt feeding and resting of migrating birds. Additionally, off-trail hiking by turkey hunters could disturb low-elevation or ground nesting breeding birds as they attempt to establish and settle into nest territories, build nests, or incubate eggs. State-listed species that could possibly be present and active on the refuge during the turkey hunt include State-endangered peregrine falcon, red-shouldered hawk, bald eagle, vesper sparrow, blue-spotted salamander and bobcat, and the State-threatened barred owl, long-eared owl, red-headed woodpecker, and wood turtle. While temporary disturbance to wildlife may occur on the refuge due to the turkey hunt, long-term negative effects are unlikely due to the limited number of hunters distributed over about 5,000 acres, the short duration of the hunt, the type of hunting, which requires stealth, and the fact that hunters frequently become sedentary once set up to hunt.

Effects on Threatened and Endangered Species: Two federally listed species occur on the refuge, the endangered Indiana bat and the threatened bog turtle. Indiana bats are known to forage and roost throughout the Wilderness and Management Areas during the summer maternity period (Kitchell 2008). Bats arrive in April and remain on the refuge into October, after which they migrate to winter hibernacula (USFWS 2007). The refuge also provides foraging, nesting, and hibernation habitat for the bog turtle. A small population occurs in a few acres of emergent wetland habitat in a refuge Safety Zone area. Additionally, several wetlands associated with seeps that historically have supported bog turtles are scattered throughout the refuge; in the recent past, single occurrences of the species have been documented in two of these areas. Disturbance by turkey hunting to Indiana bats is unlikely because bats are rare, they roost during the day under the exfoliating bark of trees, and are they most active at night. Also, it is very unlikely that a hunter will encounter a bog turtle, as the primary population falls within a Safety Zone and much of the area is protected by fencing. Additionally, because turkeys are an upland species, hunters are less likely to enter or remain in wetland habitats, where turtles are found. In fact, the type of habitat that bog turtles use (characterized by shallow water and deep "mucky" soils USFWS 2012) likely will be avoided by hunters as they travel to their desired turkey hunting areas.

Effects on Vegetation: Spring turkey hunting could directly impact native vegetation, depending on the time of year, length of season, number of hunters, and extent of hunt locations. Spring is the time ephemeral plants are in bloom and are most vulnerable to trampling. Short-term, trampling of vegetation by hunters will occur to some degree throughout the refuge during the turkey hunting season. Vegetation will be compressed in the designated grass parking lots and trails could be created by hunters. Plant species vary in their resistance to trampling, which can lead to changes in plant communities. In general, plant diversity has been shown to increase with slight use and to decrease as use intensifies (Liddle 1997). Regardless, the physical effects of turkey hunting on rare plant communities and vegetation, including wetland habitat are expected to be minimal. All-TerrainVehicles (ATV) will not be permitted on the refuge, and the high acreage to hunter ratio will minimize foot traffic.

Effects on Soil: Soils can become compacted and eroded as a result of continued foot traffic, and soils associated with wetland habitats have been rated as either high or very high in their potential for compaction (Bell 2002). Recreation impacts to soils from trampling indirectly affects vegetation by loosening the soil's surface layers and compacting the underlying layers. Coupled with a loss of plant cover, this leads to increased soil erosion (Hammitt 1986). Trampling also decreases the abundance and diversity of soil organisms such as microbes, earthworms, arthropods, snails, and slugs, which often play a major role in nutrient cycling (Liddle 1997). However, impacts on soils from hunters during the turkey hunt likely will be minimal. Because turkeys are an upland species, hunters are less likely to enter or remain in wetland habitats, where the potential for high soil compaction exists. Additionally, the use of ATVs, which can cause soil erosion, is not permitted. Further, in areas where new vegetation is

trampled from off-trail foot-traffic, effects likely will be temporary due to the low number of hunters (16) allowed on the refuge and the short duration of the hunt (5 half days). In general, the soils throughout the refuge (predominantly poor, to poorly drained silt loam, stratified lacustrine sand, silt, and clay), by nature, allow vegetation such as grasses, legumes, wild herbaceous plants, hardwoods and coniferous trees to recover rather quickly (NRCS 1976).

Effects on Hydrology and Water Quality: The refuge minimizes adverse effects on water resources in a variety of ways. Trails are placed in areas that are not subject to high levels of erosion or adjacent to sensitive areas, to minimize erosion and adverse impacts to hydrology and water quality. The refuge also does not permit the public to drive off designated refuge roads or to use ATVs, which can cause depressions in the soil and divert water from original drainage patterns. Activities associated with turkey hunting have the potential to impact refuge water resources. For example, because hunters are not restricted to using only trails designed for other public use activities, they may travel through areas that are susceptible to erosion and subsequent sedimentation. In such areas, concentrated off-trail foot traffic can affect the hydrology of an area by removing vegetation, compacting the soil, and causing water to channel and pool. Long-term, this can result in some drainages becoming dry while others accelerate erosion by being forced to carrying more water. However, impacts of hunters on the hydrology and water quality should be negligible. The duration of the hunt is short (5 days), hunter numbers are limited (16), and hunters will be dispersed across approximately 5,000 acres of the refuge, which will virtually eliminate repeated erosive actions on soils.

PUBLIC REVIEW AND COMMENT

This compatibility determination is being released concurrent with the draft Comprehensive Conservation Plan/Environmental Assessment for a 45-day review and comment period.

DETERMINATION (CHECK ONE BELOW):

____ Use is not compatible

__X__ Use is compatible with the following stipulations

STIPULATIONS NECESSARY TO ENSURE COMPATIBILITY

To minimize inconvenience to the non-hunting public who use the refuge, signs that portions of the refuge will be closed on the scheduled days of the hunt will be posted at public access points, and the closure publicized in local newspapers. The timing of the hunt also will coincide with the end of the peak bird migration season to reduce conflicts with other public uses.

To maintain a safe hunt, Safety Zones in which hunters are not permitted to carry a loaded firearm or nocked arrow will be established and delineated with pink flagging. A no hunt buffer zone will be flagged around the Morris County Park Commission's Outdoor Education Center.

Carrying a loaded firearm within 450 feet or a nocked arrow within 150 feet of a building or within 450 feet of any school playground (whether or not occupied) is prohibited. Loaded firearms also will not be permitted on public roads and in parking areas. Recreational trails will be closed during the hunt to maintain visitor safety and minimize other public use conflicts.

To reduce the level of disturbance to wildlife, the number of hunters on the refuge will be limited; initially, a density of two hunters per square mile will be allowed. Hunter parking lots will be established to help distribute hunters across the refuge. Vehicles will be restricted to public roads and in designated parking areas, use of ATVs will be prohibited, target practice will be prohibited, and fires and camping will not be permitted. Hunters will be required to be out of the field by 12 noon. Additionally, driving or chasing turkeys to put them in range of other hunters will be prohibited.

To monitor the turkey population, the refuge will conduct annual gobbler and polt surveys. Additionally, hunters will be required to bring their harvested turkeys to the refuge Turkey Check Station so that biological data can be collected [spur length, beard length, weight, etc.]. An annual Turkey Hunt Plan will be prepared, and seasons will be adjusted if needed, as part of an adaptive management scheme.

JUSTIFICATION

Public hunting, and more specifically wild turkey hunting, will not prevent the refuge from fulfilling the purposes of the Fish and Wildlife Act (1956) or the mission of the refuge system for conserving, managing, restoring, and protecting wildlife resources. Hunting is one of the six priority public uses defined by the National Wildlife Refuge System Administration Act of 1966, as amended by the National Wildlife Refuge System Improvement Act of 1997. The Act states that hunting, if compatible, is to receive enhanced consideration over other general public uses in refuge planning and management. More specifically, the refuge mission instructs the refuge to provide for fish and wildlife-oriented recreation; a well-managed wild turkey hunting season provides that opportunity.

The Service's policy is to provide expanded opportunities for recreational, public hunting when it is compatible with the Refuge System mission and specific refuge purposes, and consistent with sound wildlife management and public safety. We ensure that this use receives enhanced attention during planning and management. As listed in the purposes section of this compatibility determination, the refuge was established and subsequently land was acquired for a total of six purposes. Turkey hunting will not materially interfere with or detract from the purposes related to wildlife conservation, because turkeys are common throughout New Jersey wherever there is suitable habitat. There is no evidence that a permitted regulated turkey hunt on the refuge will significantly impact the local or regional turkey population, other wildlife, the refuge environment, adjacent lands, or nearby residents. Hunting will not materially interfere with or detract from the purposes related to migratory bird conservation because the numbers of

hunters and duration of the hunt are regulated to minimize impacts associated with human disturbance on migrating birds. Hunting will not materially interfere with or detract from the mission of the Service, because providing hunting opportunities is a focus of the Refuge System.

SIGNATURE:

Refuge Manager: _____ _____
(Signature) (Date)

CONCURRENCE:

Regional Chief: _____ _____
(Signature) (Date)

MANDATORY 15-YEAR REEVALUATION DATE: _____

LITERATURE CITED

Erikson, R., A. McBride, and G. Norman. 2009. Survival and hunting mortality of male wild turkeys in New Jersey. Unpublished Report. New Jersey Division of Fish and Wildlife, Trenton, NJ.

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COMPATIBILITY DETERMINATION

USE

Special Birding Events

REFUGE NAME

Great Swamp National Wildlife Refuge

DATE ESTABLISHED

1960

ESTABLISHING AND ACQUISITION AUTHORITY

Great Swamp National Wildlife Refuge (NWR, refuge) was established primarily under the authorities of the Migratory Bird Treaty Act of 1918 (16 U.S.C. 703-711, 40 Stat. 755) and the Migratory Bird Conservation Act of 1929 (16 U.S.C. 715-715r, 45 Stat. 1222), as amended, by transfer of approximately 2,900 acres of land donated to the Federal Government by the Great Swamp Committee of the North American Wildlife Foundation.

REFUGE PURPOSES

Based upon land acquisition documents and authorities, refuge purposes were identified as follows:

> *"…for use as an inviolate sanctuary, or for any other management purpose, for migratory birds*". (Migratory Bird Conservation Act of 1929; 16 U.S.C. 715d)
>
> *"...suitable for (1) incidental fish and wildlife-oriented recreational development, (2) the protection of natural resources, (3) the conservation of endangered species or threatened species ..."* (Refuge Recreation Act; 16 U.S.C. 460k-1) *"the Secretary…may accept and use…real…property. Such acceptance may be accomplished under the terms and conditions of restrictive covenants imposed by donors"*…(Refuge Recreation Act; 16 U.S.C. 460k-2, as amended)
>
> *"...for the conservation of the wetlands of the Nation in order to maintain the public benefits they provide and to help fulfill international obligations contained in various migratory bird treaties and conventions ..."* (Emergency Wetlands Resources Act of 1986; 16 U.S.C. 3901(b)); and,

"... to conserve (A) fish or wildlife which are listed as endangered species or threatened species .... or (B) plants ..." (Endangered Species Act of 1973; 16 U.S.C. 1534).

"…to secure for the American people of present and future generations the benefits of an enduring resource of wilderness… wilderness areas ... shall be administered for the use and enjoyment of the American people in such manner as will leave them unimpaired for future use and enjoyment as wilderness, and so as to provide for the protection of these areas, the preservation of their wilderness character, and for the gathering and dissemination of information regarding their use and enjoyment as wilderness: …" (Wilderness Act of 1964; Public Law 88-577; 16 U.S.C. 1131-1136)

NATIONAL WILDLIFE REFUGE SYSTEM MISSION

The Mission of the National Wildlife Refuge System (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 (National Wildlife Refuge System Improvement Act; 16 U.S.C. 668dd(a)(2)).

DESCRIPTION OF PROPOSED USE

(a) What is the use? Is the use a priority public use?
The use is special birding events including, but not limited to, the "World Series of Birding" (WSB), Christmas Bird Count (CBC), "Big Sit" (BS), and "Owl Prowls" (OP).

WSB: The WSB is a 24-hour competitive birding event held throughout the State of New Jersey that typically takes place in mid-May to coincide with spring bird migration. The event is hosted by the New Jersey Audubon Society (NJAS) and is used as a fundraiser for numerous conservation organizations. Many teams (usually 3-6 individuals per team) raise money from pledges based on the number of bird species they identify by sight and sound during the course of the 24-hour contest. Annually, 15-25 teams have requested permission to participate in the event on the refuge since the WSB began in 1984. In addition to the event itself, a small number of scouting days are designated during the two weeks leading up to the event.

CBC: The CBC is an annual early-winter bird census sponsored by the National Audubon Society (NAS) that began in 1900. It is the longest running citizen science survey in the world and has grown to more than 2,000 counts done in countries throughout the Western Hemisphere. CBC volunteers follow specific routes through designated 15-mile diameter "circles" counting every bird seen or heard during the count period. The refuge lies within the "Great Swamp-Watchung Ridges" circle (circle code NJGS). CBCs have been done on and around the Great

Swamp since before the refuge was established and have continued annually since then. In recent years, four teams have requested permission to participate in the CBC on the refuge.

BS: The BS is an annual, international, noncompetitive birding event hosted by Bird Watcher's Digest. The refuge has hosted the event every fall since 2007 to coincide with the start of NWR Week. The Friends of Great Swamp NWR (FOGS) organizes the event and has used it as a fundraiser. The goal of the BS is to record all birds seen or heard in the area during a 24-hour period while remaining within a 17-foot diameter circle. The refuge's count circle is laid out in a publically accessible area and, at any given time, 6-12 participants are within the circle searching for birds. Many visitors (approximately 110 in 2011) stop by during the event to lend a hand and enjoy the event.

OP: Since 2008, the refuge has granted permission to The Raptor Trust (TRT), a local non-profit bird rehabilitation center, to lead guided night tours that focus on seeing or hearing owls. TRT staff lead between one to three OPs on the refuge annually during the fall and winter months when nights are longer and owls are easier to locate. Group size is limited to 20 participants. TRT uses the event as a fundraiser through the collection of voluntary donations from participants.

Special birding events are forms of wildlife observation and as such are a priority public uses (National Wildlife Refuge System Improvement Act of 1997; Public Law 105-57).

(b) Where would the use be conducted?

WSB: The WSB would be conducted throughout the entire refuge, including areas generally closed to the public.

CBC: The CBC would be conducted throughout the entire refuge, including areas generally closed to the public.

BS: The BS would be conducted in a publically accessible area of sufficient size to safely accommodate the count circle and stream of participants and visitors who attend throughout the day. To date, the parking area in the refuge's "Overlook" has been used for this event.

OP: OPs are conducted along Pleasant Plains Road which is open to the public during the day.

(c) When would the use be conducted?

WSB: The WSB typically takes place on a Saturday in mid-May and runs from midnight to midnight. The refuge has allowed scouting two weeks before the event on certain days and at certain times. Both day and night scouting has been allowed. In recent years, 6 scouting days have been allowed.

CBC: The CBC typically takes place within a week of Christmas Day and runs from several hours before sunrise to several hours after sunset.

BS: The BS has typically been held in mid-October on the first Saturday of NWR Week and runs from midnight to midnight, though participants have typically departed by 9 p.m. The general public is restricted to visiting during normal refuge hours (i.e. between sunrise and sunset).

OP: OPs have been conducted typically from October-February between 8-10 p.m. when the refuge is closed to the public for the night.

(d) How would the use be conducted?

WSB: It is important to note that the refuge does not administer the WSB event itself but rather controls participant access to the refuge in areas and at times typically closed to the public. WSB teams requesting special access must secure a Special Use Permit (SUP) in advance of the event. SUPs are issued during a 2-week window from the Monday of the week before the event until the Friday prior. WSB participants not requesting special access do not require a SUP. Disabled individuals in need of assistance may qualify for special accommodations by making arrangements in advance with refuge staff. Teams are free to scout the refuge on the dates, times, and in the locations permitted. Access to areas closed to the public is by foot travel only. On the day of the event, teams record all of the bird species seen or heard on the refuge during all or part of the 24-hour contest period. Highly competitive teams generally spend a short time on the Refuge and quickly leave to travel the State in search of additional species. Information on the species identified is reported to Audubon as part of the competition. Teams also submit a list of the species recorded at Great Swamp to the refuge to supplement avian monitoring data.

CBC: CBC teams requiring access not typically granted to the public must request a SUP before being allowed to participate in the event on the refuge. Access to areas closed to the public is by foot travel only. CBC participants not requesting special access do not require a SUP. In recent years, four teams have requested SUPs. Teams larger than 10 individuals are required to split into groups of no more than 10 to minimize disturbance. Teams typically start several hours before sunrise and finish several hours after sunset. On the day of the event, teams record all of the bird species seen or heard on the Refuge during the count period. Teams are required to submit a list of the number of birds recorded by species at Great Swamp to the refuge to supplement avian monitoring data.

BS: A SUP is required for participation in the BS. Participants are allowed to enter the refuge at midnight and may stay until the event ends 24-hours later. The event, however, has typically ended by 9 p.m. A 17-foot diameter circle is laid out with chalk powder in the refuge's Overlook

parking area within which participants must remain to officially record bird observations. Participants bring their own lawn chairs, binoculars, and spotting scopes and are free to leave the count circle at any time. A portable canopy is erected to provide shade and tables are set up for refreshments and information in the adjacent kiosk. A running tally of bird observations is maintained on a white board for the public's enjoyment. Since the count circle (including a buffer for safety) occupies a large portion of the parking area, additional parking has been made available in the "turnaround" northwest of the Great Brook Bridge. Visitors are allowed to observe the event during normal refuge hours. BS participants are required to submit a list of the number of birds recorded by species to the refuge to supplement avian monitoring data.

OP: The refuge has issued a SUP to TRT for one to three OPs each season since the event began. Group size is limited to 20 participants. TRT staff lead a small caravan of vehicles down Pleasant Plains Road after sundown in search of owls. The caravan makes several stops either along the road or in refuge parking areas to listen for owls. TRT naturalists may also attempt to "call" owls to solicit a response. TRT is required to submit a report to the refuge of the number of participants involved and the number and species of owls identified during each outing.

(e) Why is this use being proposed?

These special birding events are all forms of wildlife observation and, as such, are priority wildlife-dependent public uses. Refuges have a proactive responsibility to provide such uses when appropriate and compatible. In 1994, a compatibility determination (CD) was completed for the WSB given the scope and unique nature of the event. The use was determined to be compatible at that time. The current CD expands this focus to include additional special birding events, some of which (BS and OP) were not occurring in 1994. Note that wildlife observation in general is addressed in a separate CD.

