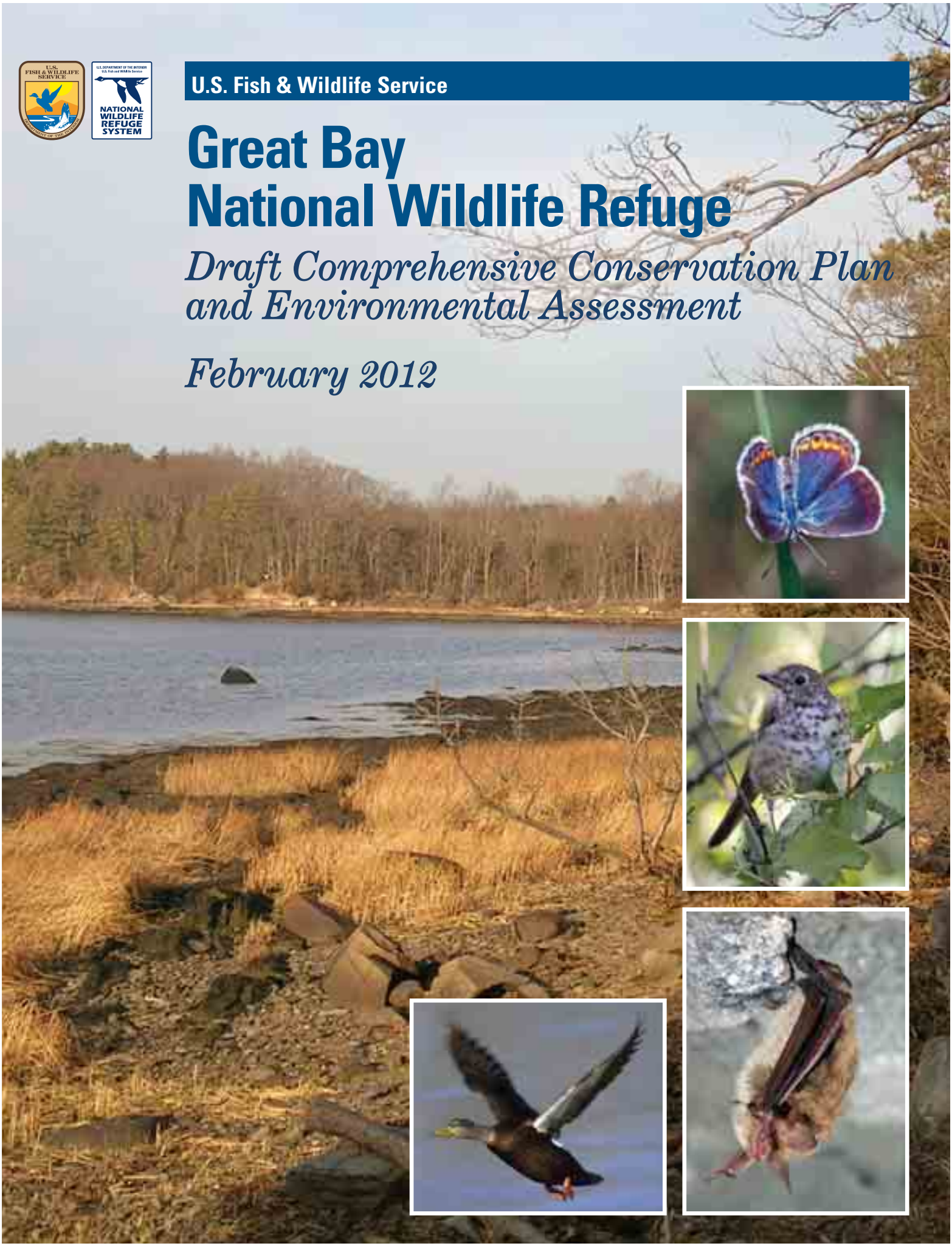
U.S. Fish & Wildlife Service

Great Bay National Wildlife Refuge

Draft Comprehensive Conservation Plan and Environmental Assessment

February 2012



Front cover:

Great Bay Refuge shoreline near Woodman Point
USFWS

Karner blue butterfly
USFWS

Wood thrush
Bill Thompson

Northern myotis
Al Hicks/NYDEC

American black duck
USFWS

Back cover:

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

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

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Great Bay Refuge Vision Statement

Great Bay National Wildlife Refuge will be a treasured cornerstone in protecting and restoring the Great Bay Estuary's unique and significant ecological and cultural resources, which are unparalleled in New England. The estuary's shallow tidal waters will teem with a rich diversity of aquatic resources, from oysters and eelgrass beds, to healthy populations of migratory fish. The refuge's oak-hickory forests, grasslands, shrublands, and freshwater ponds will support a bounty of wildlife throughout the year. During winter, bald eagles will thrill refuge visitors as they taunt the many and diverse flocks of waterfowl and waterbirds foraging and resting in its quiet, protected waters. In spring, the refuge's forests, fields, and wetlands will fill with a symphony of bird songs and frog calls. The summer will reward visitors with the opportunity to view native fledgling birds, fawns, and other young of the year. During the fall, the refuge will host hundreds of migrating species ranging from waterfowl, to songbirds, bats, and butterflies, all needing safe haven in an increasingly urbanized landscape.

Visitors from throughout New England will travel to the refuge to become immersed in the sights and sounds of nature. The refuge will showcase innovative, science-based, adaptive management techniques and, coupled with exceptional outreach, education, and interpretive programs, help raise awareness and appreciation of the natural world and uphold the mission of the National Wildlife Refuge System. The refuge, in collaboration with partners, will work tirelessly to expand the protection and conservation of the Great Bay Estuary and its native habitats and wildlife for the benefit of the American people.

The Karner blue butterfly easement lands in Concord, New Hampshire, will contribute to the recovery of the federally endangered Karner blue butterfly. Each spring, the flowers of native lupine plants growing among pitch pine on the easement lands will attract thousands of adult Karner blue butterflies to feed on nectar. During the summer, an abundance of Karner blue caterpillars will feed on the lupine leaves. As part of an extraordinarily dedicated partnership, the easement is a key link in the network of lands in the Concord area managed to help reverse the butterfly's decline and bring the species back from the brink of extirpation.

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Summary

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

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

Location: Great Bay National Wildlife Refuge
Newington, New Hampshire

Administrative Headquarters: Parker River National Wildlife Refuge
Newburyport, Massachusetts

Responsible Official: Wendi Weber, Regional Director, Region 5

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This Draft Comprehensive Conservation Plan and Environmental Assessment analyzes three alternatives for managing the 1,103-acre Great Bay National Wildlife Refuge (Great Bay Refuge; the refuge) and the 29-acre Karner blue butterfly conservation easement over the next 15 years. This document also contains 10 appendixes that provide additional information supporting our analysis. Following is a brief overview of each alternative:

Alternative A–Current Management: Alternative A satisfies the National Environmental Policy Act requirement of a "no action" alternative, which we define as "continuing current management." It describes our existing management priorities and activities for Great Bay Refuge and Karner blue butterfly conservation easement, and serves as a baseline for comparing and contrasting alternatives B and C.

Alternative B–Habitat Diversity and Focal Species Emphasis: Alternative B is the U.S. Fish and Wildlife Service (Service)-preferred alternative. It combines the actions we believe would best achieve the refuge's purposes, vision and goals, and respond to public issues. Under alternative B, we would emphasize the management of specific refuge habitats to support focal species whose habitat needs benefit other species of conservation concern that are found in the Great Bay region. In particular, we would focus on habitat for priority migratory birds, such as the upland sandpiper; for rare and declining species, such as the New England cottontail and Karner blue butterfly; and for estuarine species of concern, including oysters and eelgrass. We propose removing the Lower Peverly Pond Dam to restore stream habitat, while maintaining the dams at Upper Peverly Pond and Stubbs Pond to benefit a range of fish and wildlife. We would expand our conservation, research, and management partnerships to help restore and conserve the Great Bay estuarine ecosystem. This

alternative would enhance our visitor services programs, which have been limited under current management due to lack of staff. On Great Bay Refuge, we propose to enhance the entrance to the refuge, create new interpretive materials, expand our existing volunteer program, and offer visitors more opportunities to learn about the refuge and the surrounding landscape. On the Karner blue butterfly easement, we propose to install new interpretive signs, offer guided interpretive walks, and enhance our Web-based information.

Alternative C–Emphasis on Natural Processes: Alternative C would rely primarily on ecosystem processes and natural disturbances to restore the biological integrity, diversity, and ecological health of Great Bay Refuge. All grassland and shrubland habitat on the refuge would be allowed to naturally succeed to forest. All three refuge impoundments would be removed, restoring Peverly Brook to stream habitat and returning Stubbs Pond to salt marsh. We would also remove all remaining structures in the former Weapons Storage Area. Under this alternative, we would expand the refuge visitor services program and public access. We would construct two new trails and, as sensitive shrubland and grassland habitats succeed to forest, we would open up larger portions of the refuge to public use. The management of the Karner blue butterfly easement would be the same as that proposed under alternative B.

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Chapter 1

USFWS

Upper Peverly Pond

Purpose of, and Need for, Action

- Introduction
- Purpose of, and Need for, Action
- Service Policies, Legal Mandates, and Other Policies Guiding Planning Process
- National and Regional Plans and Conservation Initiatives
- Refuge Purposes and Land Acquisition History
- Refuge Vision Statement
- Refuge Goals
- The Comprehensive Conservation Planning Process
- Issues, Concerns, and Opportunities

Introduction

The U.S. Fish and Wildlife Service (Service, we, our) established Great Bay National Wildlife Refuge (Great Bay Refuge, the refuge) in 1992. It is located in the town of Newington in southeastern New Hampshire, on the eastern shore of the tidally influenced Great Bay Estuary. This 1,103-acre refuge includes 2 miles of rocky shoreline and is the largest parcel of protected land on the estuary (map 1.1). Great Bay Refuge was established to protect the natural diversity of fish, wildlife, and plants within its boundaries; protect federally listed species; preserve and enhance water quality and aquatic habitats; and fulfill the U.S.'s international treaty obligations relating to fish and wildlife resources. In the three decades prior to refuge establishment, the refuge lands were part of the former Pease U.S. Air Force (Air Force) Base. Despite this intensive land use, and its earlier use as a farm, the refuge has a rich diversity of habitat types including oak-hickory forests, grasslands, shrub thickets, freshwater and saltwater wetlands, and open water.

Great Bay Refuge also includes a 29-acre conservation easement in remnant pine barrens along the Merrimack River in Concord, New Hampshire. The easement lies approximately 45 miles west of the refuge and abuts the Concord Airport. The pine barrens on easement lands are managed for the federally listed endangered Karner blue butterfly. The easement is part of a fragmented, but important, complex of remnant pine barrens that supports rare moths and butterflies. The habitat primarily consists of a mix of open pitch pine-scrub, pine-hardwood, and other shrubland (map 1.2).

Purpose of, and Need for, Action

This draft Comprehensive Conservation Plan (CCP) and the accompanying Environmental Assessment (EA) combines two documents required by Federal law:

- A CCP, required by the National Wildlife Refuge System Administration Act of 1966, as amended by the National Wildlife Refuge System Improvement Act of 1997 (Pub. L. 105-57; 111 Stat. 1253) (Refuge Improvement Act)
- An EA, required by the National Environmental Policy Act (NEPA) of 1969 (42 U.S.C. § 4321 *et seq.*, 83 Stat. 852)

We propose to develop a CCP for the refuge that, in our professional judgment, best

- achieves the purposes, goals, and vision of the refuge;
- contributes to the National Wildlife Refuge System's (Refuge System) mission;
- adheres to Service's policies and other mandates;
- addresses key issues; and
- incorporates sound principles of fish and wildlife science.

NEPA regulations require us to evaluate a reasonable range of alternatives, including our preferred action and no action. The no action alternative can mean either

(1) not managing the refuge, or
(2) not changing its present management.

In this plan, alternative A is the latter and describes our current refuge programs.

Great Bay National Wildlife Refuge - Comprehensive Conservation Plan
Conservation Lands Surrounding Great Bay NWR
Madbury
Dover
Durham
Newington
Great Bay NWR
Newmarket
Great Bay
Greenland
Stratham
Portsmouth
Piscataqua River
VT
NH
ME
MA
CT
RI
Concord
Boston
Hartford
Providence
Approved Refuge Boundary
Refuge Right of Way
NH Conservation Lands
Term of Protection*
Limited
Perpetual
Unknown
New Hampshire Towns
Town Boundaries
Miles
Kilometers

Great Bay National Wildlife Refuge - Comprehensive Conservation Plan
Karner Blue Butterfly Easement
Concord, New Hampshire
VT
NH
ME
Concord
MA
Boston
Hartford
CT
Providence
RI
Regional Drive
Concord Municipal Airport
Trail
Gate
Kiosk
Gate
Chenell Drive

A CCP's *purpose* is to provide strategic management direction on a refuge for the next 15 years by

- providing a clear statement of desired future conditions for habitat, wildlife, visitor services, staffing, and facilities;
- providing state agencies, refuge neighbors, visitors, and partners with a clear explanation of the reasons for management actions;
- ensuring refuge management reflects the policies and goals of the Refuge System and legal mandates;
- ensuring the "compatibility" of current and future public use;
- providing long-term continuity and direction for refuge management; and
- providing direction for staffing, operations, maintenance, and annual budget requests.

There are many reasons the refuge presently needs a CCP. First, Great Bay Refuge lacks a master plan to fulfill its obligations especially as administrative, environmental, economic, and social conditions have changed since the refuge was first established in 1992. Prior to 2005, the refuge employed an onsite refuge manager and an administrative assistant. In 2006, the Service made a decision to destaff Great Bay Refuge after budget cuts led to a new regional strategic staffing plan. Great Bay Refuge and the Karner blue butterfly conservation easement are now administered by the refuge manager at Parker River National Wildlife Refuge in Newburyport, Massachusetts.

Second, in the last few decades, development has increased around the refuge. In response, land protection efforts have also increased. The refuge is an integral part of the network of conserved lands throughout the region. Great Bay Refuge has the potential to provide opportunities for environmental education and outreach that have not yet been fully realized. This CCP is a valuable tool to help us articulate our management priorities to the State of New Hampshire (State) natural resource agencies, refuge partners, other conservation organizations, local communities, and the public. Through this CCP, we hope that we will strengthen our existing partnerships, and forge new ones, to help achieve our refuge purposes and goals and support the Refuge System mission.

Third, the 1997 National Wildlife Refuge System Improvement Act (Refuge Improvement Act) requires that all national wildlife refuges have a CCP in place by 2012 to help fulfill the mission of the Refuge System.

Finally, the CCP is needed to address key issues identified through the planning process by the public, partners, other agencies, and refuge staff. A primary concern is those issues that are adversely affecting the populations and habitats of fish, wildlife, and plants within the refuge. These key issues are described in detail below in the section titled, "Issues, Concerns, and Opportunities."

Following the public review of this draft CCP/EA, the Service's Northeast Regional Director will decide on the components of a final CCP to guide refuge management decisions over the next 15 years. This CCP/EA evaluates and compares three alternatives for managing Great Bay Refuge and the Karner blue butterfly conservation easement, and their effects on key biological, physical, social, and cultural resources: Alternative A, "Current Management," Alternative B, "Habitat Diversity and Focal Species Emphasis," and

Alternative C, "Emphasis on Natural Processes."Alternative B represents the proposed action and the Service-preferred alternative. It was selected as the Service-preferred alternative because the CCP planning team believes it best achieves refuge purposes, vision, and goals; contributes to the Refuge System mission; addresses the issues and relevant mandates; and is consistent with sound principles of fish and wildlife management.

Chapter 1 explains the purpose of, and need for, preparing a CCP/EA, and sets the stage for the 4 subsequent chapters and 10 appendixes. Specifically, it

- defines our planning analysis area;
- presents the mission, policies, and mandates affecting the development of the plan;
- 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 our planning process and its compliance with NEPA regulations; and
- identifies public issues or concerns that surfaced as we developed the plan.

Chapter 2, "Affected Environment," describes the refuge's physical, biological, and human environments.

Chapter 3, "Alternatives, Including the Service-preferred Alternative," presents three management alternatives for Great Bay Refuge, and two management alternatives for the Karner blue butterfly conservation easement. Each alternative presents a set of objectives and array of strategies for meeting refuge goals and addressing public issues. It also describes the activities that we expect to occur regardless of the alternative selected for the final CCP.

Chapter 4, "Environmental Consequences," assesses the environmental consequences of implementing each of the management alternatives. It predicts the foreseeable benefits and consequences affecting the socioeconomic, physical, cultural, and biological environments described in chapter 2.

Chapter 5, "Consultation and Coordination," summarizes how we involved the public and our partners in the planning process, and credits the contributors to this plan. Public and partner involvement is vital for the future management of this refuge and all national wildlife refuges.

Ten appendixes, a glossary with a list of acronyms and species scientific names, and a bibliography provide additional documentation and references to support our narratives and analysis. The appendixes include:

- Appendix A: Species and Habitats of Concern Known, or Potentially Occurring, on Great Bay National Wildlife Refuge and Karner Blue Butterfly Easement
- Appendix B: Process for Establishing Focal Species and Priority Habitats
- Appendix C: Findings of Appropriateness and Compatibility Determinations

- Appendix D: Refuge Operations Needs System (RONS) and Service Asset Maintenance Management System (SAMMS)
- Appendix E: Wilderness Review
- Appendix F: Staffing Charts
- Appendix G: Fire Management Program Guidance
- Appendix H: Forest Health Assessment
- Appendix I: Contaminants Review of Peverly Stream System
- Appendix J: Refuge Headquarters/Visitor Contact Station Proposed Under Alternatives A and B

USFWS

Woodman Point looking west

Service Policies, Legal Mandates, and Other Policies Guiding the Planning Process

This section presents highlights of Service policy, legal mandates and regulations, and existing resource plans and conservation initiatives that directly influenced development of this draft CCP/EA.

U.S. Fish and Wildlife Service

The Service, part of the Department of the Interior (Department), administers the Refuge System. The mission of the Service 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 to the Service the conservation and protection of the following national natural resources: migratory birds, federally listed endangered or threatened species, migratory and interjurisdictional fish, wetlands, certain marine mammals, and national wildlife refuges. The Service also enforces Federal wildlife laws and international treaties on importing and exporting wildlife, assists states with their fish and wildlife programs, and helps other countries develop conservation programs.

The Service Manual, available online at: *http://www.fws.gov/policy/manuals* (accessed May 2011), contains the standing and continuing directives on fulfilling our responsibilities. The 600 series of the Service Manual addresses land use management, and sections 601-609 specifically address management of national wildlife refuges.

We publish special directives that affect the rights of citizens or the authorities of other agencies separately in the Code of Federal Regulations (CFR); the Service Manual does not duplicate them (see 50 CFR 1–99 online at: *http://www.gpoaccess.gov/cfr/index.html* (accessed May 2011).

The National Wildlife Refuge System

The Refuge System is the world's largest network of public lands and waters set aside specifically for conserving wildlife and protecting ecosystems. From its inception in 1903, the Refuge System has grown to over 150 million acres, encompassing more than 550 national wildlife refuges and other units of the Refuge System, plus 37 wetland management districts. More than 40 million visitors annually hunt, fish, observe and photograph wildlife, or participate in environmental education and interpretive activities on these refuges.

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 of 1997

The fundamental focus of the Refuge System is wildlife conservation. The goals of the Refuge System are to

- fulfill our statutory duty to achieve refuge purposes and further the Refuge System mission;
- conserve, restore where appropriate, and enhance all species of fish, wildlife, and plants that are endangered or threatened with becoming endangered;

- perpetuate migratory bird, interjurisdictional fish, and marine mammal populations;
- conserve a diversity of fish, wildlife, and plants;
- conserve and restore, where appropriate, representative ecosystems of the United States, including the ecological processes characteristic of those ecosystems; and
- foster understanding and instill appreciation of fish, wildlife, and plants, and their conservation, by providing the public with safe, high-quality, and compatible wildlife-dependent public uses including hunting, fishing, wildlife observation and photography, environmental education, and interpretation.

Refuge Planning and Management Guidance
This Service policy (602 FW 1, 2, 3) establishes the requirements and guidance for Refuge System planning, including CCPs and step-down management plans. It states that we will manage all refuges in accordance with an approved CCP 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 and the National Wild and Scenic Rivers System; and
- conform to other applicable laws, mandates, and policies.

Dave Menke/USFWS

Raccoon

Service planning policy provides step-by-step directions and identifies the minimum requirements for developing all CCPs. Among them, we are to review any existing special designation areas such as Wilderness Areas and Wild and Scenic Rivers designations, address the potential for any new special designations, conduct a wilderness review, and incorporate a summary of that review into each CCP (602 FW 3). Appendix D summarizes the results of our wilderness review. Based on our findings, Great Bay Refuge does not meet the minimum requirement for wilderness, and we are not recommending it for inclusion in the National Wilderness Preservation System. At this time, we do not see the potential for any other special designations on the refuge.

Policy on Maintaining Biological Integrity, Diversity, and Environmental Health
Service policy (601 FW 3) provides guidance on maintaining and restoring the biological integrity, diversity, and environmental health of the Refuge System, including the protection of a broad spectrum of fish, wildlife, and habitat resources in refuge ecosystems. The policy provides the following definitions:

- Biological diversity is the "variety of life and its processes, including the variety of living organisms, the genetic differences among them, and communities and ecosystems in which they occur."

- Biological integrity is the "biotic composition, structure, and functioning at genetic, organism, and community levels comparable with historic conditions, including the natural biological processes that shape genomes, organisms, and communities."

- Environmental health is 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."

The policy provides refuge managers with a process for evaluating the best management direction to prevent 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 biological integrity, diversity, and environmental health of a refuge and its ecosystem.

Habitat Management Planning
In collaboration with other refuges in the region, Great Bay Refuge staff prepared a draft Habitat Management Plan (HMP) in 2006 based on the guidelines set out in the Service's HMP policy (620 FW 1). The HMP describes the process that the refuge used to identify priority resources of concern and to set habitat management priorities to benefit those resources. The HMP includes a set of goals, objectives, and strategies for habitat management on the refuge and provides the biological foundation for this CCP. Appendix A lists the species of conservation concern at Great Bay Refuge identified during the HMP process. Appendix B details the process used to select these species of concern. A final HMP will be developed after the completion of the CCP.