AVAILABILITY OF RESOURCES

The resources necessary to provide and administer this use are available within the current and anticipated refuge budgets. Staff time associated with administration of this use is related to coordinating with the various permittees (NJAS, NAS, FOGS, TRT), updating SUPs every year, issuing SUPs to the various requesters and answering questions, law enforcement to ensure safety and compliance during the events, follow-up contacts to ensure required reports are submitted to the refuge, reevaluating the appropriateness and compatibility of this use every 15 years, and monitoring to ensure that the conditions and stipulations of the SUPs and CD are followed. The deputy refuge manager, Federal wildlife officer, and office automation assistant have primary responsibility for these duties which require approximately 14 days of staff time per year.

- GS-12 Deputy Refuge Manager: 3 days = $1,041.00

- GL-09 Federal Wildlife Officer: 3 days = $639.00
- GS-04 Office Automation Assistant: 8 days = $1,003.00
- Office supplies: postage, etc. = $200.00
- Total = $2,883.00

ANTICIPATED IMPACTS OF THE USE

The special birding events associated with this use have been occurring annually on the refuge, in some cases, since the refuge was established, with negligible impacts. Impacts are anticipated to remain negligible in the future. Given the nature of these events, participants strive to minimize disturbance in order to maximize bird identification opportunities. All events are conducted in ways, at times, and in locations to minimize disturbance to wildlife and other refuge resources while providing outstanding opportunities for wildlife observation and environmental education and interpretation. In the case of the WSB, the impact on waterfowl has been minimal since over 90 percent of the ducks which use the refuge in spring migrate north prior to the event. In 2011, vehicular access to roads in closed areas was permanently terminated which resulted in fewer teams participating in the event on the refuge. These changes have further lessened potential impacts. The CBC is conducted on foot by groups limited to no more than 10 participants. The BS is held in a refuge parking area with a solid gravel base which minimizes any physical disturbance associated with the event. Similarly, OPs are restricted to Pleasant Plains Road and refuge parking areas which are surfaced with gravel or asphalt. In total, these events occupy the refuge for no more than12 days (some partial) per year. Disturbance to wildlife, including species of conservation concern, has been and is expected to remain negligible.

The presence of people on refuge trails and roads can lead to displacement of animals from trails, although disturbance usually is a negligible influence on large mammal distributions and movements (Purdy et al. 1987; Boyle and Samson 1985). The effects on other forms of wildlife appear to be short-term with the exception of breeding bird communities. A study by Miller, Knight, and Miller (1998) indicates that species composition and nest predation was altered adjacent to trails in both forested and grassland habitats. It appears that species composition changes are due to the presence of humans and not the trail or roadway itself. On the other hand, nest predation does appear to be a function of the trail which allows access to mammalian nest predators (Miller, Knight, and Miller 1998). With respect to Great Swamp, we anticipate that similar impacts will occur here as well, particularly in high visitor use areas. Negative influences may be amplified during breeding seasons, especially to ground nesting birds and amphibians that may be crossing trails. Martinez-Abrain et al. (2010) conducted a systematic review of the effects of recreational activities on nesting birds of prey. They detected an overall statistically significant impact on the displacement of nests from roads and concluded that the magnitude of the displacement was likely to be biologically relevant. Siemers and Schaub (2011) found that bat foraging efficiency decreased as traffic noise increased. Disturbance to forest birds at Great

Swamp is complex and involves many factors. Important factors include the height and density of vegetation; topography; behavioral differences in species for ground nesting birds, low nesting birds, or foraging birds; and species response to human behaviors. Vegetation density and topography can obscure line of sight for birds. Some birds are more tolerant than others with respect to human proximity, while some birds are more apt to flee than others, (e.g. wood ducks).

Direct impacts on wildlife in the form of disturbance can be expected wherever humans have access to an area, and the degree may vary depending on the habitat type. In general, human presence disturbs most wildlife, which typically results in a temporary displacement without long-term effects on individuals or populations. Rochelle, Pickering, and Castley (2011) examined studies of the impacts of nature-based recreation such as hiking, wildlife viewing, cycling, and horse riding on birds. Of the 69 studies they considered, 88 percent found negative impacts including changes in bird physiology, immediate behavior, abundance, and reproductive behavior. Some species, such as wood thrush, will avoid areas frequented by people, such as developed trails and buildings. Other species, particularly highly social species such as eastern 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. Calling owls during OPs may cause a temporary impact to the individuals from which a response is elicited. Owl calling, however, is infrequent (1-3 nights per year) and non-invasive and is unlikely to cause any more that a short-term impact in the immediate surrounding area. The extent of disturbance along trails depends on a number of factors including visibility, determined by the density of vegetation through which the trail is laid. Various studies have shown that edge effect is variable and conservation design recommendations related to public use areas vary from 50 meters (164 feet) (Paton 1994) to about 90 meters (300 feet) (Robbins et al 1989; Brittingham and Temple 1983, Jones et al. 2000). Since the trails do not occur in the highest quality habitat, we anticipate that impacts will be minimal.

OPs and the BS are confined to roadways and parking areas. WSB and CBC participants are free to roam on foot throughout the refuge. The use of trails and gravel roads could lead to soil compaction, exposure of tree roots, and the modification of plant species 1 to 2 meters on either side of the trail which is a function of soil compaction, invasive species, and direct trampling of plants (Kuss 1986). The refuge will continue to use boardwalks, woodchips, erosion control, and user education to protect plant species and habitats along trails and roadways. Providing trails concentrates use to areas that can be routinely maintained to ensure a quality visitor use experience while also minimizing impacts to vegetation. The implementation of boardwalks and use of woodchips along trails has reduced impacts to vegetation and reduced soil erosion along trails. Some trampling of vegetation by special birding event participants is unavoidable. Such damage, however, is transient and inconsequential. People and vehicles can, however, be vectors for invasive plants when seeds or other propagules are moved from one area to another. Once established, invasives can out-compete native plants, thereby altering habitats and indirectly

impacting wildlife. The threat of invasive plant establishment is an ongoing issue requiring continual monitoring and, when necessary, treatment. Staff will work with permittees to prevent the spread of invasives and eradicate new infestations following an Early Detection – Rapid Response strategy.

This use will have minimal impacts to water quality because special birding events are not physically disruptive to natural resources and are either held in developed areas (BS and OP) away from waterways and bodies of water or managed to limit and disperse human impacts (WSB and CBC). Where trails are involved, the majority are set back from water. In instances where trails are adjacent to water, pollutants and sediments are unlikely to be introduced to waterways given how lightly the trails will be used. Further, given the flat topography and rich vegetative cover characteristic of most of the refuge, sedimentation is unlikely to develop.

PUBLIC REVIEW AND COMMENT

This compatibility determination is being released concurrent with the draft Comprehensive Conservation Plan/Environmental Assessment for a 45-day review and comment period.

DETERMINATION (CHECK ONE BELOW):

____ Use is not compatible

__X__ Use is compatible with the following stipulations

STIPULATIONS NECESSARY TO ENSURE COMPATIBILITY

- Special birding events are administered through SUPs issued every year. Stipulations are listed as "Special Conditions" in the SUPs.
    - Stipulations/special conditions for all permittees are as follows:
        - The permit is not transferrable.
        - All vehicles must be parked in designated refuge lots.
        - SUP must be prominently displayed on the dash of each permittee's vehicle and a copy must also be in the possession of each team or group while on the refuge. The permit must be presented to refuge officials upon request.
        - Permittees must obey all refuge rules and regulations, including the speed limit along Pleasant Plains Road (15 mph unless otherwise posted).
        - A report listing all birds identified must be submitted to the refuge manager within two weeks of the completion of the event.
        - Access to the refuge during nighttime (i.e. before sunrise and after sunset) is permitted.

        - The refuge reserves the right to postpone or cancel any activity that may interfere with public safety or refuge management activities. Access to the refuge will not be permitted during the annual refuge deer hunt.
        - All other refuge rules and regulations remain in force.
        - Any violation of permit conditions may result in the denial of future permits.
    - Additional stipulations/special conditions for the WSB are as follows:
        - Access to the Management (i.e. closed) and Wilderness Areas is by foot travel only.
        - Individuals must notify Refuge Headquarters before each visit into the Management Area and before night visits into the Wilderness Area.
        - Participants must stay out of the fields along Pleasant Plains Road, and away from the blinds at the Wildlife Observation Center, during daytime hours.
    - Additional stipulations/special conditions for the CBC are as follows:
        - Access to the Management and Wilderness Areas is by foot travel only.
        - Groups are limited to a maximum of 10 individuals. If more than 10 individuals are on a team, the team must split into smaller groups to minimize disturbance. Should the team split up, each group must have their own copy of the SUP.
    - Additional stipulations/special conditions for the BS are as follows:
        - Access to the Management Area is prohibited.
    - Additional stipulations/special conditions for the OP are as follows:
        - Permittee will provide a brief educational overview of the refuge to program participants as outlined by refuge staff and provided in the Great Swamp NWR Fact Sheet.
        - Access to the Management Area is prohibited.

JUSTIFICATION

The special birding events associated with this use are forms of wildlife observation and, as such, are priority wildlife-dependent public uses. Refuges have a proactive responsibility to provide such uses when appropriate and compatible. The abundance and diversity of bird species on the refuge makes it a popular site for birding events. Renowned birders have participated in these events generating recognition and support for the refuge and the Refuge System's conservation mission. Many others have simply enjoyed the opportunity to connect with nature through these unique events. Significant funding for wildlife conservation has been raised through these events which also supports the Refuge System's conservation mission. Through these events, the refuge has developed stronger relationships with conservation partners. In addition, the refuge gains valuable avian data at no additional cost from experienced bird watchers. Over time, the

species lists submitted from the various events have provided information useful for monitoring bird populations and updating the refuge's bird list. To date, any impacts associated with these events have been transient and negligible.

Allowing special birding events at Great Swamp NWR will not materially interfere with or detract from the fulfillment of the migratory bird, habitat protection, or wetland purposes of the refuge because the use occurs either in already developed areas (parking lots, gravel and paved roads) or is tightly managed to limit participant density and resultant impacts. The use will not materially interfere with or detract from the wilderness purpose of the refuge because the impacts are similar to those resulting from normal pubic use, do not involve any actions generally prohibited in Wilderness, and are tightly managed to minimize disturbance. The use will not materially interfere with or detract from the mission of the National Wildlife Refuge System mission because special birding events will be carefully managed to avoid anything more than localized, transient impacts or disturbance.

SIGNATURE:

Refuge Manager: _____ _____
(Signature) (Date)

CONCURRENCE:

Regional Chief: _____ _____
(Signature) (Date)

MANDATORY 10-YEAR REEVALUATION DATE: _____

LITERATURE CITED

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FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Great Swamp National Wildlife Refuge

Use: Alternate Forms of Transportation

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:_____

If found to be **Not Appropriate**, the refuge supervisor does not need to sign concurrence if the use is a new use.

If an existing use is found **Not Appropriate** outside the CCP process, the refuge supervisor must sign concurrence.

If found to be **Appropriate**, the refuge supervisor must sign concurrence.

Refuge Supervisor:_____ Date:_____

A compatibility determination is required before the use may be allowed.

FWS Form 3-2319
02/06

JUSTIFICATION FOR A FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Great Swamp National Wildlife Refuge

Use: Alternate Forms of Transportation

NARRATIVE:

The proposed uses are biking and horseback riding. Although these uses are not priority public uses, they do support wildlife observation, which is a priority public use. These uses may provide opportunities for visitors to observe and learn about wildlife, habitats, and refuge lands firsthand and at their own pace in an unstructured environment. These uses may also enhance the public's appreciation for wildlife conservation and land protection. It is anticipated that participation in these uses will produce a more informed public, with an enhanced stewardship ethic and enhanced support and advocacy for the U.S. Fish and Wildlife Service (Service) and natural resources as a whole.

These uses are low impact and low cost. The area where these uses are allowed on the refuge is Pleasant Plains Road, which is used to access a number of public use areas, including the Helen C. Fenske Visitor Center, and the refuge administrative offices.

These uses are consistent with the goals and objectives in the comprehensive conservation plan, particularly goal four, which provides opportunities for visitors of all ages and abilities to enjoy wildlife-dependent recreation, appreciate the cultural and natural resources of Great Swamp National Wildlife Refuge, and increase understanding and support of the refuge's mission. The uses will provide wholesome, safe outdoor recreation in a scenic setting. In addition, these uses promote Let's Go Outside, Connecting People with Nature, and other health-related initiatives that the Service supports.

COMPATIBILITY DETERMINATION

Use:

Alternate forms of transportation on Pleasant Plains Road.

REFUGE NAME

Great Swamp National Wildlife Refuge

DATE ESTABLISHED

1960

ESTABLISHING AND ACQUISITION AUTHORITY

Great Swamp National Wildlife Refuge (NWR, refuge) was established primarily under the authorities of the Migratory Bird Treaty Act of 1918 (16 U.S.C. 703-711, 40 Stat. 755) and the Migratory Bird Conservation Act of 1929 (16 U.S.C. 715-715r, 45 Stat. 1222), as amended, by transfer of approximately 2,900 acres of land donated to the Federal Government by the Great Swamp Committee of the North American Wildlife Foundation.

REFUGE PURPOSES

Based upon land acquisition documents and authorities, refuge purposes were identified as follows:

> *"…for use as an inviolate sanctuary, or for any other management purpose, for migratory birds.*" (Migratory Bird Conservation Act of 1929; 16 U.S.C. 715d)
>
> *"...suitable for (1) incidental fish and wildlife-oriented recreational development, (2) the protection of natural resources, (3) the conservation of endangered species or threatened species ..."* (Refuge Recreation Act; 16 U.S.C. 460k-1) *"the Secretary…may accept and use…real…property. Such acceptance may be accomplished under the terms and conditions of restrictive covenants imposed by donors…"* (Refuge Recreation Act; 16 U.S.C. 460k-2, as amended)
>
> *"...for the conservation of the wetlands of the Nation in order to maintain the public benefits they provide and to help fulfill international obligations contained in various migratory bird treaties and conventions ..."* (Emergency Wetlands Resources Act of 1986; 16 U.S.C. 3901(b)); and,
>
> *"... to conserve (A) fish or wildlife which are listed as endangered species or threatened species .... or (B) plants ..."* (Endangered Species Act of 1973; 16 U.S.C. 1534).

> *"…to secure for the American people of present and future generations the benefits of an enduring resource of wilderness… wilderness areas ... shall be administered for the use and enjoyment of the American people in such manner as will leave them unimpaired for future use and enjoyment as wilderness, and so as to provide for the protection of these areas, the preservation of their wilderness character, and for the gathering and dissemination of information regarding their use and enjoyment as wilderness: …"*
> (Wilderness Act of 1964; Public Law 88-577; 16 U.S.C. 1131-1136)

NATIONAL WILDLIFE REFUGE SYSTEM MISSION

The Mission of the National Wildlife Refuge System (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 (National Wildlife Refuge System Improvement Act; 16 U.S.C. 668dd(a)(2)).

Description of Use:

(a) What is the use? Is the use a priority public use? The use is alternate forms of transportation to provide access to and facilitate priority uses on the Great Swamp NWR. Alternate forms of transportation is defined as horseback riding and bicycling. Alternate forms of travel is not a priority public use of 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 (Public Law 105-57). They facilitate priority public uses such as, wildlife observation and photography, environmental education and interpretation.

(b) Where would the use be conducted? Horseback riding and bicycling are permitted only on the 2.5 mile section of Pleasant Plains Road that is owned and controlled by the refuge. This road is 1.7 miles of gravel with a .8 section of pavement, open to refuge visitors for wildlife observation and photography and has a regulated speed limit of 15 to 25 miles per hour. Other connecting roads in the area are not controlled by the refuge or covered by this Compatibility Determination. These uses are restricted to the road surface and are not allowed on any adjacent sensitive areas or management roads.

(c) When would the use be conducted? Alternate forms of transportation would be allowed throughout the entire year, during the refuge's normal open hours. The refuge is open daily sunrise to sunset. Exceptions would occur during the refuge deer firearm hunt and under the auspices of Special Use Permits.

(d) How would the use be conducted? Alternate forms of transportation are currently allowed on the refuge to facilitate priority public uses. Visitors using alternate modes of transportation typically would enter the refuge at public entry points and use refuge parking areas as needed.

To accommodate other users and promote a wildlife watching experience, pedestrian group size larger than 10 should coordinate with the refuge office and/or visitor services staff. Individuals biking will be allowed to enter the refuge portion of Pleasant Plains Road from the south end of the road and the north

end of the road. Bicycling on Pleasant Plains Road during daylight hours is restricted to the road surface only.

Horseback travel to facilitate wildlife observation involves observing natural landscape features from horseback. Horseback travel for such purposes is done at a walking gait. Riding commonly occurs in groups with an average group size of 2-4 riders but a single rider is not unusual. Travel is limited to the 2.5 mile section of Pleasant Plains Road with mostly gravel surfaces and where the road width can accommodate the safe passage of other users. Pleasant Plains Road is open to refuge visitors and considered as a wildlife tour route where other legitimate alternate modes of transportation i.e. auto, motorcycle, bicycle, foot, etc. are permitted without discrimination. Overall traffic volumes are low on this road. The road also has sufficient viewing distance from horseback riders to timely detect the approach of other users and maneuver to accommodate them. Riders will remain with horses at all times on the refuge. To promote safety with other users and encourage a nature viewing experience, group size would be limited to a maximum of 5 riders. Riders would enter the refuge at the public entry points at the north or south end of Pleasant Plains Road. Riders would share roads and travel single file to accommodate other users. Horseback travel on the refuge is currently minimal. A refuge officer will routinely monitor rider numbers seen during patrols, user interactions, and potential safety concerns. This use will be conducted in accordance with the stipulations necessary to ensure compatibility.

(e) **Why is the use being proposed?** Alternate modes of travel are a fundamental method for the public to access the refuge. Pleasant Plains Road provides the public with an opportunity to view the diversity of habitats and wildlife that characterize the refuge and to access the refuge headquarters, visitor center, and public access areas without significant environmental consequences at current levels of use.