Policy on the Appropriateness of Refuge Uses
Federal law and Service policy provide the direction and planning framework for protecting the Refuge System from inappropriate, incompatible, or harmful human activities and ensuring that all visitors can enjoy its lands and waters. This Service policy (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. 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 described in a refuge management plan approved after October 9, 1997, the date the Improvement Act became law.

(3) The use involves the take of fish or wildlife under state regulations.

(4) The use has been found to be appropriate after concluding a specified findings process using the 10 specific criteria included in the policy.

Appendix C includes the findings of appropriateness for Great Bay Refuge. You may view the appropriateness policy on the Web at: *http://www.fws.gov/policy/603fw1.html* (accessed May 2011).

Policy on Compatibility
This Service policy (603 FW 2) complements the appropriateness policy and provides guidance on how to prepare a compatibility determination. The refuge

manager first must find a use appropriate before undertaking a review of that use to determine if it compatible. According to this policy, 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." If the proposed use is found not appropriate, a compatibility determination is unnecessary and the use is not allowed. If the refuge manager finds a use appropriate, it is further evaluated through a compatibility determination. Other guidance in that chapter follows:

- The Refuge Improvement Act and its regulations require an affirmative finding by the refuge manager on the compatibility of a public use before we allow it on a national wildlife refuge.
- The act defines six wildlife-dependent uses that are to receive enhanced consideration on refuges: hunting, fishing, wildlife observation, photography, environmental education, and interpretation.
- The refuge manager may authorize these six priority uses on a refuge when they are compatible and consistent with public safety.
- When the refuge manager publishes a compatibility determination, it will specify the required maximum reevaluation dates: 15 years for wildlife-dependent recreational uses; or, 10 years for other uses.
- However, the refuge manager may reevaluate the compatibility of a use at any time: for example, sooner than its mandatory date, or even before we complete the CCP process, if new information reveals unacceptable impacts or incompatibility with refuge purposes (603 FW 2.11, 2.12).
- The refuge manager may allow or deny any use, even one that is compatible, based on other considerations such as public safety, policy, or available funding.

Appendix C includes the draft compatibility determinations for Great Bay Refuge.

Policy on Wildlife-dependent Public Uses
This Service policy (605 FW 1) presents specific guidance about wildlife-dependent recreation programs within the Refuge System. We develop our wildlife-dependent recreation programs in consultation with state fish and wildlife agencies and stakeholder input based on the following criteria:

- Promotes safety of participants, other visitors, and facilities
- Promotes compliance with applicable laws and regulations and responsible behavior
- Minimizes or eliminates conflict with fish and wildlife population or habitat goals or objectives in an approved plan
- Minimizes or eliminates conflicts with other compatible wildlife-dependent recreation
- Minimizes conflicts with neighboring landowners
- Promotes accessibility and availability to a broad spectrum of the American people
- Promotes resource stewardship and conservation

- Promotes public understanding and increases public appreciation of America's natural resources and our role in managing and conserving these resources
- Provides reliable/reasonable opportunities to experience wildlife
- Uses facilities that are accessible to people and blend into the natural setting
- Uses visitor satisfaction to help to define and evaluate programs

Other Mandates

While Service and Refuge System policies and each refuge's purpose(s) provide the foundation for management, national wildlife refuges are administered consistent with a variety of other Federal laws, executive orders, treaties, interstate compacts, and regulations on the conservation and protection of natural and cultural resources. The "Digest of Federal Resource Laws of Interest to the U.S. Fish and Wildlife Service" lists them and can be accessed at: *http://www.fws.gov/laws/Lawsdigest.html* (accessed August 2011).

Chapter 4, "Environmental Consequences," specifically evaluates compliance with the Clean Water Act, Clean Air Act, and the Endangered Species Act (ESA). This draft CCP/EA is written to comply with NEPA.

Historic Resources

Federal laws require the Service to identify and preserve its important historic structures, archaeological sites, and artifacts. NEPA mandates our consideration of cultural resources in planning Federal actions. The Refuge Improvement Act requires that the CCP identify the refuge's archaeological and cultural values. The following four Federal laws also cover historic and archaeological resources on national wildlife refuges:

- The Archaeological Resources Protection Act (ARPA) (16 U.S.C. § 470aa–470ll; Pub.L. 96–95), approved October 31, 1979 (93 Stat.721). ARPA establishes detailed requirements for issuance of permits for any excavation for, 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 resources removed from Federal or Native American land in violation of any provision of Federal law; and for interstate and foreign commerce in such resources acquired, transported, or received in violation of any state or local law.

- The Archaeological and Historic Preservation Act (AHPA) (16 U.S.C. § 469–469c; Pub.L. 86–523), approved June 27, 1960 (74 Stat. 220), as amended by Pub.L. 93–291 approved May 24, 1974 (88 Stat. 174). APHA carries out the policy established by the Historic Sites Act (see below). It 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.

- The Historic Sites, Buildings, and Antiquities Act (16 U.S.C. § 461–462, 464–467; 49 Stat. 666) of August 21, 1935, popularly known as the Historic Sites Act, as amended by Pub.L. 89–249, approved October 9, 1965 (79 Stat. 971). This Historic Sites Act declares it a national policy to preserve historic sites and objects of national significance, including those located on refuges. It provides procedures for designating, acquiring, administering, and protecting these sites and objects. Among other things, National Historic and Natural Landmarks are designated under the authority of this act.

- The National Historic Preservation Act of 1966 (NHPA) (16 U.S.C. § 470–470b, 470c–470n), Pub.L. 89–665, approved October 15, 1966 (80 Stat. 915), and repeatedly amended. The NHPA provides for the preservation of significant historical features (buildings, objects, and sites) through a grant-in-aid program to the states. It establishes the National Register of Historic Places (National Register) 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 Pub.L. 94–422, approved September 28, 1976 (90 Stat. 1319). The act created the Historic Preservation Fund. It 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. The Margeson-Hawkridge-Loomis Estate (Margeson Estate) on Great Bay Refuge is on the National Register.

The Service also owns and cares for museum properties. The most common are archaeological, zoological, and botanical collections, and historical photographs, objects, and art. Each refuge maintains an inventory of its museum property. Our regional museum property coordinator in Hadley, Massachusetts, guides the 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.

National and Regional Plans and Conservation Initiatives

To the extent possible, a CCP assists in meeting the conservation goals established in existing national and regional conservation plans, state fish and wildlife conservation plans, and other landscape-scale plans covering the same watershed or ecosystem in which the refuge resides. The following plans were consulted in the development of this draft CCP.

Birds of Conservation Concern 2008 Report

The 1988 amendment to the Fish and Wildlife Conservation Act mandates the Service to "identify species, subspecies, and populations of all migratory nongame birds that, without additional conservation actions, are likely to become candidates for listing under ESA. *Birds of Conservation Concern 2008* (BCC) is the most recent effort to carry out this mandate (USFWS 2008). The overall goal of this report is to accurately identify the migratory and nonmigratory bird species, beyond those already federally listed as threatened or endangered, that represent our highest conservation priorities.

BCC 2008 encompasses three distinct geographic scales—North American Bird Conservation Initiative (NABCI) Bird Conservation Regions (BCRs), Service Regions, and National—and is primarily derived from three major bird conservation plans: the Partners in Flight (PIF) North American Landbird Conservation Plan, the U.S. Shorebird Conservation Plan, and the North American Waterbird Conservation Plan. All three bird conservation plans identify species of concern based on several factors, including population trends, threats, distribution, abundance, and relative density.

The goal of the BCC 2008 report is to encourage Federal, state, and private agencies to coordinate, develop, and implement integrated approaches for conserving and managing the birds deemed most in need of conservation. The report is available online at: *http://www.fws.gov/migratorybirds/NewReportsPublications/SpecialTopics/BCC2008/BCC2008.pdf* (accessed May 2011). These birds of conservation concern are incorporated into Appendix A, "Species and Habitats of Conservation Concern on Great Bay Refuge."

North American Bird Conservation Initiative

The North American Bird Conservation Initiative (NABCI) brings together the individual landbird, shorebird, waterbird, and waterfowl plans described below into a coordinated effort to protect and restore all native bird populations and their habitats in North America. It uses BCRs to guide landscape-scale, science-based approaches to conserving birds and their habitats. Visit: *http://www.nabci-us.org/* (accessed May 2011) for more information on NABCI.

Les Brooks

Baltimore oriole

Great Bay Refuge is located in the New England/Mid-Atlantic Coast BCR (BCR 30). BCR 30 has the densest human population of any region in the country (*http://www.nabci-us.org/bcr30.htm* [accessed May 2011]) (map 1.3). A draft BCR 30 plan was developed in September 2002 and a meeting in December 2004 at Cape May, New Jersey produced a list of priority bird species and draft actions. An updated BCR 30 draft plan was developed in 2006 (Steincamp 2006, draft). We used these documents, as well as information in the four additional bird conservation plans described below, to identify focal species and habitat management goals and objectives for the refuge.

Partners in Flight Landbird Conservation Plans

In 1990, PIF was conceived as a voluntary, international coalition of government agencies, conservation organizations, academic institutions, private industry, and other citizens dedicated to reversing the population declines of bird species and "keeping common birds common." The foundation of PIF's long-term strategy for landbird conservation is a series of scientifically and geographically based bird conservation plans.

Initially, PIF developed draft conservation plans within "physiographic areas." PIF developed a set of science-based rules to evaluate the conservation status of all bird species using a species' population size, distribution, population trend, threats, and regional abundance to objectively identify regional and continental conservation priorities. These rules were adapted and are now being used at the BCR level to identify bird conservation priorities and opportunities. Great Bay Refuge lies within PIF Area 09–Southern New England (Dettmers and Rosenberg 2000). The Karner blue butterfly conservation easement is within PIF Area 27–Northern New England (Hodgman and Rosenberg 2000) (map 1.3).

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

The U.S. Shorebird Conservation Plan (Brown et al. 2001) is a partnership across the United States to ensure that stable and self-sustaining populations of all shorebird species are restored and protected. Collaborators include local, state, and Federal agencies, nongovernmental organizations, businesses, researchers, educators, and policymakers. The plan was closely coordinated with North American Waterfowl Management Plan and Joint Venture staff, as well as the PIF and North American Waterbird Plan teams, as they concurrently developed their revised national plans. These experts helped set conservation goals for each region of the country, identify critical habitat and research needs, and propose education and outreach programs to increase awareness of shorebirds and the threats they face.

The U.S. Shorebird Plan identified three primary objectives:

- Develop a standardized, scientifically sound system for monitoring and studying shorebird populations that will provide practical information to researchers and land managers for shorebird habitat conservation.
- Identify the principles and practices upon which local, regional, and national management plans can effectively integrate shorebird habitat conservation with multiple species strategies.

Great Bay National Wildlife Refuge - Comprehensive Conservation Plan

Service and Partner Conservation Regions

Partners in Flight Physiographic Areas

Bird Conservation Regions

The Nature Conservency Ecoregions

USFWS Landscape Conservation Cooperatives

- Design an integrated strategy for increasing public awareness and information concerning wetlands and shorebirds.