Bicycling on Pleasant Plains Road is permitted because this section of roads is open to the public and considered as a wildlife tour route. Overall traffic volumes are low on this section of road.

Horseback travel on the refuge would provide an increased opportunity for the public to participate in priority public uses. This has been a traditional use on Pleasant Plains Road. Current levels of use are minimal and with the prescriptions necessary to ensure compatibility, the sharing of designated roads with other users and alternate modes of transportation, is unlikely to be a safety risk. At current levels of use and riding restricted to Pleasant Plains Road which has a pavement, and a hard modified surface, horseback travel would cause minimal surface disturbance

Availability of Resources:

Refuge roads and trails are routinely patrolled by refuge officers, regularly traveled by refuge personnel and volunteers, and several refuge employees also live in government quarters on the refuge. This presence will help monitor, administer and enforce these activities and restrictions on alternate modes of transportation.

Since these uses are occurring on Pleasant Plains Road, which is open to the public for access to the refuge headquarters, visitor center, and public use parking lots, there will be no additional costs associated with allowing these uses.

Based on existing refuge expenditures for managing visitor use, funding is adequate to ensure compatibility at the current level of use and to administer and manage the subject use.

Anticipated Impacts of Use:

Natural resource management is a key purpose and responsibility for all refuges. Refuge staff must determine how to accommodate visitor use while protecting sensitive natural resources. Regional staff can promote alternate transportation as a means of reducing negative impacts on resources. They can also promote both the visitor experience and interpretation benefits that come from using alternative transportation. (Mast, 2012 RATE Report).

Benefits of alternate forms of transportation such as horseback riding and bicycling can include but are not limited to; reduce the Service's overall carbon footprint, reduce the use of carbon-based fuels, enhance accessibility, and reduce the volume of air pollutants emanated from vehicles.

Spatial and temporal restrictions will minimize recreational impacts on wildlife in wild lands (Knight & Cole 1991). Minimizing negative impacts is most effective when alternate travel is confined to trail corridors and select trails as well as time restrictions. More specifically, because Pleasant Plains Road and refuge parking areas are gravel or paved they have limited habitat value and the potential impacts to wildlife are minimized.

Horseback and bicycle forms of alternate transportation will have minimal negative impacts on the hydrology, plants, or soils due to the restricted nature of this use. Pleasant Plains Road is the only area that this use will be permitted. The number of horseback riders over the last 5 years has been minimal if any (verbal communication with Refuge Manager Koch). The road is devoid of vegetation and part has a hard packed graded surface while part is pavement. Based on current levels of use it is anticipated that no significant increase in invasive plant species introduced by manure will occur as a result of this use. This section of road is also routinely traveled by refuge staff that monitors and responds to invasive plants. Further, refuge staff in concert with volunteers has formed an "Early Detection-Rapid Response Team" to identify and control invasive(s). Impacts on wildlife will be minimal since the road is not close enough to wildlife concentration areas. Short-term disturbance may occur to wildlife directly adjacent to the road. It is anticipated that horse and bike use of these routes will not cause any direct or indirect impacts to threatened or endangered species. The road is not habitat for bog turtles nor is it adjacent to known bog turtle areas. The timing of the uses will be such that disturbance to bats, including Indiana bats, will be unlikely. Routes for both are on existing Pleasant Plains Road. No new habitat disturbance will occur outside of this route. User conflicts are unlikely to occur due to the low number of users in the area; however the use should be monitored to adjust management strategies to any significant increase in use. Continuing alternate forms of transportation on these routes is not likely to cause any significant impacts to plants or plant communities.

The refuge staff will closely monitor pedestrian and alternate modes of travel on the refuge for user conflicts, resource impacts, dramatic increase in visitation, and safety issues. It will be incumbent on the refuge management to adjust management strategies to ensure proper stewardship of refuge resources while providing quality and safe wildlife dependent experiences for its visitors.

Public Review and Comment:

This compatibility determination is being released concurrent with the draft Comprehensive Conservation Plan/Environmental Assessment for a 45-day review and comment period.

Determination (check one below):

_____ **Use is not compatible**

__X__ **Use is Compatible**

Stipulations Necessary to Ensure Compatibility:

- Restricted to 2.5 mile section of Pleasant Plains Road and only during daylight hours.
- Horseback riders limited to 5 riders maximum per group
- Horseback riders travel in single file, horses not tied to trees and must be accompanied by riders at all times.
- NO access to refuge during firearm deer hunt.

Justification:

By allowing these uses in the manner described, physical impacts to vegetation, soils, hydrology, wetland communities, and ecological integrity of Great Swamp NWR will be minimized. Hydrologic and soil impacts were generally inherited with refuge lands and are being remediated through routine maintenance operations. These uses will not affect the refuge's ability to restore impacted lands nor will they materially increase sedimentation, erosion or hydrologic impacts on refuge lands.

These uses will be allowed adjacent to the most common habitat type, and disturbance will be limited and manageable. For this reason disturbance effects will not prevent the refuge from fulfilling the purposes of the Fish and Wildlife Act (1956) or the mission of the Refuge System for conserving, managing, restoring, and protecting wildlife resources. Through these measures the refuge still fulfills its obligations to ensure the biological integrity of the refuge's wildlife, plant and habitat resources.

Two Federal-listed species occur on the refuge, the endangered Indiana bat and the threatened bog turtle. These uses will not have an effect on threatened or endangered species. Neither Pleasant Plains Road nor adjacent habitat is habitat for bog turtles there are also no known bog turtles present in this area. There will be no impacts to the bog turtle with these uses. Indiana bats are known to forage and roost throughout the Wilderness and Management Areas during the summer maternity period (Kitchell 2008). Bats arrive in April and remain on the refuge into October, after which they migrate to winter hibernacula (USFWS 2007). Alternate forms of transportation will not have an impact on the Indiana Bat as it nocturnal and will be roosted during the day. The refuge is open sunrise to sunset when the bats are not active therefore these uses will not affect their foraging activities.

These uses will not be allowed in the Wilderness area, so the uses will not materially interfere with or detract from the Wilderness purpose.

For the reasons discussed above, these uses will not affect the refuge's ability to conserve wetlands or protect, manage, and restore the wildlife and plant resources, as mandated through the Emergency Wetlands Resources Act (1986) and the Fish and Wildlife Act (1956), or the mission of the Refuge System. Based on this information, we have determined that environmental education and interpretation and wildlife observation and photography will not materially interfere with or detract from the mission of the Refuge System or the purposes for which the refuge was established. This use has been determined to be compatible provided the stipulations necessary to ensure compatibility are implemented. Under such conditions, the use is not expected to materially interfere with or detract from the mission of the Refuge System nor diminish the purpose for which the refuge was established, will not pose significant adverse effects on refuge resources, will not interfere with public use of the refuge, nor cause an undue administrative burden.

SIGNATURE:

Refuge Manager: _____ _____
(Signature) (Date)

CONCURRENCE:

Regional Chief: _____ _____
(Signature) (Date)

MANDATORY 15-YEAR REEVALUATION DATE: _____

Literature Cited:

Beal, C.M., and P. Monaghan. 2004. Human Disturbance: people as predation-free predators? Journal of Applied Ecology 41:335-343

Gabrielson , G.W. and E.N. Smith. 1995. Physiological responses of wildlife to disturbance. Pages 95-107 in R. L. Knight and K. J. Gutzwiller, ed. Wildlife and Recreationists: coexistence through management and research. Island Press, Washington, D.C. 372pp.

Keller, V. 1991. Effects of human disturbance on eider ducklings *Somateria mollissima* in an estuarine habitat in Scotland. Biological Conservation 58:213-228.

Kitchell, M. 2008. Roost Selection and landscape movements of females Indiana bats at the Great Swamp National Wildlife Refuge, New Jersey. Thesis. William Paterson University, Wayne, NJ.

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USFWS. 2007. Indiana bat (*Myotis sodal*) draft recovery plan: First Revision. Department of the Interior, USFWS, Great Lakes-Big River Region – Region 3 Fort Snelling, MN

Yalden, P.E., and D. Yalden. 1990. Recreational disturbance of breeding golden plovers *(Pluvialis apricarius)*. Biological Conservation 51:243-262.

FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Great Swamp National Wildlife Refuge

Use: Snowshoeing and Cross Country Skiing

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:_____

If found to be **Not Appropriate**, the refuge supervisor does not need to sign concurrence if the use is a new use.

If an existing use is found **Not Appropriate** outside the CCP process, the refuge supervisor must sign concurrence.

If found to be **Appropriate**, the refuge supervisor must sign concurrence.

Refuge Supervisor:_____ Date:_____

A compatibility determination is required before the use may be allowed.

FWS Form 3-2319
02/06

JUSTIFICATION FOR A FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Great Swamp National Wildlife Refuge

Use: Snowshoeing and Cross-country Skiing

NARRATIVE:

The proposed uses are snowshoeing and cross-country skiing. Although these uses are not priority public uses, they do support wildlife observation, which is a priority public use. These uses may provide opportunities for visitors to observe and learn about wildlife, habitats, and refuge lands firsthand and at their own pace in an unstructured environment. These uses may also enhance the public's appreciation for wildlife conservation and land protection. It is anticipated that participation in these uses will produce a more informed public, with an enhanced stewardship ethic and enhanced support and advocacy for the U.S. fish and Wildlife Service (Service) and natural resources as a whole.

These uses are low impact and low cost. The uses would be limited to those times when there is enough snow on the ground. There have been no documented complaints or conflicts between users of multiple activities.

These uses will not have an effect on threatened or endangered species. The bog turtle is in hibernation and not active during the winter months. It would be unlikely for a visitor to discover a hibernation turtle under snow and ground water-washed root systems of woody plants. The endangered Indiana bat is in hibernation and not present on the refuge during the winter mounts therefore these uses will not affect any of their activities.

These uses are consistent with the goals and objectives in the comprehensive conservation plan, particularly goal four, which is to provide opportunities for visitors of all ages and abilities to enjoy wildlife-dependent recreation, appreciate the cultural and natural resources of Great Swamp National Wildlife Refuge, and increase their understanding and support of the refuge's mission. The uses will provide wholesome, safe outdoor recreation in a scenic setting. The hope is that those who come strictly for recreational enjoyment will be enticed to participate in the more educational and wildlife dependent facets of public use programs on the refuge. In addition, these uses promote Let's Go Outside, Connecting People with Nature, and other health-related initiatives that the Service supports.

COMPATIBILITY DETERMINATION

Use:

Snowshoeing and Cross-country skiing

REFUGE NAME

Great Swamp National Wildlife Refuge

DATE ESTABLISHED

1960

ESTABLISHING AND ACQUISITION AUTHORITY

Great Swamp National Wildlife Refuge (NWR, refuge) was established primarily under the authorities of the Migratory Bird Treaty Act of 1918 (16 U.S.C. 703-711, 40 Stat. 755) and the Migratory Bird Conservation Act of 1929 (16 U.S.C. 715-715r, 45 Stat. 1222), as amended, by transfer of approximately 2,900 acres of land donated to the Federal Government by the Great Swamp Committee of the North American Wildlife Foundation.

REFUGE PURPOSES

Based upon land acquisition documents and authorities, refuge purposes were identified as follows:

> *"…for use as an inviolate sanctuary, or for any other management purpose, for migratory birds.*" (Migratory Bird Conservation Act of 1929; 16 U.S.C. 715d)
>
> *"...suitable for (1) incidental fish and wildlife-oriented recreational development, (2) the protection of natural resources, (3) the conservation of endangered species or threatened species ..."* (Refuge Recreation Act; 16 U.S.C. 460k-1) *"the Secretary…may accept and use…real…property. Such acceptance may be accomplished under the terms and conditions of restrictive covenants imposed by donors…"* (Refuge Recreation Act; 16 U.S.C. 460k-2, as amended)
>
> *"...for the conservation of the wetlands of the Nation in order to maintain the public benefits they provide and to help fulfill international obligations contained in various migratory bird treaties and conventions ..."* (Emergency Wetlands Resources Act of 1986; 16 U.S.C. 3901(b)); and,
>
> *"... to conserve (A) fish or wildlife which are listed as endangered species or threatened species .... or (B) plants ..."* (Endangered Species Act of 1973; 16 U.S.C. 1534)

"…to secure for the American people of present and future generations the benefits of an enduring resource of wilderness… wilderness areas ... shall be administered for the use and enjoyment of the American people in such manner as will leave them unimpaired for future use and enjoyment as wilderness, and so as to provide for the protection of these areas, the preservation of their wilderness character, and for the gathering and dissemination of information regarding their use and enjoyment as wilderness: …"
(Wilderness Act of 1964; Public Law 88-577; 16 U.S.C. 1131-1136)

NATIONAL WILDLIFE REFUGE SYSTEM MISSION

The Mission of the National Wildlife Refuge System (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 (National Wildlife Refuge System Improvement Act; 16 U.S.C. 668dd(a)(2)).

Description of Use:

(a) What is the use? Is the use a priority public use? The uses are snowshoeing and cross country skiing in the Wilderness Area. Just as with other uses of the Wilderness Area, these uses will be allowed on and off designated trails. While these uses are not priority public uses 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 (Public Law 105-57), they facilitate visitor participation in priority public uses.

(b) Where would the use be conducted ? Throughout the 3,660-acre Wilderness Area hiking, cross country skiing and snowshoeing are permitted. There are designated trails in the wilderness area covering a total of 8.5 miles.

Wilderness area Trails

Ivory	0.8 miles
Yellow	0.9 miles
Blue	2.4 miles
Red	0.5 miles
Orange	1.6 miles
Silver	0.4 miles
Green	0.7 miles
Beige	0.5 miles
White	0.7 miles

(c) When would the use be conducted? These uses occur in the winter when there is sufficient snow to allow the activities and when the refuge is open to the public. Most cross-country skiing and snowshoeing occur December through February. Currently the refuge is open daily from one half-hour before sunrise until one half-hour after sunset.

(d) How would the use be conducted? Visitors on cross-country skis and snowshoes depart from refuge roads or parking areas and are authorized to use the Wilderness Area. Parking lots and kiosks have been constructed at the trailheads of refuge trails to help orient visitors.

(e) Why is the use being proposed? While cross-country skiing and snowshoeing are not priority public uses, they provide opportunities for visitors to observe and learn about the Refuge System, Great Swamp NWR, and wildlife and habitats firsthand. Often visitors skiing and snowshoeing on the refuge engage in priority public uses such as wildlife observation and photography. Although much of the bird life is gone for the season and many mammal species are dormant or active only at night, this activity does help provide opportunities for wildlife observation. Winter species such as chickadees, nuthatches, and tufted titmouse are commonly observed. Mammal tracks are used to interpret the area's wildlife populations during the winter months. This exposure may lead to a better understanding of, and interest in, natural ecosystems, the importance of national wildlife refuges, and the role of the Service in protecting and restoring natural resources.

Availability of Resources:

Refuge roads and trails are routinely patrolled by refuge officers, regularly traveled by refuge personnel and volunteers, and several refuge employees also live in government quarters on the refuge. This presence will help monitor, administer and enforce these activities and restrictions on alternate modes of transportation.

With the administration of pedestrian /alternate travel on the refuge is estimated below:

Providing information to the public and administration needs

Resource impacts/monitoring, maintaining and updating of interp. Signs, and maint. of boundary signs.

Maintenance needs of Wilderness parking lots and trails.

Based on existing refuge expenditures for managing visitor use, funding is adequate to ensure compatibility at the current level of use and to administer and manage the subject use.

Anticipated Impacts of Use:

In general, negative effects on habitat and wildlife associated with these activities are minimal. Most wildlife species are less active during winter months, sensitive migratory birds have largely left the refuge, and it is not breeding season for any of the wildlife that may be present. The refuge does not groom or maintain trails in the winter. Cross-country skiing and snowshoeing are limited to winter and require sufficient snow cover to allow access. Surface water and soil may be frozen for at least a portion of this time, most vegetation is dormant, and sensitive habitat will largely be protected by a surface layer of snow. In addition, skis and snowshoes are designed to distribute weight, decreasing potential for eroding soils near waterways. Skiing and snowshoeing are limited to established roads and trails, and no recreational snowmobiles are allowed. Following are more specific descriptions of potential impacts associated with cross-country skiing and snowshoeing.

Effects on Hydrology and Water Quality: Visitor use has minimal potential to contaminate the Passaic River and its tributaries through soil sedimentation into streams caused by skiing and snowshoeing. There may also be runoff of petroleum products from parking lots.

The refuge minimizes adverse effects on water resources in a variety of ways. Refuge staff routinely monitors roads and trails for damage and remediates problem areas as needed. The refuge also conducts public outreach efforts to notify visitors of proper precautions, including carrying out all trash. This helps minimize risks associated with visitor use on the refuge. Visitors are also encouraged to limit group size to less than 10 people, and groups of more than 10 are asked to check in at the refuge office. Because of these efforts, combined with the seasonal limitations, trail restrictions, and stipulations listed in this document, impacts to water resources are expected to be minimal.

Effects on Vegetation: Short-term effects consist of the deterioration of plant material, whereas long-term effects of trampling include direct and indirect effects on vegetation and soils like diminishing soil porosity, aeration, and nutrient availability through soil compaction (Kuss 1986, Roovers et al. 2004). Compaction of soils thus limits the ability of plants, particularly rare and sensitive species, to re-vegetate affected areas (Hammitt and Cole 1998). Kuss (1986) found plant species adapted to wet or moist habitats are the most sensitive and increased moisture content reduces the ability of the soil to support recreational traffic.

Overall effects on vegetation are expected to be minimal. As mentioned previously, skiing and snowshoeing are limited to winter and require sufficient snow cover to allow access. Vegetation is largely dormant during the winter and will largely be protected by a surface layer of snow. In addition, skis and snowshoes are designed to distribute weight, decreasing potential for compacting or eroding soils and trampling vegetation. The Wilderness Area and trails do not have any known occurrences of rare plant species on their surface that would be impacted by these uses.

Effects on Soils: Soils can be compacted and eroded as a result of continued use of roads and trails. Overall effects on soils are expected to be minimal. Skiing and snowshoeing are limited to winter and require sufficient snow cover to allow access. The soil surface will likely be frozen for some of the season, making it much less vulnerable to compaction or erosion. When these activities are occurring, soils also will largely be protected by a surface layer of snow. In addition, skis and snow shoes are designed to distribute weight, decreasing potential for compacting or eroding soils. Over the long-term, the risk of erosion and sedimentation problems that might affect soils in these habitats would increase with increased visitor use and trail use. However, given the time of year, locations, and methods used, increased levels of skiing and snowshoeing are not expected to significantly affect soils on the refuge.

Effects on Wildlife: Short-term and long-term adverse impacts would be expected for wildlife populations in relation to increasing trail miles and visitor use. Disturbances will vary by wildlife species involved and the type, level, frequency, duration and the time of year activities occur. Beale and Monaghan (2004) found that adverse effects to wildlife increase as number of users increase. The study found that an animal's response to one visitor walking down a trail is entirely different than its response to a group of users walking down a trail.

During winter months when the ground is frozen, erosive potential of soils are reduced and impacts of cross-country skiing snowshoeing on erosion and sedimentation of aquatic habitats would be minimal.

The use of trails in the winter for cross-country skiing and snowshoeing have similar wildlife disturbance effects as those which occur through pedestrian travel on these trails during the other seasons. One of the primary differences is that many migratory birds are not present and most resident species are not breeding or raising young during the time of year when cross-country skiing and snowshoeing occur. Additionally, many mammal species are less active during winter months. The most commonly-observed wildlife in the winter is chickadees, nuthatches, and ravens. Winter conditions cause increased stress through extreme weather conditions and food availability (Hammit and Cole 1998). Both bird and mammal species which are present and active this time of year can be even more negatively affected from the same level of disturbance because of the added environmental stressors of severe weather and food shortages.

We will take all necessary measures to mitigate any negative effects on wildlife associated with skiing and snowshoeing. We will evaluate the Wilderness Area periodically to assess potential negative effects. If evidence of unacceptable adverse effects is observed, we will curtail or discontinue activities as needed. We will post and enforce refuge regulations, and establish, post, and enforce closed areas as needed. However, negative effects on wildlife are expected to be minimal. As discussed previously, cross-country skiing and snowshoeing are limited to winter months and require sufficient snow levels to allow access.

The refuge also recognizes that large group sizes may amplify negative effects to wildlife. Therefore, groups larger than 10 are required to notify the refuge prior to visiting to determine if a Special Use Permit will be needed. Requiring large groups to contact the refuge prior to visiting will enable the refuge to understand which trails are preferred by large groups, and to monitor any potential excessive wildlife disturbance created by large groups. Having the ability to monitor these kinds of disturbances will enable the refuge to mitigate impacts associated with large groups, Examples of mitigation may include directing large groups to less sensitive habitats during breeding seasons or assigning refuge staff to lead or meet with the group while on refuge lands. Limiting group size will also increase the quality of the experience and decrease the potential of conflicting with other users' experience.

Effects on Threatened and Endangered Species: There are two federally listed species known to occur on the refuge the Indiana bat and bog turtle. Indiana bats (*Myotis sodalis*), listed as endangered, is known to use the refuge's forested areas for summer foraging and roosting. It is possible that they have a summer maternity colony on refuge lands as well, but this has not been documented. Disturbance to the Indiana bat is unlikely as the bat is not known to be present on the refuge during the winter month for hibernation. The refuge also provides habitat for the bog turtle. A small population occurs in a few acres of emergent wetland habitat that is closed to the public. Additionally, several wetlands associated with seeps that historically have supported bog turtles are scattered throughout the refuge; in the recent past, single occurrences of the species have been documented in two of these areas. In general, these activities should not affect the Bog Turtle as these activities take place during the winter when the Bog Turtle have entered their hibernacula (e.g., ground water-washed root systems of woody plants).

The refuge staff will closely monitor pedestrian and alternate modes of travel on the refuge for user conflicts, resource impacts, dramatic increase in visitation, and safety issues. It will be incumbent on the refuge management to adjust management strategies to ensure proper stewardship of refuge resources while providing quality and safe wildlife dependent experiences for its visitors.

Public Review and Comment:

This compatibility determination is being released concurrent with the draft Comprehensive Conservation Plan/Environmental Assessment for a 45-day review and comment period.

Determination (check one below):

_____ **Use is not compatible**

__X__ **Use is Compatible**

Stipulations Necessary to Ensure Compatibility:

These activities are allowed in the Wilderness Area.

Information about allowable uses and refuge regulations are available at Refuge Headquarters or the Visitor Center.

Minimum of 2 inches of snow.

Groups of 10 or larger must check in at Refuge Headquarters.

Justification:

By allowing these uses in the manner described, physical impacts to vegetation, soils, hydrology, wetland communities and ecological integrity of Great Swamp will be minimized. Through proper trail maintenance these impacts will be further reduced. Hydrologic and soil impacts were generally inherited with refuge lands and are being remediated through routine maintenance operations. These uses will not affect the refuge's ability to restore impacted lands nor will they materially increase sedimentation, erosion or hydrologic impacts on refuge lands.

By limiting the uses to the Wilderness Area and within the most common habitat type, disturbance will be limited and manageable. For this reason disturbance effects will not prevent the refuge from fulfilling the purposes of the Fish and Wildlife Act (1956) or the mission of the Refuge System for conserving, managing, restoring, and protecting wildlife resources. Through these measures the refuge still fulfills its obligations to ensure the biological integrity of the refuge's wildlife, plant, and habitat resources.

These uses will not have an effect on threatened or endangered species. No public use trails are open on lands which are occupied by threatened bog turtle. The bog turtle is in hibernation and not active during the winter months. It would be unlikely for a visitor to discover a hibernation turtle under snow and ground water-washed root systems of woody plants. The endangered Indiana bat is in hibernation and not present on the refuge during the winter mounts therefore these uses will not affect any of their activities.

For the reasons discussed above, these uses will not affect the refuge's ability to conserve wetlands or protect, manage, and restore the wildlife and plant resources, as mandated through the Emergency Wetlands Resources Act (1986) and the Fish and Wildlife Act (1956), or the mission of the Refuge

System. Based on this information, we have determined that environmental education and interpretation and wildlife observation and photography will not materially interfere with or detract from the mission of the Refuge System or the purposes for which the refuge was established. This use has been determined to be compatible provided the stipulations necessary to ensure compatibility are implemented. Under such conditions, the use is not expected to materially interfere with or detract from the mission of the Refuge System nor diminish the purpose for which the refuge was established, will not pose significant adverse effects on refuge resources, will not interfere with public use of the refuge, nor cause an undue administrative burden.

SIGNATURE:

Refuge Manager: _____ _____
(Signature) (Date)

CONCURRENCE:

Regional Chief: _____ _____
(Signature) (Date)

MANDATORY 15-YEAR REEVALUATION DATE: _____

Literature Cited:

Beale, C.M. and P. Monaghan. 2004. Human disturbance: people as predation-free predators? Journal of Applied Ecology 41:335-343.

Gabrielson , G.W. and E.N. Smith. 1995. Physiological responses of wildlife to disturbance. Pages 95-107 in R.L. Knight and K.J. Gutzwiller, ed. Wildlife and Recreationists: coexistence through management and research. Island Press, Washington, D. C. 372pp.

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FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Great Swamp National Wildlife Refuge

Use: Dog Walking on Pleasant Plains Rd. and Designated Parking Aeras

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:_____

If found to be **Not Appropriate**, the refuge supervisor does not need to sign concurrence if the use is a new use.

If an existing use is found **Not Appropriate** outside the CCP process, the refuge supervisor must sign concurrence.

If found to be **Appropriate**, the refuge supervisor must sign concurrence.

Refuge Supervisor:_____ Date:_____

A compatibility determination is required before the use may be allowed.

FWS Form 3-2319
02/06

JUSTIFICATION FOR A FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Great Swamp National Wildlife Refuge

Use: Dog Walking

NARRATIVE:

The proposed use is dog walking on designated trails and with dogs on a leash. This use is not a priority public use, however, it may provide opportunities for visitors to observe and learn about wildlife, habitats, and refuge lands firsthand and at their own pace in an unstructured environment. This use may also enhance the public's appreciation for wildlife conservation and land protection. It is anticipated that participation in this use will produce a more informed public, with an enhanced stewardship ethic and enhanced support and advocacy for the U.S. Fish and Wildlife Service and natural resources as a whole.

Dog walking is an existing use on Great Swamp National Wildlife Refuge's (NWR) public trails and has occurred without incident. Dog walking is a very popular activity which encourages public visitation, exposure to the refuge and the mission of the National Wildlife Refuge System. Dog walking is strictly enforced on the refuge, and regulations require dogs to be on a leash of 10 feet or less. Dog owners are also required to immediately pick up, and properly dispose of, dog waste. Dog walking is restricted to Pleasant Plains Road. These regulations minimize impact to wildlife and their habitats.

Great Swamp NWR is located in a highly suburban area. Pleasant Plains Road is used for a variety of activities and consists of a wide corridor. Most dog walkers are local residents who regularly visit the refuge and understand and comply with this regulation. Limiting the area for dog walking to Pleasant Plains Road and parking areas which are presently open to automobiles, motorcycles, bicycles, horseback riding, and walking would minimize potential disturbance to wildlife and other user groups. Impacts associated with dog walking given the setting and type of trails that are used, combined with the history of dog use on the lands, lead us to consider dog walking as an appropriate use of the refuge.

COMPATIBILITY DETERMINATION

USE

Dog walking on Pleasant Plains Road and in designated parking areas

REFUGE NAME

Great Swamp National Wildlife Refuge

DATE ESTABLISHED

1960

ESTABLISHING AND ACQUISITION AUTHORITY

Great Swamp National Wildlife Refuge (NWR, refuge) was established primarily under the authorities of the Migratory Bird Treaty Act of 1918 (16 U.S.C. 703-711, 40 Stat. 755) and the Migratory Bird Conservation Act of 1929 (16 U.S.C. 715-715r, 45 Stat. 1222), as amended, by transfer of approximately 2,900 acres of land donated to the Federal Government by the Great Swamp Committee of the North American Wildlife Foundation.

REFUGE PURPOSES

Based upon land acquisition documents and authorities, refuge purposes were identified as follows:

> *"…for use as an inviolate sanctuary, or for any other management purpose, for migratory birds.*" (Migratory Bird Conservation Act of 1929; 16 U.S.C. 715d)
>
> *"...suitable for (1) incidental fish and wildlife-oriented recreational development, (2) the protection of natural resources, (3) the conservation of endangered species or threatened species ..."* (Refuge Recreation Act; 16 U.S.C. 460k-1) *"the Secretary…may accept and use…real…property. Such acceptance may be accomplished under the terms and conditions of restrictive covenants imposed by donors…"*(Refuge Recreation Act; 16 U.S.C. 460k-2, as amended)
>
> *"...for the conservation of the wetlands of the Nation in order to maintain the public benefits they provide and to help fulfill international obligations contained in various migratory bird treaties and conventions ..."* (Emergency Wetlands Resources Act of 1986; 16 U.S.C. 3901(b)); and,

"... to conserve (A) fish or wildlife which are listed as endangered species or threatened species .... or (B) plants ..." (Endangered Species Act of 1973; 16 U.S.C. 1534).

"…to secure for the American people of present and future generations the benefits of an enduring resource of wilderness… wilderness areas ... shall be administered for the use and enjoyment of the American people in such manner as will leave them unimpaired for future use and enjoyment as wilderness, and so as to provide for the protection of these areas, the preservation of their wilderness character, and for the gathering and dissemination of information regarding their use and enjoyment as wilderness: …" (Wilderness Act of 1964; Public Law 88-577; 16 U.S.C. 1131-1136)

NATIONAL WILDLIFE REFUGE SYSTEM MISSION

The Mission of the National Wildlife Refuge System (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 (National Wildlife Refuge System Improvement Act; 16 U.S.C. 668dd(a)(2)).

DESCRIPTION OF PROPOSED USE

(a) What is the use? Is the use a priority public use?
The use is walking a properly licensed dog on a leash on Pleasant Plains Road or in designated parking areas during daylight hours. Dog walking 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 (Public Law 105-57).

(b) Where would the use be conducted? Dog walking would be permitted only in designated parking areas and on the approximately 2.5 mile section of Pleasant Plains Road which is owned and controlled by the refuge. This road is mostly gravel, open to refuge visitors for wildlife observation and photography, and has a regulated speed limit of between 15 to 25 miles per hour. Other roads through and around the refuge are not controlled by the refuge or covered by this Compatibility Determination. With a 10-foot leash, dogs would be physically restricted from accessing sensitive areas and disturbing birds or other wildlife species except those immediately adjacent to the road where fewer interactions are likely to occur due to the lower quality of habitat found immediately along roadsides.

(c) When would the use be conducted? Dog walking would be allowed throughout the year between sunrise and sunset when the refuge is open to the general public.

(d) How would the use be conducted? Dog walkers would be allowed to walk their dogs only when the dog is attached to a leash 10 feet or less in length that the dog walker is in direct

physical control of at all times. All dog walking would be restricted to Pleasant Plains Road and parking areas at all times. Dog owners would be required to pick up after their dogs using materials they supply.

(e) Why is this use being proposed? Since dogs are not permitted elsewhere on the refuge, refuge visitors will be able to walk their dogs and also have an opportunity to enjoy non-consumptive wildlife-oriented recreation, a stated purpose of this refuge. Some visitors travel a great distance so allowing a leashed dog in parking areas and Pleasant Plains Road allows visitors to extend their visit and gain a greater understanding and appreciation of the refuge.

Dog walking provides the refuge with an excellent opportunity to educate dog walkers about the refuge and the Refuge System. We currently allow dog walking on the refuge and have not had significant negative impacts from this use during the many years it has been permitted. The section of Pleasant Plains Road where this use is permitted is very popular for wildlife observation, is the safest road in the Great Swamp area for pedestrians, and is heavily used by visitors, staff, and volunteers. The Refuge Headquarters, visitor center, and three government-owned houses rented by staff are spread along its length. Therefore, a high degree of monitoring and observations supplement the refuge law enforcement officer's routine patrols. Non-law enforcement staff and volunteers are periodically briefed on "how to be a good witness" to improve their effectiveness reporting observed infractions. This serves as a deterrent to dog walkers considering unleashing their dog and to other types of infractions. Dog walkers have been historically good about keeping their pets on leashes and cleaning up after them. Regulatory signs and printed information are used to reinforce refuge rules.

AVAILABILITY OF RESOURCES

Except for maintaining and periodically updating regulatory signs and printed materials, minimal costs would be involved. Monitoring for compliance would continue but, would not require significantly more resources beyond those already provided to patrol the areas for compliance with current regulations. Permitting this use is within the resources available to administer our Visitor Services Program. There is no additional staff or material costs incurred to the refuge. Enforcing the leash regulation is within the regular duties of the refuge's Law Enforcement Officer. The financial and staff resources necessary to provide and administer this use at its current level are now available and we expect them to be available in the future. The annualized cost associated with the administration of dog walking on the refuge is estimated below:

Public information and program administration = $1,000
Law Enforcement = $1,000
Total = $ 2,000

Based on existing refuge expenditures for managing visitor use, funding is adequate to manage the subject use.

ANTICIPATED IMPACTS OF THE USE

Impacts to Birds: The presence of dogs and pedestrians on the refuge, either on trails or off trails, is likely to cause temporary disturbance to birds. A study done in Colorado (Miller et al. 2001) found that robins, representing forest species, and western meadowlarks and vesper sparrows, representing grassland species, flushed when approached by dogs on and off leash. Dogs alone generally resulted in less disturbance than when pedestrians were present, either alone or holding a leashed dog. The authors surmised that because dogs resemble coyotes and foxes, which are not considered significant predators of songbirds (Leach and Frazier 1953, Andelt et al. 1987), they may not have been perceived as an important threat. Disturbance was generally greater off trails than on trails. Dogs alone are not likely to cause significant disturbance beyond that caused by foxes and coyotes. Any disturbance would be temporary and should not lead to loss of migratory birds or their habitats.

Impacts to Wetlands: It is unlikely that dogs will enter refuge wetlands due to trail location and refuge regulations. All dogs must be on leash and regulations state that visitors must remain on public trails.

Impacts to Other Fish and Wildlife Resources: There can be an increase in wildlife disturbance from dog walking simply due to normal dog behavior (i.e., jumping, barking, running off a leash). At some level, domestic dogs maintain instincts to hunt and/or chase. Given the appropriate stimulus, those instincts can be triggered in many different settings. Even if the chase instinct is not triggered, dog presence in and of itself has been shown to disrupt many wildlife species (Sime 1999). Sime presents some effects of disturbance, harassment, and displacement on wildlife attributable to domestic dogs that accompany recreationists. Sime states that authors of many wildlife disturbance studies concluded that dogs with people, dogs on-leash, or loose dogs provoked the most pronounced disturbance reactions from their study animals. Dogs extend the zone of human influence when off-leash. Many ungulate species demonstrated more pronounced reactions to unanticipated disturbances, as a dog off-leash would be. In addition, dogs can force movement by ungulates (avoidance or evasion during pursuit), which is in direct conflict with overwinter survival strategies which promote energy conservation. Sime continues to highlight that dogs are noted predators for various wildlife species in all seasons. Domestic dogs can potentially introduce diseases (distemper, parvovirus, and rabies) and transport parasites into wildlife habitats. While dog impacts to wildlife likely occur at the individual scale, the results may still have important implications for wildlife populations. For most wildlife species, if a “red flag” is raised by pedestrian-based recreational disturbance, there could also be problems associated with the presence of domestic dogs. Recent extensive research has shown that human walkers (without dogs) can induce anti-predator responses in birds including vigilance and early flight, which may lead to a cascade of related responses that negatively affect birds (Blumstein and Daniel 2005). In a study by Banks and Bryant (2007), results reveal that even dogs restrained on leads can disturb birds sufficiently to induce displacement. Responses to transient human disturbance are well known (Blumstein et al. 2005) and predicted to lead to population-level impacts on some birds species (Hill et al. 1997). One study found no net difference in bird diversity or abundance between areas with and without regular dog walking receiving the same treatment, suggesting that long-term impacts in that area may be small (Banks and Bryant 2007). The amplitude of this type of impact would be greater if

ground nesting birds were disturbed to the extent that they would stop returning to their nest, or if nests, eggs, or young were to be trampled by foot traffic, especially since handlers or trainer are more likely to be focusing on their dogs, not the ground. Off-lead dog walking can also disturb some species of breeding shorebirds from their nests (Lord et al. 2001). To minimize these potential impacts, dogs are required to be on a leash of 6 feet or less at all times, and in control of the owner. In addition, trails that accommodate dog walking do not traverse wetlands or areas that support shorebird nesting. Lastly, dog waste can create sanitation issues and an unsightly environment to other refuge visitors. Therefore, dog owners are required to immediately pick up after their pets and pack out waste.