Regional plans, including the North Atlantic Regional Shorebird Plan, were developed as part of the overall strategy (Clark and Niles 2000). We used both the U.S. and North Atlantic Regional Shorebird Plans to develop the species of concern list (appendix A) and in considering the value of the refuge to migrating shorebirds.

The national plan can be accessed at: *http://www.fws.gov/shorebirdplan/USShorebird.htm* (accessed May 2011) and the regional plan at: *http://www.fws.gov/shorebirdplan/regionalshorebird/regionalplans.htm* (accessed May 2011).

North American Waterbird Conservation Plan
This conservation plan for waterbirds is an independent partnership among individuals and institutions with interest and responsibility for conserving waterbirds and their habitats. The primary goal of the plan is to ensure that the distribution, diversity, and abundance of populations and habitats of breeding, migratory, and nonbreeding waterbirds are sustained or restored throughout the lands and waters of North America, Central America, and the Caribbean. The plan provides a framework for conserving and managing colonially nesting water-dependent birds and promotes continentwide planning and monitoring, national-state-provincial conservation action, regional coordination, and local habitat protection and management (Kushlan et al. 2002). You can access the plan online at: *http://www.pwrc.usgs.gov/nacwcp/nawcp.html* (accessed May 2011).

A partnership of organizations and individuals working to facilitate waterbird conservation in the Mid-Atlantic, New England, and Maritimes (MANEM) region of the U.S. and Canada has developed a regional waterbird conservation plan. Over 200 partners, comprising the MANEM Waterbird Working Group, have compiled and interpreted technical information on the region's waterbird populations and habitats, assessed conservation status of these natural resources, developed strategies to ensure the persistence of sustainable waterbird populations in the region, and identified near-term priorities. MANEM partners include wildlife managers, scientists, policymakers, educators, and funders.

The MANEM region consists of BCR 30 (New England/Mid-Atlantic Coast), BCR 14 (Atlantic Northern Forest), and Pelagic Bird Conservation Regions 78 (Northeast U.S. Continental Shelf) and 79 (Scotian Shelf). The MANEM Waterbird Conservation Plan is being implemented within the context and framework of the North American Waterbird Conservation Plan *(http://www.waterbirdconservation.org* [accessed May 2011]).

Seventy-four waterbird species use habitats in MANEM for breeding, migrating, and wintering. Avian families include loons, grebes, shearwaters, storm-petrels, boobies, pelicans, cormorants, herons, ibises, rails, gulls, terns, skuas, jaegers, and alcids. Partners in 4 subregions of MANEM selected 43 focal species for immediate conservation action. In addition, 55 of MANEM's waterbirds are identified in state wildlife action plans as Species of Greatest Conservation Need. You can access information on MANEM Regional planning at: *http://www.fws.gov/birds/waterbirds/MANEM/* (accessed May 2011).

We used these waterbird plans to help develop objectives and strategies for goals 1 and 2, and to create Appendix A, "Species and Habitats of Concern at Great Bay Refuge."

North American Waterfowl Management Plan: Atlantic Coast Joint Venture
The North American Waterfowl Management Plan (NAWMP), signed by the U.S. and Canada in 1986 and by Mexico in 1994, provides a strategy to protect North America's remaining wetlands and to conserve waterfowl populations through habitat protection, restoration, and enhancement (USFWS and CWS 1986). The plan was updated in both 1998 and 2004 with an emphasis on strengthening its biological foundation, using a landscape planning approach, and expanding partnerships (USFWS and CWS 2004). Implementation of this plan is accomplished at the regional level within 16 joint venture areas in the U.S. and Canada. Partnerships involve Federal, state, and local governments; Tribal nations; local businesses; conservation organizations; and individual citizens for the purpose of protecting habitat. By 2004, NAWMP partners had invested more than $3.2 billion to protect, restore, or enhance more than 13.1 million acres of habitat. More information on the NAWMP is available at: *http://www.fws.gov/birdhabitat/nawmp/nawmphp.htm* (accessed May 2011).

Great Bay Refuge lies within the Atlantic Coast Joint Venture (ACJV), one of the original joint ventures formed under the NAWMP. The ACJV was initially focused on protecting and restoring habitat for the American black duck and other waterfowl species in the Atlantic Coast region of the U.S. While maintaining this strong focus on waterfowl, the ACJV mission has evolved to include the conservation of habitats for all birds. The ACJV is working on integrated planning efforts in eight BCRs. Focus areas, which are specific, important geographic areas with joint venture regions, were identified and mapped for waterfowl and are being developed for other migratory birds within each BCR. These focus areas are discrete and distinguishable habitats or habitat complexes that are regionally important for one or more priority waterfowl species during one or more life history stages.

The Great Bay Estuary is a major wintering area for American black duck, and supports over 80 percent of all waterfowl populations wintering in New Hampshire. The area has been recognized as a waterfowl focus area in the ACJV Waterfowl Implementation Plan. Visit: *http://www.acjv.org* (accessed May 2011) for more information on the ACJV.

The State of New Hampshire's Birds: 2009

This report provides an overview of the conservation status of New Hampshire's bird species, including their population trends, the major threats they face, and proposed strategies for their conservation (Hunt 2009). Overall, the report finds that nearly 47 percent of the 186 birds species in New Hampshire are declining, particularly grassland, shrubland, and ground-nesting forest species. For an additional 38 percent of species, too little information exists to determine trends. The major threats to the conservation of New Hampshire's birds identified in the report include forest fragmentation; conversion of natural habitats to urban, commercial, and residential development; loss of late successional forest; climate change; and impacts to breeding, migration, and wintering habitats outside of the region. To counteract declining trends and reduce these threats, the report suggests six major strategies:

- Improve and enhance monitoring of species of concern.
- Maintain intact forests.
- Prioritize conservation of early successional habitats.
- Protect sensitive habitats by minimizing human disturbances.
- Work at a regional scale.

We used this report to help create Appendix A, "Species and Habitats of Conservation Concern at Great Bay Refuge."

Karner Blue Butterfly Recovery Plan

The Karner blue butterfly formerly occurred in a band extending across 12 states from Minnesota to Maine, as well as Ontario, Canada. Currently, the species only occurs in seven states: Minnesota, Wisconsin, Indiana, Michigan, New York, New Hampshire, and Ohio. Currently, Wisconsin and Michigan support the greatest number of Karner blue butterflies and habitat sites. The majority of the populations in the remaining states are small and several are at risk of extripation from habitat degradation or loss. Based on the decline of the Karner blue butterfly across its historic range, it was listed as federally endangered in 1992. Since listing, two populations have been extirpated and are being reintroduced to Concord, New Hampshire, and West Gary, Indiana. A third population is being reintroduced to Ohio (USFWS 2003).

The final recovery plan for the species was prepared in September 2003 (USFWS 2003). The objective of the recovery plan is to restore viable metapopulations of Karner blue butterflies across the species extant range so that it can be reclassified from federally endangered to threatened. The long-range goal is to remove it from the Federal list of endangered and threatened wildlife and plants. An update to the recovery plan was added in February 2011 to include a new potential recovery unit, the Michigan Oak Openings Unit. Both the 2003 plan and its update can be accessed at: *http://www.fws.gov/midwest/endangered/insects/kbb/index.html* (accessed May 2011).

Phil Delphey/USFWS

Karner blue butterfly

Additional Background on the Karner Blue Butterfly

The Karner blue butterfly is dependent on wild lupine—its only known larval food plant—and on nectar plants. These plants historically occurred in savanna and barrens habitats typified by dry sandy soils, and now occur in remnants of these habitats. The primary factor limiting Karner blue butterfly recovery is loss of habitat due to development and increased forest canopy closure due to natural succession.

By 2003, no native Karner blue butterfly populations remained in New England. The last native New England population occurred in the Concord pine barrens in Concord, New Hampshire, and was extirpated in 2000. This last population, which existed in a power line right-of-way and along the grassy safeways of the Concord Airport Industrial Park, had declined from 3,700 estimated butterflies in 1983, to 219 butterflies in 1991, and to less than 50 in 1994. This decline made this site's population at extreme risk for extinction (Peteroy 1998). A reintroduction program was started in 2001 in Concord with a donor population from the Saratoga Airport in New York. For 5 years in a row (2005 to 2009) biologists have observed and documented Karner blue butterflies surviving on their own in the wild at the Concord pine barrens. The Karner blue butterfly conservation easement, administered by Great Bay Refuge, is central to this success (see discussion in this chapter under the section "Refuge Purposes and Land Acquisition History). New Hampshire Fish and Game (NHFG) coordinates habitat management, lupine propagation and planting, and captive rearing and introduction of the Karner blue butterfly on the easement.

New England Cottontail Spotlight Action Plan

Great Bay Refuge is within the historic range of New England's only native rabbit species, the New England cottontail. The New England cottontail is listed as endangered in the State of New Hampshire and is also currently a candidate species for listing on the Federal list of threatened and endangered species due to population decline. Candidate species are plant and animal species for which the Service has sufficient information on biological vulnerability and threats to support a proposal to list as endangered or threatened, but that have yet to be listed due to higher priorities. Since candidate species are not yet listed, there is still the opportunity that proactive conservation actions can prevent the need for listing.

The New England Cottontail Spotlight Action Plan identifies the threats to New England cottontails, goals and actions to reduce and mitigate these threats, and measures to monitor the success of the plan (USFWS 2009). The plan identifies habitat fragmentation and habitat loss as the major threats to New England cottontail recovery. The species is dependent upon early successional habitats, such as old fields, shrub thickets, young regenerating forests, and other shrubby areas. These types of early successional habitats are currently declining throughout New England as they naturally succeed to forest. Human development has also eliminated and fragmented habitat for the New England cottontail. Although there are currently no known occurrences of New England cottontails on the refuge, there are opportunities on the refuge to create and maintain the early successional habitats that benefit the species, as well as other shrub-dependent wildlife (Arbuthnot 2008).

The Spotlight Action Plan is available online at: *http://www.fws.gov/northeast/endangered/pdf/NE%20Cottontail%20SSAP.pdf* (accessed May 2011).

U.S. Fish & Wildlife Service Fisheries Program, Northeast Region Strategic Plan 2009–2013

The Service's Fisheries Program is committed to working with partners to

- protect the health of aquatic habitats;
- restore fish and other aquatic resources; and
- provide opportunities to enjoy the many benefits of healthy aquatic resources.

In the Service's Northeast Region, fishery management offices and national fish hatcheries work with states and other partners to restore and protect a variety of fish and other aquatic species. The Serivce's Fisheries Programs' primary focus is on maintaining healthy, self-sustaining populations of coastal, anadromous, and interjurisdictional fish, as well as other threatened and endangered aquatic animal species.

In 2002, the Fisheries Program completed a strategic vision document: "Conserving America's Fisheries, U.S. Fish and Wildlife Service Fisheries Program Vision for the Future" (vision). This vision document includes goals, objectives, and action items on a national scale. The Regional Fisheries Program Strategic Plan is an extension of the national vision document and describes more specifically the tactics to be implemented by the Northeast Region to fulfill the goals and objectives identified in the vision. The current strategic plan covers 2009 to 2013 and can be viewed at: *http://www.fws.gov/northeast/fisheries/* (accessed May 2011) (USFWS 2009a).

In addition to the strategic plan, the Fisheries Program also identified and ranked the level of conservation concern of fish and other aquatic species by hydrologic unit. We used this ranking and have consulted with the Fisheries Program staff in developing aquatic objectives and strategies under goal 2, and in creating Appendix A, "Species and Habitats of Conservation Concern on Great Bay Refuge."

North American Bald Eagle Management Guidelines

In July 2007, the Service issued a final ruling to officially remove the bald eagle from the Federal list of endangered and threatened species due to its successful recovery throughout its range in the lower 48 States. The bald eagle continues to be protected by the Bald and Golden Eagle Protection Act (Eagle Act) and the Migratory Bird Treaty Act (MBTA). The Service developed the National Bald Eagle Management Guidelines to advise landowners, land managers, and others who share public and private lands with bald eagles, when and under what circumstances the protective provisions of the Eagle Act may apply to their activities (USFWS 2007).

These guidelines are intended to help people minimize such impacts to bald eagles, particularly where they may constitute "disturbance," which is prohibited by the Eagle Act. The guidelines are intended to

(1) publicize the provisions of the Eagle Act that continue to protect bald eagles, in order to reduce the possibility that people will violate the law;

(2) advise landowners, land managers, and the general public of the potential for various human activities to disturb bald eagles; and

(3) encourage additional nonbinding land management practices that benefit bald eagles.

The document is intended primarily as a tool for landowners and planners who seek information and recommendations regarding how to avoid disturbing bald eagles. You can view these management guidelines at: *http://www.fws.gov/pacific/eagle/NationalBaldEagleManagementGuidelines.pdf* (accessed May 2011). We referred to these guidelines as we developed management objectives and strategies for bald eagles.

The Land Conservation Plan for New Hampshire's Coastal Watersheds

In 2006, The Nature Conservancy (TNC), Society for the Protection of New Hampshire Forests (SPNHF), and the Rockingham and Strafford Regional Planning Commissions published *The Land Conservation Plan for New Hampshire's Coastal Watersheds* (Coastal Plan) (Zankel et al. 2006). New Hampshire's coastal watersheds span 990 square miles (approximately 633,000 acres) and 46 towns. The plan identified 75 conservation focus areas that comprise over 190,000 acres of the coastal watersheds that are of exceptional significance for living resources and water quality.

Each conservation focus area is comprised of a core area that contains the primary natural features and habitat for which the focus area was identified. Some focus areas also include a "supporting natural landscape," which is comprised of natural lands that helps safeguard the core area while also providing habitat for many common species.

A portion of Great Bay Refuge is located within the Fabyan Point Conservation Focus Area. This area was included as a focus area in the coastal plan for the following ecological features:

- Estuarine shoreline along Great Bay
- Presence of tidal rivers, including Peverly Brook
- Extensive salt marsh
- Presence of rare plants and animals: large bur-reed, salt marsh sparrow, osprey, and purple martin
- Significant wildlife habitats: grassland, marsh
- Exemplary natural community: mesic Appalachian oak-hickory forest
- Presence of prime farmland soils

New Hampshire Wildlife Action Plan

In 2002, Congress created the State Wildlife Grant Program (SWG), and appropriated $80 million in state grants. The purpose of the program is to help state and Tribal fish and wildlife agencies conserve fish and wildlife species

of greatest conservation need. The funds appropriated under the program are allocated to each state according to a formula that takes into account its size and population.

To be eligible for additional Federal grants, and to satisfy the requirements for participating in the SWG program, each state was charged with developing a statewide "Comprehensive Wildlife Conservation Strategy" and submitting it to the National Advisory Acceptance Team by October 1, 2005. Each plan must address eight required elements and identify and focus on "species of greatest conservation need." Each plan must also address the "full array" of wildlife and wildlife-related issues, and how to "keep common species common."

In response to that charge, NHFG, with support from partners, developed the "New Hampshire Wildlife Action Plan" (NHWAP) (NHFG 2005). The NHFG is the chief agency responsible for the implementation and revision of the NHWAP. The plan creates a vision for conserving New Hampshire's wildlife and encourages other states, Federal agencies, and conservation partners to think strategically about their individual and coordinated roles in prioritizing conservation.

The NHWAP helps supplement the information we gathered on species and habitat occurrences and their distribution in our area analysis, and helps us identify conservation threats and management strategies for species and habitats of conservation concern in the CCP. The development of this plan involved invaluable input from experts, partners, and the public. We used the NHWAP in developing our list of species of concern in appendix A, and the management objectives and strategies for goals 1through 3.

You may view the NHWAP at: *http://www.wildlife.state.nh.us/Wildlife/wildlife_plan.htm* (accessed May 2011).

Piscataqua Region Estuaries Partnership's Comprehensive Conservation and Management Plan

The Piscataqua Region Estuaries Partnership (PREP), formerly known as the "New Hampshire Estuaries Project," is part of the U.S. Environmental Protection Agency's (EPA) National Estuaries Program. This program is a joint local/State/Federal program established under the Clean Water Act. Its goal is to protect and enhance nationally significant estuarine resources. PREP receives its funding from the EPA and is administered by the University of New Hampshire (UNH).

PREP strives to

- improve the water quality and overall health of New Hampshire's estuaries;
- support regional development patterns that protect water quality, maintain open spaces and important habitat, and preserve estuarine resources;
- track environmental trends through the implementation of a long-term monitoring program to assess indicators of estuarine health; and,
- develop broad-based popular support for the implementation of the management plan by encouraging involvement of the public, local government, and other interested parties in its implementation.

PREP's priorities were established by local stakeholders and include water quality improvements, shellfish resources, land protection, and habitat restoration. Projects addressing these priorities are undertaken throughout New Hampshire and southern Maine's coastal watersheds.

PREP's Comprehensive Conservation and Management Plan (CCMP) for the region's estuaries was completed in 2000 and updated in 2010 (PREP 2010). The management plan outlines key issues related to the management of New Hampshire's estuaries and proposes strategies to preserve, protect, and enhance the State's estuarine resources.

Great Bay National Estuarine Research Reserve

The National Estuarine Research Reserve System (Reserve System) is a network of 28 areas protected for long-term research, water quality monitoring, education, and coastal stewardship. Established by the Coastal Zone Management Act of 1972, as amended, the Reserve System is a partnership program between the National Oceanic and Atmospheric Administration (NOAA) and the coastal states. NOAA provides funding, national guidance, and technical assistance. Each reserve is managed by a lead state agency or university, with input from local partners.

The Great Bay National Estuarine Research Reserve (GBNERR) was designated in 1989 and now encompasses 10,235 acres. Great Bay Refuge lies within the reserve's boundaries and benefits from the research, education, and outreach conducted by reserve staff. The NHFG is the lead agency. In 1993, the Great Bay Discovery Center (formerly known as Sandy Point) was constructed on the shores of Great Bay Estuary in Greenland, New Hampshire. It serves as the conservation-education headquarters for the GBNERR. The reserve's primary purpose is to promote the wise use and management of the Great Bay Estuary (*http://www.greatbay.org/index.htm* [accessed May 2011]).

New Hampshire Coastal Program

The New Hampshire Department of Environmental Services (NHDES) administers the State's Coastal Program. The New Hampshire Coastal Program (NHCP) creates and sustains partnerships with local, State, and Federal agencies, as well as businesses and nonprofit groups to complete planning, restoration, and education projects. The mission of the NHCP is to "balance the preservation of natural resources of the coast with the social and economic needs of this and succeeding generations."

To accomplish its mission, the program focuses on

- preventing and reducing coastal pollution;
- providing public access to coastal lands and waters;
- fostering community stewardship and awareness of coastal resources;
- protecting and restoring coastal natural resources; and
- encouraging a viable economy with adequate infrastructure.

In 1982, New Hampshire received Federal approval from NOAA for the Ocean and Harbor Segment of its Coastal Program, which incorporated areas in proximity to the Atlantic Ocean and the lower Piscataqua River. In 1988, the NHCP received approval from NOAA to expand its boundaries to cover all near shore areas under tidal influence, including the lands that border Great Bay and Little Bay Estuaries and several tidal rivers. The NHCP received approval from NOAA again in 2004 to expand its inland boundary to encompass the jurisdictional boundary of the 17 municipalities along New Hampshire's tidal waters.

The NHCP is responsible for administering the Federal consistency provision of the Coastal Zone Management Act in New Hampshire. As such, the NHCP will review the proposals in this CCP to ensure consistency with its enforceable policies and all State coastal management requirements.

For more information on the NHCP, please visit: *http://des.nh.gov/organization/divisions/water/wmb/coastal/index.htm* (accessed September 2011).

Partners in Amphibian and Reptile Conservation

Partners in Amphibian and Reptile Conservation (PARC) was created in response to the increasing, well-documented national declines in amphibian and reptile populations. PARC members come from state and Federal agencies, conservation organizations, museums, the pet trade industry, nature centers, zoos, power companies, universities, reptile and amphibian organizations, research laboratories, forest industries, and environmental consultants. Its five geographic regions—Northeast, Southeast, Midwest, Southwest and Northwest—focus on regional and national reptile and amphibian conservation challenges.

The National State Agency Herpetological Conservation Report, a summary report sponsored by PARC, provides a general overview of each state wildlife agency's support for reptile and amphibian conservation and research through September 2004. Each state report was compiled in cooperation with its agency's lead biologist on reptile and amphibian conservation. The purpose is to facilitate communication among state agencies and partner organizations throughout the PARC network to identify and address regional and national priorities. The State of New Hampshire completed report is included in the report online at: *http://www.parcplace.org/documents/PARCNationalStates2004.pdf* (accessed May 2011). We used the New Hampshire plan in developing objectives and strategies for goals 1 and 2 and in developing Appendix A, "Species and Habitats of Conservation Concern on Great Bay Refuge."

The Service's Climate Change Strategy, "Rising to the Urgent Challenge" (USFWS 2010)

Accelerating climate change will affect our nation's fish, wildlife, and plant resources in profound ways. While many species will continue to thrive, some populations may decline and in some instances, go extinct. Others will survive in the wild only through direct and continuous intervention by managers. The challenge of climate change requires the Service, its employees, and partners to work with determination, creativity, and commitment to conserve the nation's natural resources.

In response to Secretarial Orders #3226, "Evaluating Climate Change Impacts in Management Planning" (January 19, 2001) and #3289, "Addressing the Impacts of Climate Change on America's Water, Land, and Other Natural and Cultural Resources" (February 22, 2010), the Service developed the strategic plan, "Rising to the Urgent Challenge: Strategic Plan for Responding to Accelerating Climate Change," to address climate change. The plan establishes a basic framework for the Service's work as part of the conservation community to help ensure the sustainability of fish, wildlife, plants, and habitats in the face of accelerating climate change. It also details specific steps the Service will take during the next 5 years to implement the strategic plan (USFWS 2010). The plan can be accessed online at: *http://www.fws.gov/home/climatechange/strategy.html* (accessed December 2011).