Studies on impacts of recreational dog walking in woodlands demonstrated a 35 percent reduction in bird diversity and 41 percent reduction in abundance, both in areas where dog walking is common and where dogs are prohibited (Banks and Bryant 2007). Free-ranging and uncontrolled dogs can chase and flush ground-nesting or foraging birds and other wildlife, and occasionally prey on reptiles. Potential impacts of domestic dogs could be broadly classified as harassment, injury, or death of wildlife. Harassment is the disruption of normal maintenance activities, such as feeding, bedding, or grooming. It can take the form of disrupting, alarming, or even chasing. If dogs chase or pursue wildlife, injuries could be sustained directly or indirectly as a result of accidents that occur during the chase itself rather than direct contact with the dog. Impacts of domestic dogs can also include modification of wildlife behavior.

The presence of dogs may flush incubating birds from nests (Yalden and Yalden 1990), disrupt breeding displays (Baydack 1986), and disturb roosting activity in ducks (Keller 1991). Many of these authors indicated that people with dogs on a leash and loose dogs provoked the most pronounced disturbance reactions from their study animals. The greatest stress reaction results from unanticipated disturbance. Animals show greater flight response to humans moving unpredictably than to humans following a distinct path (Gabrielsen and Smith 1995). Despite thousands of years of domestication, dogs still maintain instincts to hunt and chase. The appropriate stimulus can trigger those instincts. Dogs that are unleashed or not under the control of their owners may disturb or threaten the lives of some 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.

The role of dogs in wildlife diseases is poorly understood. However, dogs host endo- and ecto-parasites 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 potentially can introduce various diseases and transport parasites into wildlife habitats (Sime 1999). There would be no impacts to hydrology, plants, or soils due to the restricted nature of this use.

The use would be confined to Pleasant Plains Road and parking areas and no new construction or vegetation clearing is required. Because Pleasant Plains Road and parking areas are paved or gravel they have inherently limited habitat value to wildlife. Impacts on wildlife would be minimal since the road is distant from wildlife concentration areas and the dogs would be leashed. Short-term disturbance may occur to wildlife directly adjacent to the road. User conflicts are unlikely to occur since the areas authorized for dog walking are wide and can safely

accommodate multiple simultaneous users. Dog waste can create an unsightly and unsanitary environment for other refuge visitors. Although these negative impacts exist, they are kept to a minimum by restricting dog walking to designated areas of the refuge and strictly enforcing the leash and waste removal requirements. It is anticipated that leashed dog walking on Pleasant Plains Road and in parking areas would not cause any direct or indirect impacts to federally listed, threatened or endangered species, because the areas that dog walking is allowed does not overlap with areas that threatened and endangered species are known to occur.

PUBLIC REVIEW AND COMMENT

This compatibility determination is being released concurrent with the draft Comprehensive Conservation Plan/Environmental Assessment for a 45-day review and comment period.

DETERMINATION (CHECK ONE BELOW):

____ Use is not compatible

__X__ Use is compatible with the following stipulations

STIPULATIONS NECESSARY TO ENSURE COMPATIBILITY

■ Only leashed and properly licensed dogs would be allowed on the refuge. The leash would be no more than 10 feet long. Dog walkers would be required to maintain direct physical control of their animal while on the refuge, thereby reducing the potential and severity of impacts to wildlife.
■ Dog walking is restricted to Pleasant Plains Road and parking areas only and is prohibited in all other areas of the refuge.
■ Dog walkers must pick up after their dog(s) and remove pet waste.
■ Refuge staff, especially Law Enforcement, and volunteers would monitor uses to ensure compatibility, refine user estimates, and evaluate compliance. Potential conflicts between user groups would also be evaluated.
■ If a high number of reports of negative dog-wildlife interactions are reported, the refuge would reassess the use.
■ If a high number of off-leash incidents are documented, we may consider eliminating dog walking from the refuge altogether.
■ Restricting dog walking to Pleasant Plains Road and parking areas would minimize potential disturbance of wildlife.

JUSTIFICATION

Dog walking provides visitors with a much sought-after opportunity for non-consumptive wildlife-oriented recreation, a stated purpose of this refuge. We currently allow dog walking on the refuge and have not detected significant negative impacts from this use.

Although dogs can increase disturbance to wildlife, the refuge enforces a 10-foot maximum leash regulation to keep the dog within close proximity and under the direct control of its owner. Most dog walkers are local residents who regularly visit the refuge and understand and comply with this regulation. Limiting the area for dog walking to Pleasant Plains Road and parking areas which are presently open to automobiles, motorcycles, bicycles, horseback riding, jogging, and walking would minimize potential disturbance to wildlife and other user groups.

The stipulations (listed above) would negate or minimize any significant dog-related wildlife impacts as discussed in the potential impacts section. Dogs would be under the direct control of their owners at all times while on the refuge. We would require all dogs to be on a leash 10 feet or less which would prevent dogs from directly interacting with wildlife off the road or outside parking areas. Pleasant Plains Road and parking areas are paved or graveled and thus of low wildlife habitat value. With a 10-foot leash limit, dogs would not be able to access any sensitive areas or disturb birds or other species except along roadsides where few are present.

Allowing leashed dog walking on Pleasant Plains Road within the Great Swamp NWR will not materially interfere with or detract from the mission of the Refuge System or the migratory bird, wildlife conservation, or wetland protection purposes for which the refuge was established, because the activity will be allowed on a very small percentage of refuge lands that are open to a variety of uses and will not take place in close proximity to core wildlife habitat or wetland areas. Dog walking will also not materially interfere with or detract from the Wilderness purpose, because dog walking is not allowed in the Wilderness Area.

SIGNATURE:

Refuge Manager: _____ _____
(Signature) (Date)

CONCURRENCE:

Regional Chief: _____ _____
(Signature) (Date)

MANDATORY 10-YEAR REEVALUATION DATE: _____

LITERATURE CITED

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FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Great Swamp National Wildlife Refuge

Use: Commercial Filming, Photography, and Audio Recording

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:_____

If found to be **Not Appropriate**, the refuge supervisor does not need to sign concurrence if the use is a new use.

If an existing use is found **Not Appropriate** outside the CCP process, the refuge supervisor must sign concurrence.

If found to be **Appropriate**, the refuge supervisor must sign concurrence.

Refuge Supervisor:_____ Date:_____

A compatibility determination is required before the use may be allowed.

FWS Form 3-2319
02/06

JUSTIFICATION FOR A FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Great Swamp National Wildlife Refuge

Use: Commercial Photography, Filming, or Audio Recording

NARRATIVE:

The proposed use includes the production of educational films and conducting photography filming and audio recording on Great Swamp National Wildlife Refuge. The emphasis is placed on wildlife and scenic photography. Neither film production nor conducting photography workshops are priority public uses; however, they both support and enhance the priority public uses of environmental education, interpretation, and wildlife photography.

The production of, and involvement with photography, filming, and audio recording will provide participants with an opportunity to learn about wildlife, habitats, and natural resources, while providing similar experiences to the general populous through recorded images and sounds. This allows the refuge to educate the public with a low impact secondary activity.

By allowing these uses, the visiting public will have a better understanding and appreciation for wildlife, habitats, the cultural history of the refuge, and of the importance of the National Wildlife Refuge System.

These uses are low impact, low cost, and highly controllable. Relatively small areas of the refuge are impacted by these activities. The educational value of these filming productions is very high. Many are marketed through public broadcasting stations reaching a broad spectrum and large number of potential customers.

COMPATIBILITY DETERMINATION

USE

Commercial Photography, Filming, or Audio Recording

REFUGE NAME

Great Swamp National Wildlife Refuge

DATE ESTABLISHED

1960

ESTABLISHING AND ACQUISITION AUTHORITY

Great Swamp National Wildlife Refuge (NWR, refuge) was established primarily under the authorities of the Migratory Bird Treaty Act of 1918 (16 U.S.C. 703-711, 40 Stat. 755) and the Migratory Bird Conservation Act of 1929 (16 U.S.C. 715-715r, 45 Stat. 1222), as amended, by transfer of approximately 2,900 acres of land donated to the Federal Government by the Great Swamp Committee of the North American Wildlife Foundation.

REFUGE PURPOSES

Based upon land acquisition documents and authorities, refuge purposes were identified as follows:

> *"…for use as an inviolate sanctuary, or for any other management purpose, for migratory birds.*" (Migratory Bird Conservation Act of 1929; 16 U.S.C. 715d)
>
> *"...suitable for (1) incidental fish and wildlife-oriented recreational development, (2) the protection of natural resources, (3) the conservation of endangered species or threatened species ..."* (Refuge Recreation Act; 16 U.S.C. 460k-1) *"the Secretary…may accept and use…real…property. Such acceptance may be accomplished under the terms and conditions of restrictive covenants imposed by donors…"*(Refuge Recreation Act; 16 U.S.C. 460k-2, as amended)
>
> *"...for the conservation of the wetlands of the Nation in order to maintain the public benefits they provide and to help fulfill international obligations contained in various migratory bird treaties and conventions ..."* (Emergency Wetlands Resources Act of 1986; 16 U.S.C. 3901(b)); and,
>
> *"... to conserve (A) fish or wildlife which are listed as endangered species or threatened species .... or (B) plants ..."* (Endangered Species Act of 1973; 16 U.S.C. 1534).

> *"…to secure for the American people of present and future generations the benefits of an enduring resource of wilderness… wilderness areas ... shall be administered for the use and enjoyment of the American people in such manner as will leave them unimpaired for future use and enjoyment as wilderness, and so as to provide for the protection of these areas, the preservation of their wilderness character, and for the gathering and dissemination of information regarding their use and enjoyment as wilderness: …"* (Wilderness Act of 1964; Public Law 88-577; 16 U.S.C. 1131-1136)

NATIONAL WILDLIFE REFUGE SYSTEM MISSION

The mission of the National Wildlife Refuge System (Refige 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 (National Wildlife Refuge System Improvement Act; 16 U.S.C. 668dd(a)(2)).

DESCRIPTION OF PROPOSED USE

(a) What is the use? Is the use a priority public use? The use is commercial photography, filming (including videography), and audio recording (collectively called "recording" for the purposes of this compatibility determination). This use has occurred in the past (in recent years, 1-2 permits have been issued annually) and future requests are expected to remain steady or increase slightly. The use typically involves filming scenes for a movie, television show, or commercial, taking still photographs, or recording natural sounds for commercial purposes. The primary focus of the production may or may not be wildlife-related or educational in nature. In the latter instance, the refuge is used mainly as a natural background for the production. The final creation would be produced for sale as a commercial product. The refuge is a popular location for commercial recording because it is one of the largest and most pristine natural areas in close proximity to New York City, a major global media center. This use is regulated by Refuge Manual (RM) Part 8, Chapter 16 and the Code of Federal Regulations (CFR), Title 43, Subtitle A, Section 5.1. This is not a priority public use (National Wildlife Refuge System Improvement Act of 1997; Public Law 105-57); however, it may support and enhance the priority public use of wildlife photography. The recordings produced may also support the priority public uses of environmental education and interpretation.

Photography, video, filming, and audio recording of a noncommercial nature are addressed under a separate compatibility determination (CD; Wildlife Observation, Photography, Environmental Education, and Interpretation). Also, this CD does not apply to bona fide news media activities, which are regulated by 8 RM 16.

(b) Where would the use be conducted? Commercial recording could be done anywhere on the refuge with the exception of the Wilderness Area where "commercial enterprise(s)" are prohibited (Wilderness Act of 1964; Public Law 88-577; 16 U.S.C. 1131-1136; Great Swamp Wilderness Act of 1968; PL 90-532). Locations are selected based on the needs of the permittee, the availability of suitable locations, and sufficient refuge resources to manage the use.

(c) When would the use be conducted? Commercial recording could take place at any time of year. Timing will be based on the needs of the permittee, the availability of suitable production windows, and sufficient refuge resources to manage the use.

(d) How would the use be conducted? The use could be conducted on foot, from vehicles, from the air, or from the water (using small boats, canoes, or kayaks) using commercial recording equipment. The use would be regulated by Special Use Permit (SUP) and specific conditions would be developed to minimize or avoid adverse impacts to refuge resources. See "Stipulations Necessary to Ensure Compatibility" in this CD for further information. Intensive productions that produced more than minimal short-term impacts over a small area would not be permitted. Locations would be scouted immediately prior to recording to ensure conditions are suitable for activity (i.e. no sensitive wildlife in the immediate vicinity). Refuge staff would closely monitor operations to ensure compliance with all permit conditions and stipulations. The permittee would be responsible for repairing or restoring any damage created during production.

(e) Why is this use being proposed? Commercial recording provides an excellent opportunity to inform and educate the public about the refuge and the Refuge System. This opportunity is especially great given the potential for broadcast within and beyond the New York City media market, the nation's largest. Commercial recordings may also support and enhance the priority public uses of wildlife photography, environmental education, and interpretation. When done in an appropriate and compatible manner, it is consistent with the intent and purposes of the refuge and supports the Comprehensive Conservation Plan's (CCP) educational, interpretive, and recreational goals and objectives. This use was found compatible in a CD issued in 2004.

AVAILABILITY OF RESOURCES

The resources necessary to provide and administer this use are available within the current and anticipated refuge budgets. Staff time associated with administration of this use is related to answering questions from potential users, preparing SUPs, reevaluating the appropriateness and compatibility of this use every 10 years, and monitoring for compliance with the conditions and stipulations of the SUP and CD. The deputy refuge manager has primary responsibility for these duties which require approximately one work day per year. The refuge's law enforcement officer spends approximately one work day per year monitoring to ensure compliance.

- GS-12 Deputy Refuge Manager: two days = $694.00
- GL-09 Federal Wildlife Officer: two days = $426.00
- Total = $1,120.00

ANTICIPATED IMPACTS OF THE USE

The use under consideration has been occurring periodically on the refuge with little or no apparent impacts since the refuge was established. Since only small areas of the refuge would be impacted for short periods of time and since locations would be scouted in advance, any wildlife disturbance would be minimal during the brief production period. Commercial recording would not be permitted in areas or at times of particular sensitivity for wildlife such as near impoundments during migration or during nesting season. Any vegetation or soil disturbed incidental to recording would be immediately restored by the permittee. Disturbance associated with commercial recording is expected to be comparable to that created by wildlife photography, wildlife observation, or interpretive activities. Due to the infrequency of the use and stringent restrictions, disturbance is expected to remain minimal into the future.

The presence of people involved in commercial recording on refuge trails and roads can lead to displacement of animals from trails, although disturbance usually is a negligible influence on large mammal distributions and movements (Purdy et al. 1987; Boyle and Samson 1985). The effects on other forms of wildlife appear to be short-term with the exception of breeding bird communities. A study by Miller, Knight, and Miller (1998) indicates that species composition and nest predation was altered adjacent to trails in both forested and grassland habitats. It appears that species composition changes are due to the presence of humans and not the trail or roadway itself. On the other hand, nest predation does appear to be a function of the trail which allows access to mammalian nest predators (Miller, Knight, and Miller 1998). With respect to Great Swamp, we anticipate that similar impacts will occur here as well, particularly in high visitor use areas. Negative influences may be amplified during breeding seasons, especially to ground nesting birds and amphibians that may be crossing trails. Siemers and Schaub (2011) found that bat foraging efficiency decreased as traffic noise increased. Disturbance to forest birds at Great Swamp is complex and involves many factors. Important factors include the height and density of vegetation; topography; behavioral differences in species for ground nesting birds, low nesting birds, or foraging birds; and species response to human behaviors. Vegetation density and topography can obscure line of sight for birds. Some birds are more tolerant than others with respect to human proximity, while some birds are more apt to flee than others, (e.g. wood ducks).

Direct impacts on wildlife in the form of disturbance can be expected wherever humans have access to an area, and the degree may vary depending on the habitat type. In general, human presence disturbs most wildlife, which typically results in a temporary displacement without long-term effects on individuals or populations. Some species, such as wood thrush, will avoid areas frequented by people, such as developed trails and buildings. Other species, particularly highly social species such as eastern 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. The extent of disturbance along trails depends on a number of factors including visibility, determined by the density of vegetation through which the trail is laid. Various studies have shown that edge effect is variable and conservation design recommendations related to public use areas vary from 50 meters (164 feet) (Paton 1994) to about 90 meters (300 feet) (Robbins et al 1989; Brittingham and Temple 1983, Jones et al. 2000). Since the trails do not occur in the highest quality habitat, we anticipate that impacts will be minimal.

Bisson et al. (2009) found that white-eyed vireo quickly adapted to anthropogenic disturbance and showed no long-term increases in energy expenditure, activity rates, or parental behavior when repeatedly exposed to human-caused stressors. Brown et al. (2012) did not find a significant correlation between anthropogenic noise, human activity, and ungulate behavioral response. In fact, they found that ungulates were actually less responsive with increasing levels of vehicle traffic though responsiveness increased in the presence of pedestrians and motorcycles. Riffell, Gutzwiller, and Anderson (1996) found that repeated human intrusion of bird communities did not cause substantive cumulative declines in species richness or abundance.

Commercial recording could occur anywhere on the refuge except in the Wilderness Area. The use of trails and gravel roads during recording activities could lead to soil compaction, exposure of tree roots, and the modification of plant species 1 to 2 meters on either side of the trail which is a function of soil compaction, invasive species, and direct trampling of plants (Kuss 1986). The refuge will continue to use boardwalks, woodchips, erosion control, user education, and SUP conditions to protect plant species and habitats along trails and roadways. Providing trails concentrates use to areas that can be routinely maintained to minimize impacts to vegetation. The implementation of boardwalks and use of woodchips along trails has reduced impacts to vegetation and reduced soil erosion along trails. Some trampling of vegetation during commercial recording is unavoidable. Such damage, however, will be limited to transient and inconsequential impacts. People and vehicles can, however, be vectors for invasive plants when seeds or other propagules are moved from one area to another. Once established, invasives can out-compete native plants, thereby altering habitats and indirectly impacting wildlife. The threat of invasive plant establishment is an ongoing issue requiring continual monitoring and, when necessary, treatment. Staff will work with permittees to prevent the spread of invasives and eradicate new infestations following an Early Detection – Rapid Response strategy.