Upland sandpiper

Shawn McCready_Flickr_Creative Commons

The strategic plan's six guiding principles are:

- We will continually evaluate our priorities and approaches, make difficult choices, take calculated risks, and adapt to climate change.
- We will commit to a new spirit of coordination, collaboration, and interdependence with others.
- We will reflect scientific excellence, professionalism, and integrity in all our work.
- We will emphasize the conservation of habitats within sustainable landscapes, applying our Strategic Habitat Conservation framework.

- We will assemble and use state-of-the-art technical capacity to meet the climate change challenge.
- We will be a leader in national and international efforts to address climate change.

The plan also lists three key strategies to address climate change: adaptation, mitigation, and engagement.

The Intergovernmental Panel on Climate Change (IPCC) defines **adaptation** 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." In the strategic plan, adaptation refers to planned management actions the Service will take to reduce the impacts of climate change on fish, wildlife, and their habitats. Adaptation forms the core of the Service's response to climate change and is the centerpiece of our strategic plan. This adaptive response to climate change will involve strategic conservation of terrestrial, freshwater, and marine habitats within sustainable landscapes.

The IPCC defines **mitigation** as "human intervention to reduce the sources or enhance the sinks of greenhouse gases." Mitigation involves reducing our "carbon footprint" by using less energy, consuming fewer materials, and appropriately changing our land management practices. Mitigation is also achieved through biological carbon sequestration, which is a process in which carbon dioxide (CO_2) from the atmosphere is taken up by plants through photosynthesis and stored as carbon in biomass (e.g., tree trunks and roots). Sequestering carbon in vegetation, such as native hardwood forests or grassland, can often restore or improve habitat and directly benefit fish and wildlife.

Engagement involves reaching out to Service employees; local, national, and international partners in the public and private sectors; key stakeholders; and the general public to find solutions to the challenges to fish and wildlife conservation posed by climate change.

The Association of Fish & Wildlife Agencies has developed guidance for states as they update and implement their respective wildlife action plans (AFWA 2009). This publication, "Voluntary Guidance for States to Incorporate Climate Change into State Wildlife Action Plans and Other Management Plans," also includes strategies that will help conserve fish and wildlife species and their habitats and ecosystems as climate conditions change. The broad spatial and temporal scales associated with climate change suggest that management efforts that are coordinated on at least the regional scale will likely lead to greater success. The Service will work with our state partners, among others, on meeting the climate change challenge.

The Service's Climate Change Web site at: *http://www.fws.gov/home/climatechange/strategy.html* (accessed December 2011), provides detailed information on the priority actions the Service is taking through 2011 to begin to implement the strategic plan.

North Atlantic Landscape Conservation Cooperative

Landscape Conservation Cooperatives (LCCs) are a network of conservation science and management partnerships across the U.S. and its international borders. LCCs were created in response to the unprecedented level of large-scale pressures on natural systems (e.g., land use pressures, habitat loss and fragmentation, invasive species, and climate change) and the need for agencies and organizations to work together to find long-term solutions to these threats. Each LCC is comprised of Federal and state agencies, Tribes, universities, and

public and private organizations, collectively working to sustain America's lands, waters, wildlife, and cultural resources. By functioning as an interdependent network, LCCs are able to accomplish more together than any single agency or organization alone. LCC partners use their combined resources to collaboratively

- identify common science needs, conservation goals, and priorities;
- develop science-based tools and solutions to meet shared conservation goals;
- support biological planning, conservation design, and adaptive management; and
- evaluate the effectiveness of scientific information and conservation actions (*http://www.fws.gov/science/shc/pdf/LCC_Fact_Sheet.pdf* [accessed August 2011]).

Great Bay Refuge lies in the the North Atlantic LCC, which covers portions of 12 Northeastern States and the District of Columbia (map 1.3). The North Atlantic LCC's 2009 Development and Operations Plan identified priority actions for the LCC and included a preliminary list of conservation priority species and habitats, many of which are on the refuge. The LCC partner group continues to update and refine its priorities, and is working on a representative species list to help focus inventories and monitoring. Refuge staff will stay attentive to new developments arising from the LCC partnership and adapt management accordingly. For more information on the North Atlantic LCC and its current conservation priorities, visit: *http://www.fws.gov/northeast/science/nalcc.html* (accessed August 2011).

Refuge Purposes and Land Acquisition History

Refuge Purposes

The purposes for Great Bay Refuge are derived from public law (Public Law 102-154, Section 319(d) Department of the Interior and Related Agencies Appropriations Bill, 1992). This act by Congress describes the terms of the land transfer of the Pease Air Force Base in New Hampshire, to the Department of the Interior as a national wildlife refuge. The act also states that the Secretary of the Air Force retains responsibility for any hazardous substance which may be found on the property. The following purposes were established for this refuge:

- To encourage the natural diversity of plant, fish, and wildlife species within the refuge, and to provide for their conservation and management
- To protect species federally listed as endangered or threatened or identified as candidates pursuant to the Endangered Species Act of 1973
- To preserve and enhance the water quality of aquatic habitat within the refuge
- To fulfill the international treaty obligations of the U.S relating to fish and wildlife

Acquisition History

Currently, Great Bay Refuge encompasses 1,103 acres (map 1.1), with Federal jurisdiction to the mean high waterline. In 1992, the Department of Defense transferred the original 1,054 acres of the refuge to the Service. The transfer occurred because the Pease Air Force Base was one of 89 U.S. military installations closed by the Base Closure and Realignment Act (Public Law 100-526). Although the refuge was dedicated in October of 1992, it was not officially opened to public access until 1996.

In 2003, the refuge acquired an additional 33 acres on Fabyan Point in fee title from a willing seller. Fabyan Point is a spit of land on Great Bay located south of the main portion of the refuge. The parcel was bought by the Service using Land and Water Conservation Funds (LWCF) which is a funding source appropriated annually by Congress that comes from a variety of revenue sources rather than general tax revenues. At the time of sale, seven tenants living on the parcel were relocated with compensation and their cottages still remain on the property. This acquisition included a right-of-way access in common with others on Fabyan Point Road off of McIntyre Road.

For any future land acquisitions, the Service's policy is to acquire land only from willing sellers at fair market value. Landowners may sell their land to the Service in fee title (outright), or they may sell development rights through a conservation easement. Private landowners within an approved refuge acquisition boundary who do not wish to sell will continue to retain full control of their property and their rights to use it, in compliance with applicable local, state, and Federal regulations.

Karner Blue Butterfly Conservation Easement

Great Bay Refuge also administers the 29-acre Karner blue butterfly conservation easement in Concord, New Hampshire. This easement was established in July 1992 through a cooperative agreement between the Service, the city of Concord, the Concord Community Development Corporation (CCDC), the U.S. Postal Service, and TNC. The Service's easement, located in the Concord Airport Industrial Park, consists of two adjacent parcels that were donated to the Service by the city of Concord following an exchange of airport land between the city of Concord and the nonprofit CCDC. The easement was established to protect a small remnant pine barren community in Concord that is habitat for the federally listed endangered Karner blue butterfly and other rare Lepidoptera (moths and butterflies). TNC agreed to serve as a managing partner with the Service while the city of Concord and CCDC agreed to cooperate in the research and management of Karner blue butterfly habitat in management agreement areas.

Refuge Vision Statement

Great Bay National Wildlife Refuge (Great Bay Refuge, the refuge) will be a treasured cornerstone in protecting and restoring the Great Bay Estuary's unique and significant ecological and cultural resources, which are unparalleled in New England. The estuary's shallow tidal waters will teem with a rich diversity of aquatic resources, from oysters and eelgrass beds, to healthy populations of migratory fish. The refuge's oak-hickory forests, grasslands, shrublands, and freshwater ponds will support a bounty of wildlife throughout the year. During winter, bald eagles will thrill refuge visitors as they taunt the many and diverse flocks of waterfowl and waterbirds foraging and resting in its quiet, protected waters. In spring, the refuge's forests, fields, and wetlands will fill with a symphony of bird songs and frog calls. The summer will reward visitors with the opportunity to view native fledgling birds, fawns, and other young of the year. During the fall, the refuge will host hundreds of migrating species ranging from waterfowl, to songbirds, bats, and butterflies, all needing safe haven in an increasingly urbanized landscape.

Visitors from throughout New England will travel to Great Bay Refuge to become immersed in the sights and sounds of nature. The refuge will showcase innovative, science-based, adaptive management techniques and, coupled with exceptional outreach, education, and interpretive programs, help raise awareness and appreciation of the natural world and uphold the mission of the National Wildlife Refuge System. The refuge, in collaboration with partners, will work tirelessly to expand the protection and conservation of the Great Bay Estuary and its native habitats and wildlife for the benefit of the American people.

The Karner blue butterfly easement lands in Concord, New Hampshire, will contribute to the recovery of the federally endangered Karner blue butterfly. Each spring, the flowers of native lupine plants growing among pitch pine on the easement lands will attract thousands of adult Karner blue butterflies to feed on nectar. During the summer, an abundance of Karner blue caterpillars will feed on the lupine leaves. As part of an extraordinarily dedicated partnership, the easement is a key link in the network of lands in the Concord area managed to help reverse the butterfly's decline and bring the species back from the brink of extirpation.

Refuge Goals

The purpose of the CCP is to provide the refuge with a 15-year strategic management plan, consistent with Service policies and legal mandates that will achieve the following five refuge goals. These goals were developed after consideration of refuge purposes, the Service and Refuge System missions, our vision for the refuge, and the mandates, plans, and conservation initiatives described above. These goals are intentionally broad, descriptive statements of purpose.

Greg Thompson/USFWS

A view of the salt marsh looking toward Fabyan Point

Goal 1: Perpetuate the biological integrity, diversity, and environmental health of estuarine and freshwater habitats on Great Bay Refuge to protect water quality and sustain native plant communities and wildlife, including species of conservation concern.

Goal 2: Perpetuate the biological integrity, diversity, and environmental health of upland and forested wetland habitats on Great Bay Refuge to sustain native plant communities and wildlife, including species of conservation concern.

Goal 3: Foster and maintain conservation, research, and management partnerships to promote protection and stewardship of the ecological resources of the Great Bay Estuary.

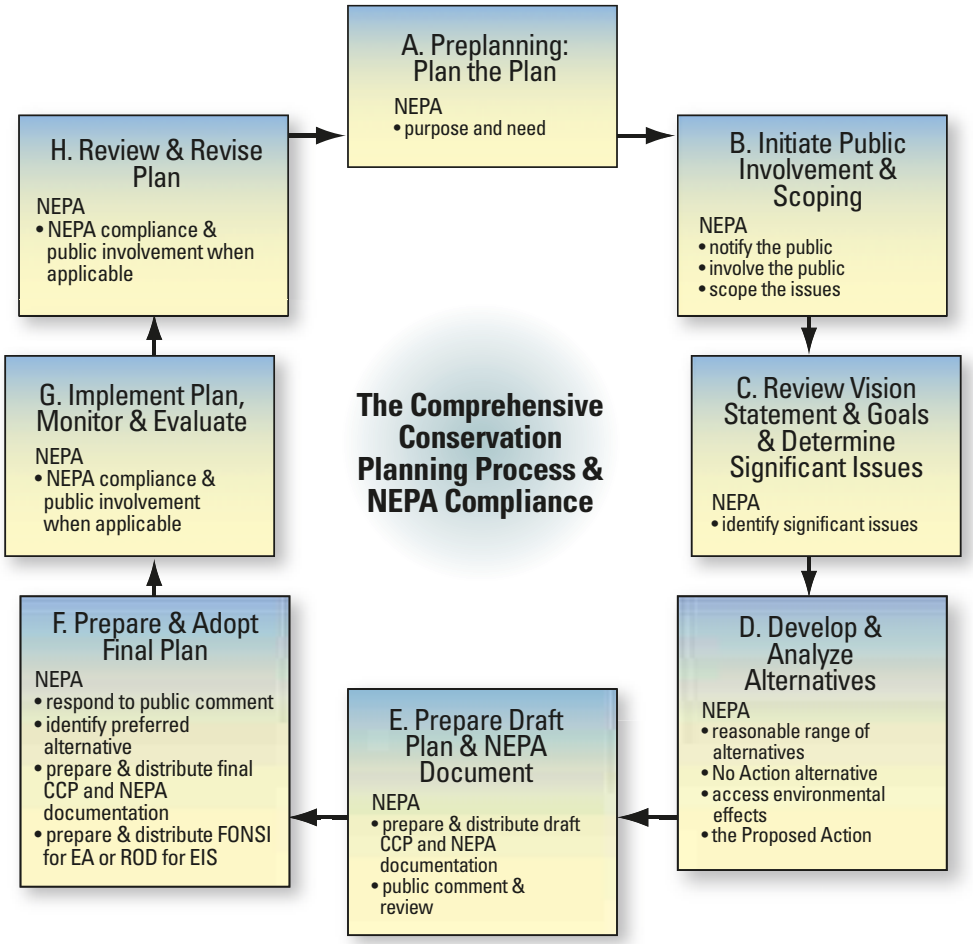
Goal 4: Promote enjoyment and awareness of Great Bay Refuge and Great Bay Estuary by providing high-quality, compatible wildlife-dependent public uses on refuge lands and on partner lands and waters around the refuge.

Goal 5: Contribute to the recovery of the federally listed endangered Karner blue butterfly and other rare Lepidoptera through the conservation, protection, and restoration of pine barrens habitat.

The Comprehensive Conservation Planning Process

Service policy (602 FW 3) establishes a planning process that also complies with NEPA (figure 1.1). The full text of the policy and a detailed description of the planning steps can be viewed at: *http://policy.fws.gov/602fw3.html* (accessed May 2011). We followed the process depicted below in developing this draft CCP/EA. The planning process for the draft CCP/EA involved three primary steps: (1) initial planning, (2) public scoping, and (3) plan development. These steps are described below in more detail and depicted in figure 1.1.

Figure 1.1 The Service's Comprehensive Conservation Planning Process



Step A: Initial Planning

We began preparing a CCP for Great Bay Refuge in 2009. Initially, we focused on collecting information on the refuge's natural and cultural resources and public use program. The CCP core team of refuge and regional office staff and two representatives from NHFG started meeting to discuss existing information, draft a vision statement, and prepare for the public scoping meeting and a technical meeting of State and Federal partners.

Step B: Public Scoping

We held a public scoping meeting on June 18, 2009, at the Newington Town Hall. We announced the location, date, and time for this meeting in local newspapers and through special mailings. Twenty-two people attended the meeting, which was held to let people know what the Service was doing to manage Great Bay Refuge, and to elicit their input on topics of interest to them about the refuge.

In June 2009, we distributed a newsletter announcing the kick-off of the planning process. We followed that distribution late June with a mailing of issues workbooks. We distributed a workbook to everyone on our mailing list, to those who attended the public meeting, and to anyone who subsequently requested one. The purpose of the workbook was to collect ideas, concerns, and suggestions on important issues about refuge management. In the workbook, we asked the public to share what they valued most about the refuge, their vision for the future of Great Bay Refuge, and any other refuge issues they wanted to raise. Eleven copies of the workbooks were completed and returned, along with other written responses.

Steps C and D: Vision, Goals, and Alternatives Development
We held a meeting with 26 representatives of State and Federal partners on July 8, 2009, at the Great Bay Discovery Center in Stratham, New Hampshire. The purpose of the meeting was to identify issues, determine the significant resource values attributed to the refuge, and to seek advice from technical experts on what resources of conservation concern in the refuge planning area should be a management priority. We continued to consult with experts throughout 2009 and 2010, and to meet regularly as a core team, as we developed and refined our alternatives.

Step E: Draft CCP and NEPA document
This draft CCP/EA represents planning step E to prepare a draft plan and NEPA document. We will publish a Notice of Availability in the *Federal Register* announcing our release of this draft for a 30-day period of public review and comment. During that comment period, we will also hold a public meeting to obtain comments directly from individuals. We expect to receive comments by regular mail, e-mail, or at the public meeting. After the comment period ends, we will review and summarize all of the comments received, develop our responses, revise the CCP as warranted based on the comments, and publish the comments and our responses in an appendix to the final CCP.

Step F: Adopt Final Plan
Once we have prepared the final CCP, we will submit it to our Regional Director for approval. The Regional Director will determine whether it warrants a Finding of No Significant Impact (FONSI), and may find its analysis sufficient to simultaneously issue a decision adopting a CCP. If the Regional Director has concerns, we may be required to revise the EA or complete an environmental impact statement (EIS). We will announce the final decision by publishing Notice of Availability in the *Federal Register*, where we will also notify people of the availability of the final CCP. That will complete planning step F to prepare and adopt a final plan.

Issues, Concerns, and Opportunities

We developed a list of key issues to address in the CCP from the responses to our issues workbook, public scoping meeting, technical meeting with partners, and planning team discussions. We define an issue as "any unsettled matter requiring a management decision." This can be an "initiative, opportunity, resource management problem, threat to a resource, conflict in use, or a public concern." One of the distinctions among the proposed management alternatives is how each addresses these key issues. The following summary provides a context for the issues that arose during the scoping process.

Habitat and Species Management

The refuge was acquired in 1992, to conserve fish and wildlife and their habitats and to protect water quality. This is the foundation for what we do on the refuge. Despite its relatively small size at just over 1,100 acres, Great Bay Refuge is surprisingly diverse in its habitats and the species that it supports. The wide variety of habitats on the refuge is the result of human disturbances and past

land uses. The grasslands and impounded wetlands are examples of habitats that were created prior to Service ownership, and are now maintained to benefit wildlife. The refuge's shoreline along Great Bay Estuary is important in protecting water quality in the bay. The refuge's salt marsh and rocky shoreline, as well as adjacent intertidal areas, are critical to the health of the entire Great Bay Estuary.

We heard a range of opinions, particularly from our partners, on which habitat types we should emphasize and which Federal trust and State species of concern should be a management focus. Some of those habitats favored, in particular those for grassland and shrublands habitats, can be labor-intensive and expensive to maintain. Impounded wetlands can also require intensive management and maintenance. All habitat management decisions present tradeoffs between various suites of species that use different habitat types. Many people noted the potential role of the refuge in helping to restore oysters and eelgrass in the bay. The history of the refuge as a former Air Force base presents some species and habitat management considerations due to remaining military infrastructure and historic buildings and environmental contaminants. The alternatives in chapter 3 analyze different habitat management priorities.

The following key issues and concerns arose concerning habitat and species management:

- What is the appropriate contribution of the refuge to regional landscape habitat goals, including grassland and shrubland habitats?
- Which grassland and shrub habitat areas on the refuge should be maintained? How will we manage for them on the refuge?
- Which upland forest habitats and forest-dependent species should be management priorities? How will we manage for them on the refuge?
- How should we manage the former Weapons Storage Area, consistent with refuge goals and objectives?
- What role, if any, should the refuge have in restoring New England cottontail, a candidate for the Federal List of Threatened and Endangered Species?
- What is the refuge's role in restoring Karner blue butterflies to the Concord pine barrens?
- How will we balance the management of aquatic habitats for wetland-dependent birds, fisheries, and biological integrity?
- How will we manage the refuge's impoundments? Should we pursue restoration of wetland habitats through dam removal?
- How will we ensure the integrity of water quality to protect freshwater and saltwater-dependent species?
- What role should the refuge have in helping to restore oysters and eelgrass beds in Great Bay Estuary?
- How will the refuge manage exemplary natural communities and protect rare plant populations?

Invasive Species

Invasive species are those that are nonnative (or alien) to the area and which cause, or are likely to cause, economic or environmental damage or harm to human health. Great Bay Refuge began a systematic inventory and mapping of invasive plant species in 2002. Much of the refuge has been mapped and 34 invasive species recorded. This is typical of southeastern New Hampshire, and especially on lands previously disturbed, like the refuge. Invasive plant species are a significant management challenge given that they occur in all habitats on the refuge. Invasive species control methods used on the refuge include hand pulling with weed wrenches, annual mowing, herbicides, and biological controls for purple loosestrife. In addition to invasive plants, the nonnative mute swan occurs in Great Bay waters, including the refuge. The Service has partnered with NHFG to control this species given its negative impact on native waterfowl and their habitats.

The following key issues and concerns arose concerning invasive species:

- Which invasive species should be a priority for control on refuge lands?
- How will we control specific invasive plant and animal species on refuge lands?

Environmental Contaminants

As the site of a former Air Force base, the refuge still has potential contaminant issues. The adjacent Pease Airport presents additional challenges because runoff from the airport could flow onto the refuge. The airport authority is currently installing new de-icing pads not far from the refuge boundary. It is unclear what, if any, potential threat runoff from these pads might pose to refuge resources.

The following key issues and concerns arose concerning environmental contaminants:

- How will we address environmental contaminants resulting from past land uses and from offsite activities?
- How will we work with the Pease Airport Authority to protect water quality and address potential airport/wildlife conflicts?

Landscape-scale Conservation and Climate Change

Historically, wildlife conservation efforts have tended to focus on single species or small suites of species. Given the changing landscape and climate, we need to manage and collaborate with partners beyond traditional boundaries. Some impacts—such as climate change, urbanization, resource extraction, and other economic and social pressures—occur at scales well beyond the boundaries of a single refuge and affect entire ecosystems, not just a few species. Landscape-level conservation involving multiple partners working together across large regions might be one of the most effective and important ways to help species of conservation concern and their habitats. Research collaboratives among multiple partners and at multiple scales can identify regional trends that would inform site specific management on the refuge. Almost all the respondents to the issues workbook supported a greater refuge role in protecting habitats outside the current refuge boundary. This included support for all methods of habitat conservation, including fee simple and conservation easement acquisition, supporting other conservation partners in their acquisitions, landowner education, and habitat restoration on private lands.

The following key issues and concerns arose concerning landscape-scale conservation and climate change:

- What role should the Service play in conserving lands and habitats in the Great Bay watershed and in the Concord pine barrens?

- How can the refuge work with partners to improve the water quality of the Great Bay Estuary?
- How can the refuge enhance its partnerships within the region to meet landscape-scale conservation concerns, such as climate change, invasive species, land development, and habitat fragmentation?
- What actions can the refuge take, in partnership with others, to minimize impacts from climate change?
- What role should the refuge play in regional research collaboratives that address management issues of concern to the Service?