This use will have minimal impacts to water quality because commercial recording will be managed in a way that ensures minimal physical disruption to natural resources. Unless required by the production, commercial recording will be conducted in areas away from waterways and bodies of water. In instances where close proximity to water is required, stringent permit conditions and careful monitoring will limit impacts. Where trails are involved, the majority are set back from water. In instances where trails are adjacent to water, pollutants and sediments are

unlikely to be introduced to waterways given how lightly the trails will be used. Further, given the flat topography and rich vegetative cover characteristic of most of the refuge, sedimentation is unlikely to develop.

PUBLIC REVIEW AND COMMENT

This CD is being released concurrent with the draft Comprehensive Conservation Plan/Environmental Assessment for a 45-day review and comment period.

DETERMINATION (CHECK ONE BELOW):

____ Use is not compatible

__X__ Use is compatible with the following stipulations

STIPULATIONS NECESSARY TO ENSURE COMPATIBILITY

- Commercial recording is administered through a SUP issued on a case-by-case basis. Stipulations are listed as "Special Conditions" in the SUP.
    - All activities must comply with 8 RM 16 and 43 CFR, Subtitle A, Section 5.1 and may require completion of a Commercial Audio-Visual Production Application and posting of a bond.
    - Prior to recording, the permittee will provide the refuge manager with a copy of their current liability insurance policy. The refuge must be named as an additional insured on the policy for the duration of the production.
    - Permittee must have the SUP in their possession at all times while on the refuge. A copy of the permit must also be prominently displayed on the dash of permittee's vehicle(s) at all times while on the refuge. The permit must be presented to refuge officials upon request.
    - The permit is not transferable.
    - Access to the refuge in areas and at times not permitted to the general public may be granted depending upon the needs of the production, the availability of suitable location(s), and refuge operations and resources. All areas and times not specifically permitted are off-limits for recording.
    - Permittee may be required to provide public safety assets such as crowd or traffic control in coordination with the refuge manager.
    - Permittee's vehicle(s) must remain on designated roads and be parked in designated refuge lots.
    - If a prop firearm is used, it must be clearly identified as a prop and kept cased when not in use.
    - Any damage created during production will be immediately repaired or restored to its original condition.

- All disturbances, including light and sound, should be minimized to the greatest extent possible.
- The refuge and Service will be explicitly recognized in the production's credits and not be identified as endorsing any products or services.
- The refuge reserves the right to postpone or cancel any activity that may interfere with public safety or refuge management activities.
- All other refuge rules and regulations remain in force.
- Permittee will provide the refuge manager with a report of pertinent information (such as species or habitats recorded and description of such recordings) within 30 days of the permit's expiration.

JUSTIFICATION

Compatible commercial recording in its various forms provides an excellent opportunity to inform and educate the public and promote the refuge and the Refuge System. This opportunity is especially great given the potential for broadcast within and beyond the New York City media market, the nation's largest. Since production activities would be greatly limited, any disturbances associated with recording would be minimal and readily controlled through the proper selection of locations, timing of production, and stringent SUP conditions and monitoring. While commercial recording is a secondary public use it may support and enhance the priority public uses of wildlife photography, environmental education, and interpretation. By allowing commercial recording, the public may gain a better understanding and appreciation for wildlife and the history of the refuge and the importance of the Refuge System. One of the secondary goals of the Refuge System is to provide opportunities for the public to develop an understanding and appreciation for wildlife wherever those opportunities are compatible. Furthermore, permitting appropriate and compatible commercial recording is consistent with the goals of the Refuge System, the intent and purposes of the refuge, and supports the CCP's educational, interpretive, and recreational goals and objectives.

Allowing the continuation of commercial photography, filming, or audio recording at Great Swamp NWR will not materially interfere with or detract from the fulfillment of the migratory bird, habitat protection, or wetland purposes of the refuge because the use is infrequent, small in scope, and carefully managed to limit impacts. The use will not materially interfere with or detract from the wilderness purpose of the refuge because commercial recording is not permitted in the Wilderness Area. The use will not materially interfere with or detract from the mission of the Refuge System because commercial recording is consistent with the goals of the Refuge System and will be carefully managed to avoid anything more than localized, transient impacts or disturbances.

SIGNATURE:

Refuge Manager: _____ _____
(Signature) (Date)

CONCURRENCE:

Regional Chief: _____ _____
(Signature) (Date)

MANDATORY 10-YEAR REEVALUATION DATE: _____

LITERATURE CITED

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Kuss, F. A review of major factors influencing plant responses to recreation impacts. Environmental Management 1986:10(5):637.

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Purdy K.G., Goff, G.R., Decker D.J., Pomerantz G.A., and Connelly N.A. A Guide to Managing Human Activity on a National Wildlife Refuge. New York Cooperative Fish and Wildlife Research Unit 1987.

Riffell S.K., Gutzwiller, K.L., and Anderson S.H. Does repeated human intrusion cause cumulative declines in avian richness and abundance? Ecological Applications 1996:6(2).

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FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Great Swamp National Wildlife Refuge

Use: Wildlife Research

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:_____

If found to be **Not Appropriate**, the refuge supervisor does not need to sign concurrence if the use is a new use.

If an existing use is found **Not Appropriate** outside the CCP process, the refuge supervisor must sign concurrence.

If found to be **Appropriate**, the refuge supervisor must sign concurrence.

Refuge Supervisor:_____ Date:_____

A compatibility determination is required before the use may be allowed.

FWS Form 3-2319
02/06

JUSTIFICATION FOR A FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Great Swamp National Wildlife Refuge

Use: Wildlife Research

NARRATIVE:

Research is conducted by colleges; Federal, State, and local agencies; non-governmental organizations; and qualified members of the general public.

The purposes of research conducted on the refuge are to further the understanding of natural resources and to improve the management of such resources on the refuge or within the National Wildlife Refuge System (Refuge System). Wildlife research opportunities on the refuge can provide insights into such topics as landscape conservation, habitat fragmentation, climate change, and other emerging issues, as well as the more traditional types of wildlife research, including inventory and monitoring techniques, land management, and understanding ecological processes. Research that supports the overall Service mission, and evaluates the best methods for protecting natural resources throughout the Refuge System and other land management agencies will be a priority. Wildlife research has therefore been found appropriate because it is consistent with the goals and objectives of the Comprehensive Conservation Plan.

COMPATIBILITY DETERMINATION

USE

Wildlife Research

REFUGE NAME

Great Swamp National Wildlife Refuge

DATE ESTABLISHED

1960

ESTABLISHING AND ACQUISITION AUTHORITY

Great Swamp National Wildlife Refuge (NWR, refuge) was established primarily under the authorities of the Migratory Bird Treaty Act of 1918 (16 U.S.C. 703-711, 40 Stat. 755) and the Migratory Bird Conservation Act of 1929 (16 U.S.C. 715-715r, 45 Stat. 1222), as amended, by transfer of approximately 2,900 acres of land donated to the Federal Government by the Great Swamp Committee of the North American Wildlife Foundation.

REFUGE PURPOSES

Based upon land acquisition documents and legal authorities, refuge purposes were identified as follows:

> *"…for use as an inviolate sanctuary, or for any other management purpose, for migratory birds.*" (Migratory Bird Conservation Act of 1929; 16 U.S.C. 715d)
>
> *"...suitable for (1) incidental fish and wildlife-oriented recreational development, (2) the protection of natural resources, (3) the conservation of endangered species or threatened species ..."* (Refuge Recreation Act; 16 U.S.C. 460k-1) *"the Secretary…may accept and use…real…property. Such acceptance may be accomplished under the terms and conditions of restrictive covenants imposed by donors"*…(Refuge Recreation Act; 16 U.S.C. 460k-2, as amended)
>
> *"...for the conservation of the wetlands of the Nation in order to maintain the public benefits they provide and to help fulfill international obligations contained in various migratory bird treaties and conventions ..."* (Emergency Wetlands Resources Act of 1986; 16 U.S.C. 3901(b)); and,

"... to conserve (A) fish or wildlife which are listed as endangered species or threatened species ... or (B) plants ..." (Endangered Species Act of 1973; 16 U.S.C. 1534).

"…to secure for the American people of present and future generations the benefits of an enduring resource of wilderness… wilderness areas ... shall be administered for the use and enjoyment of the American people in such manner as will leave them unimpaired for future use and enjoyment as wilderness, and so as to provide for the protection of these areas, the preservation of their wilderness character, and for the gathering and dissemination of information regarding their use and enjoyment as wilderness: …" (Wilderness Act of 1964; Public Law 88-577; 16 U.S.C. 1131-1136)

NATIONAL WILDLIFE REFUGE SYSTEM MISSION

The mission of the National Wildlife Refuge System (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 (National Wildlife Refuge System Improvement Act; 16 U.S.C. 668dd(a)(2)).

DESCRIPTION OF PROPOSED USE

(a) What is the use? Is the use a priority public use? The use is wildlife research conducted by non-U.S. Fish and Wildlife Service (Service) personnel. Research conducted by non-Service personnel 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 (Public Law 105-57).

(b) Where the use would be conducted? The location of the research will vary depending on the individual research project that is being conducted. The entire refuge may be made available for scientific refuge. An individual research project usually is limited to a particular habitat type, plant, or wildlife species. On occasion, research projects will encompass an assemblage of habitat types, plants, or wildlife, or may span more than one refuge or include lands outside the refuge. The research location will be limited to those areas of the refuge that are absolutely necessary to conduct the research project. The refuge may limit areas available to research as necessary to ensure the protection of trust resources or reduce conflict with other compatible refuge uses. Access to study locations will be identified by refuge staff.

(c) When would the use be conducted? The timing of the research will depend entirely on the approved design of individual research projects. Scientific research will 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. If a research project occurs during the refuge hunting season, special precautions will be required and enforced to ensure the researchers safety and so that conflicts with a priority public use (hunting) will be minimized or eliminated.

(d) How would the use be conducted? The methods of the research will depend entirely on the individual research project that is conducted. The methods of each research project will be reviewed and scrutinized 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, if it negatively impacts endangered species, migratory birds, other refuge trust resources, or it comprises public health and safety. A research proposal form will be distributed to parties interested in conducting research on the refuge.

(e) Why is this use being proposed? Research by non-Service personnel is conducted by colleges, universities, Federal, State, and local agencies, non-governmental organizations, and qualified members of the general public to further the understanding of the natural environment and to improve the management of the refuge's natural resources. Much of the information generated by the research is applicable to management on and near the refuge. In many cases research by non-Service personnel ensures the perception of un-biased and objective information gathering which can be important when using the research to develop management recommendations for politically sensitive issues. Additionally, universities and other Federal partners can access equipment and facilities unavailable to refuge staff for analysis of data or biological samples.

The Service will encourage and support research and management studies on refuge lands that will improve and strengthen natural resource management decisions. The refuge manager will encourage and seek research relative to approved refuge objectives that clearly improves land management and promotes adaptive management. Priority research addresses information that will better manage the nation's biological resources and is generally considered important to: agencies of the Department of Interior; the Service; the Refuge System; and State fish and Game agencies, and that addresses important management issues or demonstrates techniques for management of species and/or habitats.

The refuge also will consider research for other purposes which may not be directly relate to refuge-specific objectives, but contribute to the broader enhancement, protection, use, preservation, and management of native populations of fish, wildlife and plants, and their natural diversity within the region of flyway.

The refuge will maintain a list of research needs that will be provided to prospective researchers or organizations upon request. Refuge support of research directly related to refuge objectives

may take the form of funding, in-kind services such as housing or use of other facilities, direct staff assistance with the project in the form of data collection, provision of historical records, conducting management treatments, or other assistance as appropriate.

AVAILABILITY OF RESOURCES

The bulk of the cost for research is incurrence in staff time to review research proposals, coordinate with the researchers and write special use permits (SUP). In other cases, a research project may take an accumulation of weeks, as the refuge biologist must coordinate with students and advisors and accompany researchers on site visits. Because research conducted on the refuge is not constant, there may be fiscal years when little if any time is spent on managing outside research projects by refuge staff. Support includes review of the proposal by the refuge manager, deputy refuge manager and senior staff, consultation and coordination with principal researcher and field staff, issuance of SUP, and review of progress reports and other daily operational communications.

Annual costs associated with the administration of permitting research by non-service personnel are estimated below:

■ Review of research proposals, administration work, and consultation with refuge staff

GS 13 Refuge Manager:	2 days = $923
GS 12 Deputy Refuge Manager:	3 days = $1,041

■ Review of research proposals, administration work, coordination with principal researcher and field crew, and project monitoring and review

GS 12 Visitor Services Manager:	2 days = $617
GS 12 Contaminant Biologist:	2 days = $617
GS 11 Wildlife Biologist:	10 days = $2,573
GS 4 Administrative Assistant:	1 day = $121

■ Maintenance of housing facilities and coordination with field crew

GS 12 Deputy Refuge Manager:	3 days = $1,041
GS 7 Maintenance Worker:	3 days = $505

After review of the refuge budget, there are sufficient staff and funds to sustain this activity.

ANTICIPATED IMPACTS OF THE USE

The Service encourages approved research to further the understanding of 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, mist-netting, banding, and accessing the study area by foot or vehicle. Mist-netting or other wildlife capture techniques, for example, can cause direct mortality through the capture method or in trap predation, and indirectly through capture injury or stress caused to

the organism. Plant collection also can cause direct mortality of the target plant and can cause indirect mortality through the collection process.

Disturbance to wildlife and vegetation by researchers could occur through observation, a variety of wildlife capture techniques, banding, collecting blood samples, flushing wildlife, and vegetation trampling from accessing the study area by foot or vehicle. It is possible that direct or indirect mortality could result as a by-product of research activities. Mist-netting or other wildlife capture techniques, for example, can cause mortality directly through the capture method or in-trap predation, and indirectly through capture injury or stress caused to the organism. Multiple, concurrent research projects could exacerbate impacts. Additional impacts could result from abandoned research apparatus left in the field. Overall, however, allowing well-designed and properly reviewed research 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 through allowing the research. The refuge maintains a database and geographic information system based maps of current research to prevent conflicts and imposes guidelines to prevent negative impacts, such as keeping vehicles on refuge roads, prohibiting intrusive marking of vegetation, or staggering the timing of research at same sites. Most research projects are conducted on small areas; few are refuge-wide.

Project-specific stipulations outlined in each SUP will act to minimize anticipated impacts of research projects. These stipulations will prevent impacts to wetlands, water quality, soils, and hydrology, or actions which would significantly affect fish, wildlife, or habitat that the refuge was established to protect. Projects which occur within the habitat of, or include direct monitoring of, threatened and endangered species will be subject to a Section 7 informal consultation with the Service's New Jersey Field Office under the Endangered Species Act (87 Stat. 854, as amended; 16 U.S.C. 1531 et. seq). Only with the approval of the Section 7 consultation will the refuge permit research to be conducted on habitats or individuals of threatened and endangered species. Research that could adversely affect critical habitat or threatened and endangered wildlife will not be permitted.

The potential for user conflicts is minimal with research projects conducted on the refuge. Generally, most research occurs within closed areas and away from public use trails and facilities. During hunting seasons, hunters may encounter monitoring plots or other research infrastructure in the field. These encounters, however, should be infrequent and researchers are encouraged to use low profile infrastructure to prevent disturbance or vandalism of study sites. In some cases, placing signs at study sites will be appropriate.

Overall, 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 or plant communities simply by the nature of most proposed studies and the pre-screening of proposals by the refuge.

If the research project is conducted with professionalism and integrity, potential adverse impacts are likely to be minimal and outweighed by the knowledge gained about a species, habitat or public use. Additionally, researchers are required to present information to the refuge in the form of status reports and a final report as a condition of the SUP.

PUBLIC REVIEW AND COMMENT

This compatibility determination is being released concurrent with the draft Comprehensive Conservation Plan/Environmental Assessment for a 45-day review and comment period.

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 following Service policy (Service Refuge Manual Chapter 4 Section 6). The refuge must be given at least 45 days to review proposals before initiation of research. If collection of wildlife is involved, the refuge must be given 60 days to review and decide whether to approve the proposal. Proposals will be prioritized and approved based on need, benefit, compatibility, and funding required. The decision whether to approve any research proposal will be at the sole discretion of the refuge manager.

■ SUPs will be issued for all research conducted by non-Service personnel. The SUP will list all conditions that are necessary to ensure compatibility. The SUP will also identify a schedule for annual progress reports and the submittal of a final report or scientific paper. The regional refuge biologists, other Service divisions, and State agencies may be asked to review and comment on proposals.

■ All researchers will be required to obtain appropriate State and Federal permits.

■ All research projects will be designed to avoid significant impacts to hydrology, water quality, and soils.

■ All research related SUPs will contain a statement regarding the Service's policy regarding disposition of biotic specimens. The current Service policy language in this regard (USFWS 1999) is, "*You may use specimens collected under this permit, any components of any specimens (including natural organisms, enzymes, genetic material or seeds), and research results derived from collected specimens for scientific or educational purposes only, and not for*

commercial purposes unless you have entered into a Cooperative Research and Development Agreement (CRADA) with us. We prohibit the sale of collected research specimens or other transfers to third parties. Breach of any of the terms of this permit will be grounds for revocation of this permit and denial of future permits. Furthermore, if you sell or otherwise transfer collected specimens, any components thereof, or any products or any research results developed from such specimens or their components without a CRADA, you will pay us a royalty rate of 20 percent of gross revenue from such sales. In addition to such royalty, we may seek other damages and injunctive relief against you."

■ Any research project may be terminated at any time for non-compliance with the SUP conditions, or modified, redesigned, relocated or terminated upon determination by the refuge manager that the project is causing unanticipated adverse impacts to wildlife, wildlife habitat, approved priority public uses, or other refuge management activities.

■ The following language is included in all wildlife research SUPs: In consideration of being permitted to engage in the activity authorized under a permit at Great Swamp NWR, Permittee, being of lawful age, for himself and his personal representative, heirs, and next of kin, hereby releases, waives, and forever discharges the United States of America, its agents and employees, all for the purposes herein referred to as, Releasees, from any and every claim, demand, action or right of action, of whatsoever kind or nature, either in law or in equity, arising from or by reason of any bodily injury or personal injuries known or unknown, death and/or property damage resulting or to result from any injury, which may occur while engaged in the permitted activity, and covenants not to sue the Releasees, for any loss or damages, and any claim or damage therefore, on account of injury to the person or property or resulting in death of the Permittee, whether caused by the negligence of Releasees or otherwise.

JUSTIFICATION

The Service encourages approved research to further understanding of refuge natural resources. In fact, one of the goals that have guided management at the refuge is to encourage scientific study and research by colleges, universities, and qualified organizations and individuals that is directed toward fulfilling refuge objectives (USFWS 1987). Research by non-Service personnel adds greatly to the information base for refuge managers to make proper decisions. To protect habitat and wildlife, researchers are required to submit detailed research proposals. Proposals are reviewed and must be approved by refuge staff prior to implementation. In addition to the stipulations above, project-specific stipulations outlined in each SUP will act to minimize anticipated impacts of research projects. Projects which occur within the habitat of, or include direct monitoring of threatened and endangered species will be subject to an Intra-Service Section 7 consultation. Only with the approval of the Section 7 consultation will the refuge permit research to be conducted on habitats or individuals of threatened and endangered species. With the restrictions and approval process required to permit research activities this use will not

prevent the refuge from meeting its purposes established by the Fish and Wildlife Act (1956) and the Emergency Wetlands Resources Act (1986) of ensuring the protection, conservation, management and restoration of the wetlands of Great Swamp NWR, or for the management and conservation of wildlife or their habitats. Stipulations will be designed to prevent impacts to migratory birds to ensure the refuge meets its obligations under the Migratory Bird Conservation Act (1929). This use will not materially interfere with, or detract from, the Wilderness purpose of the refuge, because any manipulation of habitat (e.g., collecting, disturbing, or destroying plants, animals, or parts thereof) or use of any motorized equipment will be prohibited, and wilderness terrain, including trails, will be open to foot travel only. In most cases the research will help guide refuge management to meet its purposes more effectively. For these reasons, we have determined that research conducted by non-Service personnel will not materially interfere with or detract from the mission of the Refuge System or the purposes for which the refuge was established.

SIGNATURE:

Refuge Manager: _____ _____
(Signature) (Date)

CONCURRENCE:

Regional Chief: _____ _____
(Signature) (Date)

MANDATORY 10 -YEAR REEVALUATION DATE: _____

LITERATURE CITED

USFWS. 1987. Final Environmental Impact Statement. Master Plan. Great Swamp National Wildlife Refuge, Morris County, New Jersey. Department of the Interior, USFWS, Basking Ridge, NJ.

USFWS. 1999. Director's Order No. 109: Use of specimens collected on Fish and Wildlife Lands. March 30, 1999.

FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Great Swamp National Wildlife Refuge

Use: Police and Fire Training

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:_____

If found to be **Not Appropriate**, the refuge supervisor does not need to sign concurrence if the use is a new use.

If an existing use is found **Not Appropriate** outside the CCP process, the refuge supervisor must sign concurrence.

If found to be **Appropriate**, the refuge supervisor must sign concurrence.

Refuge Supervisor:_____ Date:_____

A compatibility determination is required before the use may be allowed.

FWS Form 3-2319
02/06

JUSTIFICATION FOR A FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Great Swamp National Wildlife Refuge

Use: Police and Fire Training

NARRATIVE:

The use is to allow local police and fire personnel to conduct training exercises on the refuge. Training would be conducted at various times of the year during both day and night depending upon the needs of the refuge, the availability of approved locations, and the schedule of local police and fire departments. Local police and fire personnel would use the refuge for various training exercises including, but not limited to, search and rescue, rapid intervention, hostage rescue, and high-risk warrant service. In buildings planned for disposal, increasingly aggressive tactics (such as breaking in doors or windows or venting roofs) would be allowed as the date for demolition approaches. Training exercises would need to be cleared with the refuge manager in advance and are administered through a Special Use Permit (SUP). Local police and fire personnel would then be responsible for conducting the exercises in the manner and at the location(s) previously agreed upon. Police and fire personnel are covered by their own liability insurance. The refuge is named as an additional insured.

The refuge occasionally works with local emergency responders and benefits directly from their services. In the densely suburbanized areas that surround the refuge, training locations are in short supply and high demand. The refuge, however, has numerous locations that are suitable for emergency responder training. Refuge buildings planned for disposals are especially well suited for this type of training since they are vacant, readily available, and can be used with force without fear of damage. The familiarity gained when using refuge lands and structures for training benefits the refuge in the event there were a real emergency involving such lands or structures. The highly visible presence of police and fire personnel in and around abandoned refuge buildings may serve as a deterrent to unauthorized activity which has been a problem in the past. Putting these otherwise useless structures to good use prior to their removal may also engender support for the refuge's ongoing land acquisition program. Refuge law enforcement staff have been invited to participate in training exercises and have benefitted from these additional opportunities. Finally, the goodwill generated by providing training opportunities to local emergency responders serves to strengthen the refuge's relationship with these important partners.

While this use does not directly contribute to the public's understanding and appreciation of resources, it does not detract from the refuge fulfilling their establishing purposes of supporting research, habitats and wildlife.

COMPATIBILITY DETERMINATION

USE

Police and Fire Training

REFUGE NAME

Great Swamp National Wildlife Refuge

DATE ESTABLISHED

1960

ESTABLISHING AND ACQUISITION AUTHORITY

Great Swamp National Wildlife Refuge (NWR, refuge) was established primarily under the authorities of the Migratory Bird Treaty Act of 1918 (16 U.S.C. 703-711, 40 Stat. 755) and the Migratory Bird Conservation Act of 1929 (16 U.S.C. 715-715r, 45 Stat. 1222), as amended, by transfer of approximately 2,900 acres of land donated to the Federal Government by the Great Swamp Committee of the North American Wildlife Foundation.

REFUGE PURPOSES

Based upon land acquisition documents and authorities, refuge purposes were identified as follows:

> *"…for use as an inviolate sanctuary, or for any other management purpose, for migratory birds.*" (Migratory Bird Conservation Act of 1929; 16 U.S.C. 715d)
>
> *"...suitable for (1) incidental fish and wildlife-oriented recreational development, (2) the protection of natural resources, (3) the conservation of endangered species or threatened species ..."* (Refuge Recreation Act; 16 U.S.C. 460k-1) *"the Secretary…may accept and use…real…property. Such acceptance may be accomplished under the terms and conditions of restrictive covenants imposed by donors"*…(Refuge Recreation Act; 16 U.S.C. 460k-2, as amended)
>
> *"...for the conservation of the wetlands of the Nation in order to maintain the public benefits they provide and to help fulfill international obligations contained in various migratory bird treaties and conventions ..."* (Emergency Wetlands Resources Act of 1986; 16 U.S.C. 3901(b)); and,

> *"... to conserve (A) fish or wildlife which are listed as endangered species or threatened species .... or (B) plants ..."* (Endangered Species Act of 1973; 16 U.S.C. 1534).

> *"…to secure for the American people of present and future generations the benefits of an enduring resource of wilderness… wilderness areas ... shall be administered for the use and enjoyment of the American people in such manner as will leave them unimpaired for future use and enjoyment as wilderness, and so as to provide for the protection of these areas, the preservation of their wilderness character, and for the gathering and dissemination of information regarding their use and enjoyment as wilderness: …"* (Wilderness Act of 1964; Public Law 88-577; 16 U.S.C. 1131-1136)

NATIONAL WILDLIFE REFUGE SYSTEM MISSION

The mission of the National Wildlife Refuge System (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 (National Wildlife Refuge System Improvement Act; 16 U.S.C. 668dd(a)(2)).

DESCRIPTION OF PROPOSED USE

(a) What is the use? Is the use a priority public use? The use is to allow local police and fire personnel to conduct training exercises on the refuge. This is not a priority public use (National Wildlife Refuge System Improvement Act of 1997; Public Law 105-57).

(b) Where would the use be conducted? Training would be allowed only in pre-approved locations including, but not limited to, refuge buildings planned for disposal.

(c) When would the use be conducted? Training would be conducted at various times of the year during both day and night depending upon the needs of the refuge, the availability of approved locations, and the schedule of local police and fire departments.

(d) How would the use be conducted? Local police and fire personnel would use the refuge for various training exercises including, but not limited to, search and rescue, rapid intervention, hostage rescue, and high-risk warrant service. In buildings planned for disposal, increasingly aggressive tactics (such as breaking in doors or windows or venting roofs) would be allowed as the date for demolition approaches. Training exercises would need to be cleared with the refuge manager in advance and are administered through a Special Use Permit (SUP). Local police and fire personnel would then be responsible for conducting the exercises in the manner and at the location(s) previously agreed upon. Police and fire personnel are covered by their own

liability insurance. The municipality is required to include the refuge as an additional insured party to relieve the Federal Government of all tort liability.

(e) Why is this use being proposed? Local police and fire personnel are constantly training to improve their skills in an effort to better protect themselves and the public when responding to emergencies. The refuge frequently works with local emergency responders and benefits directly from their services. In the densely suburbanized areas that surround the refuge, training locations are in short supply and high demand. The refuge, however, has numerous locations that are suitable for emergency responder training. Refuge buildings planned for disposals are especially well suited for this type of training since they are vacant, readily available, and can be used with force without fear of damage. The familiarity gained when using refuge lands and structures for training benefits the refuge in the event there were a real emergency involving such lands or structures. The highly visible presence of police and fire personnel in and around abandoned refuge buildings may serve as a deterrent to unauthorized activity which has been a problem in the past. Putting these otherwise useless structures to good use prior to their removal may also engender support for the refuge's ongoing land acquisition program. Refuge law enforcement staff have been invited to participate in training exercises and have benefitted from these additional opportunities. Finally, the goodwill generated by providing training opportunities to local emergency responders serves to strengthen the refuge's relationship with these important partners. This use was found compatible in a compatibility determination (CD) issued in 2004.

AVAILABILITY OF RESOURCES

The resources necessary to provide and administer this use are available within the current and anticipated refuge budgets. Staff time associated with administration of this use is related to coordinating with local police and fire personnel, preparing SUPs for this use every year, reevaluating the appropriateness and compatibility of this use every 10 years, and monitoring to ensure that the conditions and stipulations of the SUPs and CD are followed. The deputy refuge manager has primary responsibility for these duties which require approximately one work day per year. The refuge's law enforcement officer occasionally participates in training exercises which occupy approximately one work day per year.

- GS-12 Deputy Refuge Manager: 1 day = $347
- GL-09 Federal Wildlife Officer: 1 day = $213

Total = $560

ANTICIPATED IMPACTS OF THE USE

The use under consideration has been occurring on the refuge with negligible impacts since 2003. Sites have been and will continue to be selected that minimize impacts to refuge

operations and resources and to neighboring properties. Abandoned buildings are generally not considered wildlife habitat, however, all buildings will be checked for the presence of wildlife, especially owls and bats, before being approved for use.

PUBLIC REVIEW AND COMMENT

This CD is being released concurrent with the draft Comprehensive Conservation Plan/Environmental Assessment for a 45-day review and comment period.

DETERMINATION (CHECK ONE BELOW):

____ Use is not compatible

__X__ Use is compatible with the following stipulations

STIPULATIONS NECESSARY TO ENSURE COMPATIBILITY

- This use is administered through SUPs issued to local police and fire departments every year. Stipulations are listed as "Special Conditions" in the SUP.
    - Stipulations/special conditions for police training are as follows:
        - No ammunition will be allowed in firearms. Paintballs or other non-lethal training ammunition are allowed.
        - Local police will be responsible for alerting neighbors and other interested parties in advance of training.
        - The refuge will provide access to the building(s) and local police will be required to restore building(s) to previous locked/boarded/secured condition.
        - Local police must coordinate with refuge manager prior to scheduling activities to ensure facilities are available and that the nature of training and the equipment planned for use is appropriate.
        - Nighttime access to the refuge is permitted.
        - A brief report of the training program's purpose and the number of officers involved will be provided to the refuge manager within 2 weeks following each training session.
        - On average, no more than one training exercise will be allowed per month. Exceptions may be allowed by the refuge manager.
        - Training should be conducted so as to minimize damage to buildings and property and disturbance to wildlife and neighbors. This condition may be waived in advance by the refuge manager on a case-by-case basis. Windows and doors should not be broken without specific advance permission from the refuge manager.

    - The refuge reserves the right to postpone or cancel any activity that may interfere with public safety or refuge management activities. Access to the refuge will not be permitted during the annual refuge deer hunt.
    - All other refuge rules and regulations remain in force.
  - Stipulations/special conditions for fire training are as follows:
    - Local fire department must coordinate with refuge manager at least 14 days prior to scheduling activities to ensure facilities are available.
    - Permittee must have a copy of their SUP with them at all times and present it as requested.
    - Permittee must avoid damage to the grounds and exterior of building(s) (i.e. ruts from vehicles; exterior doors, windows, and roof must remain intact). Local fire department is responsible for ensuring that the site is restored to its previous condition as necessary.
    - The refuge manager may authorize more realistic training scenarios involving more destructive tactics (i.e. breaking in a door or window or venting a roof) in structures soon to be demolished.
    - Heavy equipment may be parked at the Wildlife Observation Center in a manner that will not block access for other vehicles. No parking is allowed in the Wilderness Area. Off-road driving is prohibited.
    - Local fire department is responsible for contacting surrounding police, fire, emergency services, neighbors, etc. as necessary in advance to alert them of their activities.
    - Smoke will only be generated by a U.S. Environmental Protection Agency approved device and without fire hazard to the building.
    - The refuge reserves the right to postpone or cancel any activity that may interfere with public safety or refuge management activities.

JUSTIFICATION

Allowing local police and fire personnel to train on the refuge provides multiple tangible benefits. Most importantly, refuge lands, facilities, visitors, and resident staff benefit from the enhanced emergency response skills developed through such training. In addition to improved response capabilities, the refuge benefits from the greater familiarity of local emergency responders with its lands and facilities in the event of an actual emergency. Highly visible police and fire presence may provide a deterrent effect for vandal-prone abandoned refuge buildings. refuge law enforcement staff have benefitted from participating in training exercises. Also, the goodwill generated by allowing training opportunities serves to strengthen the refuge's close and ongoing relationship with these important partners. Since this use has been allowed, four to six training exercises have been held on the refuge each year with negligible impacts to refuge resources.

Allowing the continuation of police and fire training at Great Swamp NWR will not materially interfere with or detract from the fulfillment of the Refuge System mission or the purposes of the refuge.

SIGNATURE:

Refuge Manager: _____ _____
(Signature) (Date)

CONCURRENCE:

Regional Chief: _____ _____
(Signature) (Date)

MANDATORY 10-YEAR REEVALUATION DATE: _____

FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Great Swamp National Wildlife Refuge

Use: National Weather Service Sensor

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:_____

If found to be **Not Appropriate**, the refuge supervisor does not need to sign concurrence if the use is a new use.

If an existing use is found **Not Appropriate** outside the CCP process, the refuge supervisor must sign concurrence.

If found to be **Appropriate**, the refuge supervisor must sign concurrence.

Refuge Supervisor:_____ Date:_____

A compatibility determination is required before the use may be allowed.

FWS Form 3-2319
02/06

JUSTIFICATION FOR A FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Great Swamp National Wildlife Refuge

Use: Operation and maintenance of National Weather Service Automated Precipitation Sensor

NARRATIVE

This use is an National Weather Service (NWS) precipitation sensor that is an unobtrusive brown cylinder approximately 12 inches in diameter and 10 feet tall with a 4-foot radio antenna projecting from the top. The sensor is powered by a small solar panel attached to the side of the cylinder. The unit automatically sends precipitation data to an automated flood warning system receiving station by radio uplink. The data is made available to the public for viewing and download in near real-time from an NWS website. The NWS Meteorologist-In-Charge currently stationed at the Weather Forecast Office, Philadelphia/Mount Holly, New Jersey is responsible for coordinating activities with the refuge manager.

This sensor is very small and provides valuable information for the refuge, NWS, and public.

COMPATIBILITY DETERMINATION

USE

Operation and maintenance of National Weather Service Automated Precipitation Sensor

REFUGE NAME

Great Swamp National Wildlife Refuge

DATE ESTABLISHED

1960

ESTABLISHING AND ACQUISITION AUTHORITY

Great Swamp National Wildlife Refuge (NWR, refuge) was established primarily under the authorities of the Migratory Bird Treaty Act of 1918 (16 U.S.C. 703-711, 40 Stat. 755) and the Migratory Bird Conservation Act of 1929 (16 U.S.C. 715-715r, 45 Stat. 1222), as amended, by transfer of approximately 2,900 acres of land donated to the Federal Government by the Great Swamp Committee of the North American Wildlife Foundation.

REFUGE PURPOSES

Based upon land acquisition documents and authorities, refuge purposes were identified as follows:

> *"…for use as an inviolate sanctuary, or for any other management purpose, for migratory birds.*" (Migratory Bird Conservation Act of 1929; 16 U.S.C. 715d)
>
> *"...suitable for (1) incidental fish and wildlife-oriented recreational development, (2) the protection of natural resources, (3) the conservation of endangered species or threatened species ..."* (Refuge Recreation Act; 16 U.S.C. 460k-1) *"the Secretary…may accept and use…real…property. Such acceptance may be accomplished under the terms and conditions of restrictive covenants imposed by donors"*…(Refuge Recreation Act; 16 U.S.C. 460k-2, as amended)
>
> *"...for the conservation of the wetlands of the Nation in order to maintain the public benefits they provide and to help fulfill international obligations contained in various migratory bird treaties and conventions ..."* (Emergency Wetlands Resources Act of 1986; 16 U.S.C. 3901(b)); and,
>
> *"... to conserve (A) fish or wildlife which are listed as endangered species or threatened species .... or (B) plants ..."* (Endangered Species Act of 1973; 16 U.S.C. 1534).

> *"…to secure for the American people of present and future generations the benefits of an enduring resource of wilderness… wilderness areas ... shall be administered for the use and enjoyment of the American people in such manner as will leave them unimpaired for future use and enjoyment as wilderness, and so as to provide for the protection of these areas, the preservation of their wilderness character, and for the gathering and dissemination of information regarding their use and enjoyment as wilderness: …"* (Wilderness Act of 1964; Public Law 88-577; 16 U.S.C. 1131-1136)

NATIONAL WILDLIFE REFUGE SYSTEM MISSION

The mission of the National Wildlife Refuge System (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 (National Wildlife Refuge System Improvement Act; 16 U.S.C. 668dd(a)(2)).

DESCRIPTION OF PROPOSED USE

(a) What is the use? Is the use a priority public use? The use is the operation and maintenance of an automated radio-linked precipitation sensor on the grounds of Refuge Headquarters by the National Weather Service (NWS). The sensor is part of NWS' "Integrated Flood Observing and Warning System" (IFLOWS) and "Automated Flood Warning System" (AFWS). This is not a priority public use (National Wildlife Refuge System Improvement Act of 1997; Public Law 105-57).

(b) Where would the use be conducted? The sensor is located on the lawn approximately 60 feet behind Refuge Headquarters.

(c) When would the use be conducted? The sensor was installed in January of 1988 and has been in continuous use since then. Approximately once per year, NWS personnel or their contractors perform maintenance on the unit.

(d) How would the use be conducted? The sensor apparatus itself is an unobtrusive brown cylinder approximately 12 inches in diameter and 10 feet tall with a 4-foot radio antenna projecting from the top. The sensor is powered by a small solar panel attached to the side of the cylinder. The unit automatically sends precipitation data to an AFWS receiving station by radio uplink. The data is made available to the public for viewing and download in near real-time from an NWS Web site. The NWS meteorologist-in-charge currently stationed at the Weather Forecast Office, Philadelphia/Mount Holly, New Jersey is responsible for coordinating activities with the refuge manager.

(e) Why is this use being proposed? NWS requested placement of the sensor on the refuge in the late-1980s as part of the expansion of its IFLOWS system to better monitor precipitation and forecast flooding within the Passaic River Basin. The refuge allowed installation of the sensor primarily as a public service to facilitate the protection of life and property in downstream communities. The refuge also uses data from the sensor to monitor precipitation patterns and supplement management programs and decision-making. Headquarters was chosen as the location for the sensor given the security a regularly staffed facility provides such expensive equipment at no additional effort or expense. This use was found compatible in a compatibility determination (CD) issued in 2004.

AVAILABILITY OF RESOURCES

The resources necessary to provide and administer this use are available within the current and anticipated refuge budgets. Staff time associated with administration of this use is related to coordinating with the NWS meteorologist-in-chief or their staff, preparing a Special Use Permit (SUP) for this use every 5 years, reevaluating the appropriateness and compatibility of this use every 10 years, and monitoring to ensure that the conditions and stipulations of the SUP and CD are followed. The deputy refuge manager has primary responsibility for these duties which require approximately one work day per year.

- GS-12 Deputy Refuge Manager: 1 day = $347

ANTICIPATED IMPACTS OF THE USE

The use under consideration has been occurring continuously on the refuge with no apparent impacts since 1988. The sensor apparatus is located in an area of mowed lawn behind Refuge Headquarters and has a footprint of less than one square foot. This location was specifically chosen to prevent conflicts with refuge operations, to avoid potential disturbances, aesthetic or otherwise, and to provide some measure of protection for the expensive equipment. The sensor is a short walk from designated parking areas and access for maintenance is done by foot with no impact to refuge resources.

PUBLIC REVIEW AND COMMENT

This CD is being released concurrent with the draft Comprehensive Conservation Plan/Environmental Assessment for a 45-day review and comment period.

DETERMINATION (CHECK ONE BELOW):

____ Use is not compatible

__X__ Use is compatible with the following stipulations

STIPULATIONS NECESSARY TO ENSURE COMPATIBILITY

- NWS' use of the sensor is administered through a SUP issued every 5 years. Stipulations are listed as "Special Conditions" in the SUP.
    - The refuge manager should be contacted in advance prior to any personnel visiting the sensor for any purpose (e.g., routine maintenance, emergency repairs, etc.).
    - Routine maintenance should be performed during regular business hours.
    - The refuge manager should be notified within 60 days should operation of the sensor be discontinued. The sensor should be removed from the refuge within 60 days following such notification. NWS must restore the site to the refuge manager's satisfaction following removal.

JUSTIFICATION

Use and maintenance of NWS' precipitation sensor has resulted in no apparent impacts to refuge resources for nearly 25 years. Since no modifications to the sensor or its maintenance are anticipated, impacts and disturbance should remain negligible in the future. The sensor is an important node in NWS' IFLOWS system, providing data used to monitor precipitation and forecast flooding within the Passaic River Basin. IFLOWS serves a critical function in protecting public safety and property within the Basin, including the refuge. Data from the sensor has also been helpful to the refuge in monitoring precipitation patterns and supplementing management programs and decision-making. Such information may also prove valuable for monitoring potential climatic changes. Allowing this use also strengthens the partnership between the Service and NWS for the benefit of both bureaus and the general public.

Allowing the continued use of NWS' precipitation sensor at Great Swamp NWR will not materially interfere with or detract from the fulfillment of the Refuge System mission or the purposes of the refuge.

SIGNATURE:

Refuge Manager: _____ _____
(Signature) (Date)

CONCURRENCE:

Regional Chief: _____ _____
(Signature) (Date)

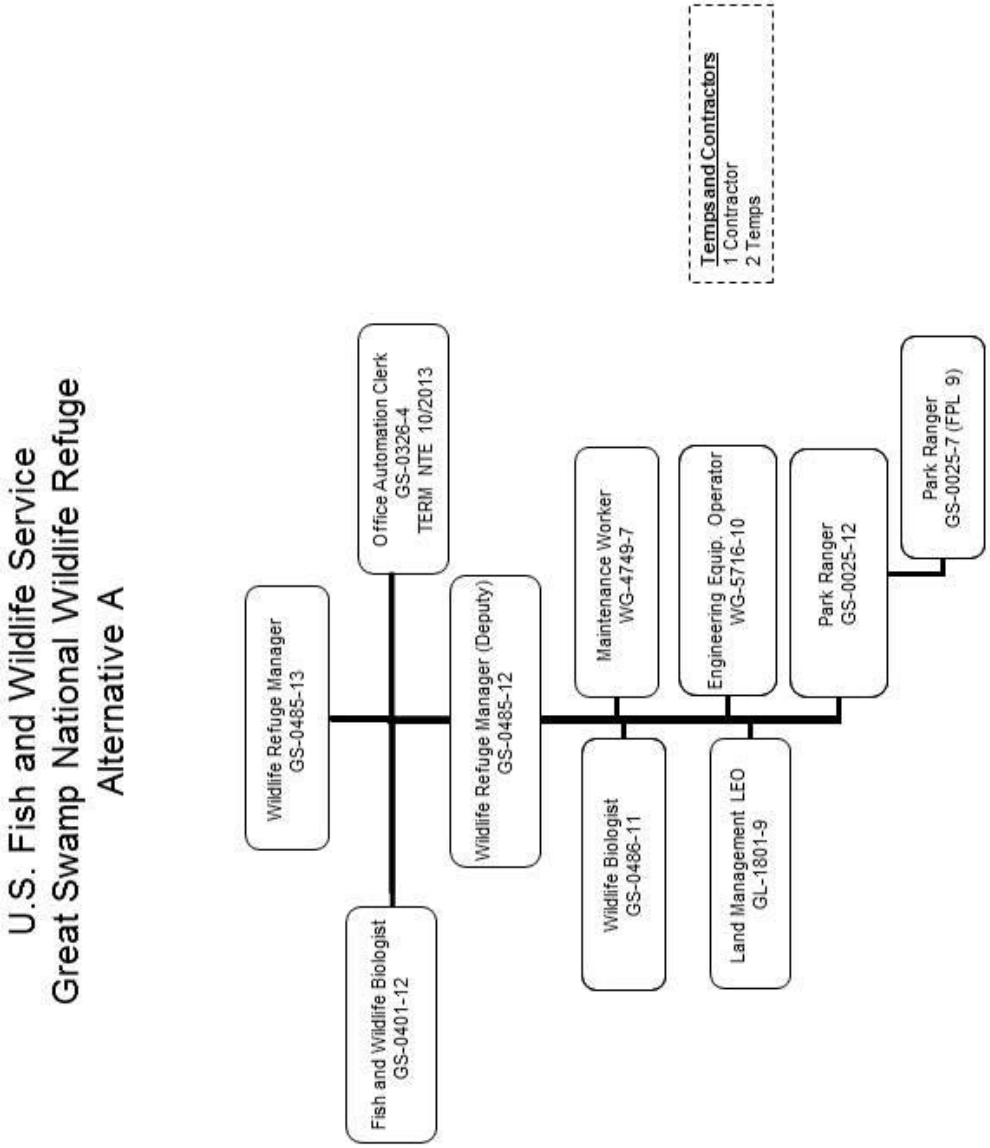
MANDATORY 10-YEAR REEVALUATION DATE: _____

Appendix D

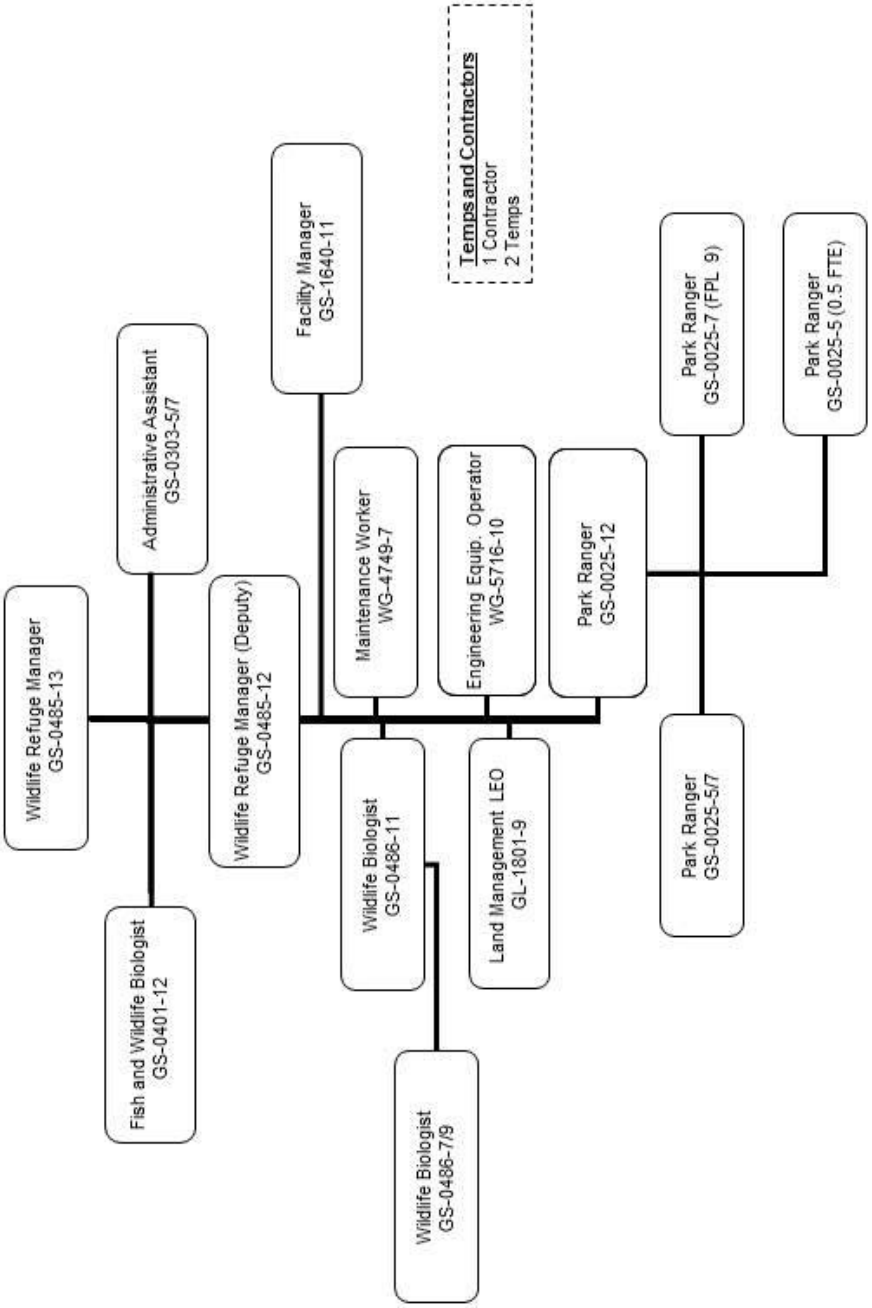
USFWS

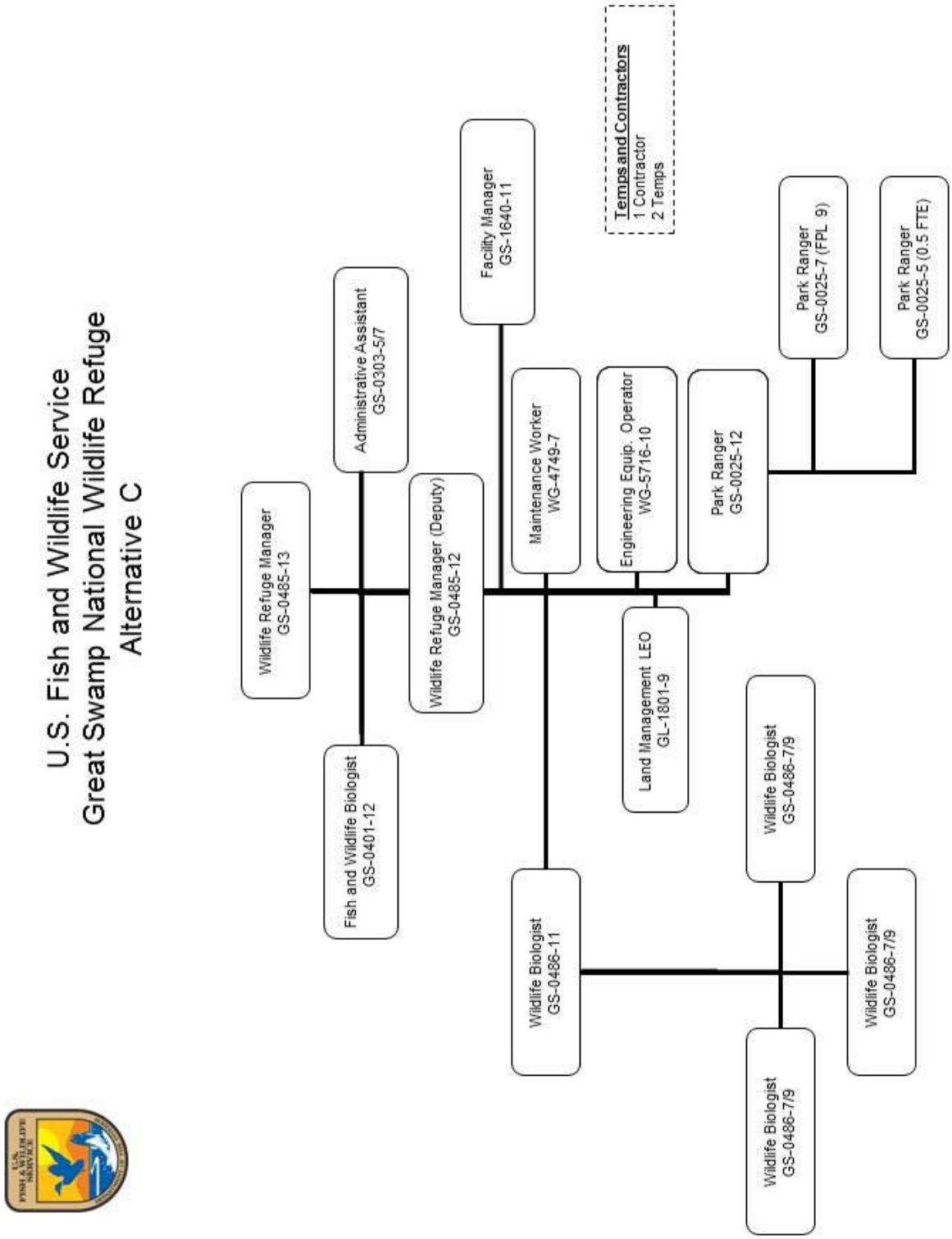
Tree Swallow

Organizational Charts for Great Swamp National Wildlife Refuge


U.S. Fish and Wildlife Service
Great Swamp National Wildlife Refuge
Alternative A
Wildlife Refuge Manager
GS-0485-13
Fish and Wildlife Biologist
GS-0401-12
Office Automation Clerk
GS-0326-4
TERM NTE 10/2013
Wildlife Refuge Manager (Deputy)
GS-0485-12
Wildlife Biologist
GS-0486-11
Maintenance Worker
WG-4749-7
Land Management LEO
GL-1801-9
Engineering Equip. Operator
WG-5716-10
Park Ranger
GS-0025-12
Park Ranger
GS-0025-7 (FPL 9)
Temps and Contractors
1 Contractor
2 Temps

U.S. Fish and Wildlife Service
Great Swamp National Wildlife Refuge
Alternatives B and D




U.S. Fish and Wildlife Service
Great Swamp National Wildlife Refuge
Alternative C
Wildlife Refuge Manager
GS-0485-13
Administrative Assistant
GS-0303-5/7
Fish and Wildlife Biologist
GS-0401-12
Wildlife Refuge Manager (Deputy)
GS-0485-12
Facility Manager
GS-1640-11
Maintenance Worker
WG-4749-7
Engineering Equip. Operator
WG-5716-10
Park Ranger
GS-0025-12
Park Ranger
GS-0025-7 (FPL 9)
Park Ranger
GS-0025-5 (0.5 FTE)
Temps and Contractors
1 Contractor
2 Temps
Land Management LEO
GL-1801-9
Wildlife Biologist
GS-0486-11
Wildlife Biologist
GS-0486-7/9
Wildlife Biologist
GS-0486-7/9
Wildlife Biologist
GS-0486-7/9

U.S. Fish & Wildlife Service
Great Swamp National Wildlife Refuge
241 Pleasant Plains Road, Basking Ridge, NJ 07920
(973) 425-1222
northeastplanning@fws.gov
http://www.fws.gov/refuge/great_swamp/
Federal Relay Service
for the deaf and hard-of-hearing
1 800/877 8339

U.S. Fish & Wildlife Service
http://www.fws.gov

For Refuge Information
1 800/344 WILD

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