Public Uses and Community Partnerships

The Refuge Improvement Act identified wildlife observation and photography as two priority public uses for refuges, along with environmental education, interpretation, hunting, and fishing. In 2006, a regional visitor services team identified wildlife observation and photography as the areas of emphasis for Great Bay Refuge. We heard during public scoping that the primary reasons that many people visit the refuge are for wildlife and nature viewing, specifically for bird watching and hiking the nature trails. Many respondents also wanted to see more access and more trails on the refuge, but supported the primary roles of the refuge as conserving habitat and protecting water quality. Our partners recognize that not all priority public uses can be provided on the refuge, and that some of these activities are available on other lands in the Great Bay area that are open to the public.

The lack of staffing at the refuge has limited our ability to expand and monitor public uses on the refuge, and outreach to the community to offer environmental education and interpretive programs in collaboration with our community partners. Partnerships, including the existing core volunteer group, are essential to meeting the vision and goals of Great Bay Refuge. In 2008, volunteers contributed 2,500 to 3,000 hours to the refuge.

The following key issues and concerns arose concerning public uses and community relations:

- What are the appropriate types and levels of wildlife-dependent public uses on the refuge?
- How will we manage compatible, nonpriority public uses on the refuge?
- What staffing levels are needed to enhance onsite interpretation, environmental education, and outreach programs to reach a wider audience?
- What partnership opportunities exist to increase the number of environmental education, interpretation, and outreach programs?
- How will the refuge cultivate an informed and educated public to support the mission of the Service and the purposes for which the refuge was established?
- How will we build and maintain an active volunteer program?

Cultural Resources

At least 22 archaeological or historical sites are present on Great Bay Refuge, including the remains of brick factories, ferry landings, and the foundations of buildings that were once part of local dairy operations. Two structures from the former Margeson Estate, the main house and a caretakers's residence, remain on the refuge and are located on Long Point Road in an area closed

to the public. Both structures are listed as part of a district nomination in the National Registry of Historic Places. As a Federal land management agency, we are responsible for locating and protecting cultural resources, including archaeological sites and historic structures. Balancing the protection of historic resources with the refuge's primary purposes of wildife and habitat conservation is a management challenge.

The following key issues and concerns arose concerning cultural resources:

- How should we steward the historical structures on the refuge, including the Margeson Estate?
- What should we do with other remaining structures, including the bunkers and other infrastructure remaining from the former Air Force base?
- How will we preserve, protect, and interpret cultural resources on refuge lands?

Mao Teng Lin/USFWS

The Margeson Estate main house at Great Bay National Wildlife Refuge

Chapter 2

Tim McCabe/USFWS

Wood duck

Affected Environment

- Introduction
- Part I–The Regional Setting
  - Water Quality and Health of the Great Bay Estuary
  - Conserved Lands Network
  - Land Use Trends
  - Climate
  - Air Quality
  - The Historical Picture
  - Regional Demographics and Economic Setting
- Part II–The Refuge and its Resources
  - Refuge Administration
  - Refuge Natural Resources
  - Cultural and Historic Resources
  - Public Use Programs
  - Volunteer Program
  - Key Refuge Partnerships
  - Karner Blue Butterfly Conservation Easement

Introduction

This chapter describes the ecological, physical, and socioeconomic setting of Great Bay Refuge in a regional and local context. We first describe the regional landscape, including its historical and contemporary influences. We then describe the refuge and its resources.

Part I. The Regional Setting

In addition to the 1,103-acre Great Bay Refuge, we also administer the 29-acre conservation easement in Concord, New Hampshire, as pine barrens habitat for the federally listed endangered Karner blue butterfly. The easement is approximately 45 miles west of Great Bay and is described separately below.

Great Bay Refuge lies within the Gulf of Maine watershed, an immense area extending from eastern Quebec to Cape Cod in Massachusetts. Along New Hampshire's coast, the Gulf of Maine's tidal waters flow twice daily up the Piscataqua River through Little Bay and then into Great Bay at Furber Strait. Collectively, these water bodies are described as the Great Bay Estuary system. This is one of the most productive ecosystems on the East Coast (Odell et al. 2006). The refuge sits on the eastern shore of Great Bay.

The Great Bay Estuary is approximately 10 miles inland from New Hampshire's seacoast and adds more than 130 miles of tidal shoreline to the 18 miles of shoreline along the State's coast. Seven major rivers flow into the Great Bay Estuary system: the Winnicut, Squamscot, Lamprey, Oyster, Bellamy, Cocheco, and Salmon Falls. Together these rivers drain nearly 1,000 square miles. The major habitats in Great Bay are eelgrass meadows, mudflats, salt marsh, channel bottoms, and rocky intertidal habitat. These habitats support over 16 bird, fish, and plant species, 26 of which are State-listed threatened or endangered (see appendix A) (*http://greatbay.org/about/index.htm;* accessed May 2011*)*. In the estuary, recreational shellfishers harvest oysters and clams; fishing enthusiasts pursue striped bass, bluefish, alewife, and blueback herring; lobstering is a commercial and recreational activity; and American eels are trapped for bait and for export. Birders from all over the world come to view migratory birds on Great Bay (NHEP 2000).

Great Bay Refuge is located on a portion of the former Pease Air Force Base. The rest of the former base is now Pease International Tradeport (Tradeport). The approximately 3,000-acre Tradeport has office and industrial spaces, an active airport, restaurants, hotels, and other amenities. Past land uses, including farming and 30 years of use as an Air Force Base, dramatically changed the upland plant community from an Appalachian oak-pine forest to a mix of transitional pine-hardwood forest, shrubs, fields, and impounded waters. Only some remnants of the historical forest community remain in the area.

Storage bunker in former Weapons Storage Area

USFWS

Water Quality and Health of the Great Bay Estuary

Several centers of ecological research and management in the area provide a detailed picture of the historical and current health of the Great Bay Estuary and watershed. These centers, described in more detail in chapter 1, include the PREP, GBNERR, and the NHCP, among others.

In an overview on the restoration of the Great Bay Estuary, Odell et al. (2006) summarized the condition of the estuary system as follows:

> "A close look at the history and current condition of the Great Bay estuarine system reveals that although it is relatively intact and remarkably resilient, it has been significantly altered and degraded. Prior to 1900, all of the rivers and many of the tributaries were dammed, extensive logging throughout the watershed brought tons of silt into tidal rivers, the bay bottom was covered in sawdust up to a foot deep and poisoned with industrial wastes, and aquatic resources were over harvested. Since that time, significant human population growth and development throughout the Great Bay watershed have created new stresses—notably habitat loss, and new levels and types of point and non-point source pollution."

A concerted effort to understand, protect, and restore the Great Bay Estuary is underway among many local, State, and Federal partners. Particular emphasis is placed on land protection, controlling discharges from wastewater treatment plants and other pollution sources, and using best management practices to minimize impacts from development and resource extraction (Odell at al. 2006).

Every 3 years, PREP compiles a report on the "State of the Estuaries." The report tracts trends in 12 environmental indicators to assess the health of New Hampshire's estuaries. The report describes each indicator as having an either positive, negative, or cautionary trend. A cautionary trend is a trend or status that demonstrates possibly deteriorating conditions, but more information is needed to fully assess the indicator. In the 2009 report, 11 out of the 12 indicators showed either negative or cautionary trends for Great Bay (table 2.1). In the previous 2006 report, only 7 out of the 12 indicators had either negative or cautionary trends. The report recognizes that although there have been many successful projects to conserve land or restore habitat around Great Bay, these projects have not been able to keep up with continued habitat loss and human development (PREP 2009).

Table 2.1. Environmental Indicator Trends in the Great Bay Estuary (PREP 2009)

Indicator	Situation	Trend*
Dry weather bacteria concentrations	Concentrations in Great Bay decreased significantly in the 1990s, but no change in last 10 years.	!
Toxic contaminants in shellfish	Concentrations of a petroleum product have increased by 218 percent in the Piscataqua River over past 16 years.	!
Toxic contaminants in sediments	Toxic contaminants found in 24 percent of estuarine sediment.	!
Nitrogen in Great Bay	Dissolved inorganic nitrogen concentrations increased in Great Bay by 44 percent in past 25 years; the total nitrogen load to Great Bay increased 42 percent in past 5 years.	–
Dissolved oxygen	Levels fall below State standards often in tidal rivers, rarely in the bay.	!
Oysters	Number of adult oysters in Great Bay declined by 95 percent in the 1990s; the population has increased slowly since 2000.	–

Indicator	Situation	Trend*
Eelgrass	Eelgrass cover in Great Bay has declined by 37 percent between 1990 and 2008 and completely disappeared from the tidal rivers, Little Bay, and the Piscataqua River.	–
Anadromous fish	Returning anadromous fish are limited by various factors including water quality, passage around dams, and flooding.	!
Habitat restoration	Yes for salt marsh, but oyster and eelgrass habitats have been restored at a slower rate.	!
Impervious surfaces	In 2005, 7.5 percent of the land area of the watershed was covered by impervious surfaces, and 9 subwatersheds had greater than 10 percent impervious cover. In 2005, the town of Newington, NH had 20.2 percent imperviousness; up from 13.2 percent in 1990.	–
Land conservation	At the end of 2008, 76,269 acres in the Piscataqua watershed are protected, which amounted to 11.3 percent of the land area.	+

** + is a positive trend; - is a negative trend; ! is a cautionary trend*

Conserved Lands Network

Great Bay Refuge is within the boundaries of the GBNERR (map 2.1). The reserve was designated in 1989, encompassing 4,500 acres of tidal waters and wetlands and 3,000 acres of surrounding upland. The refuge and the reserve are part of the Great Bay Resource Protection Partnership (GBRPP), a coalition working to permanently protect land in 24 towns around Great Bay, including those within the boundaries of the reserve (map 1.1). The partnership funded the protection of 5,098 acres in the Great Bay region from 1996 to 2008, and an additional 3,052 acres were protected as a match to the partnership-funded lands (*http://www.greatbaypartnership.org/index.html; a*ccessed May 2011*)*.

Great Bay Refuge is the largest block of protected land on Great Bay. Table 2.2 lists other key conserved lands around the Great Bay Estuary.

Table 2.2. Conservation Lands Bordering Great Bay Estuary

Name	Town	Acres	Ownership
Great Bay National Wildlife Refuge	Newington	1,103	U.S. Fish and Wildlife Service
Fox Point	Newington	119	Town of Newington
Wagon Hill Farm	Durham	130	Town of Durham
Adams Point	Durham	70	NH Fish and Game
Wilcox Point	Durham	38	NH Fish and Game
Lubberland Creek	Newmarket	70	The Nature Conservancy
Shackford Point	Newmarket	34	NH Fish and Game
Sandy Point (Great Bay Discovery Center)	Greenland	46	NH Fish and Game
Great Bay Wildlife Management Area	Greenland	32	NH Fish and Game

Great Bay National Wildlife Refuge - Comprehensive Conservation Plan
Resource Protection Areas
New Hampshire
Maine
Farmington
Lebanon
North Berwick
Rochester
Berwick
Somersworth
South Berwick
Barrington
Rollinsford
Dover
Madbury
York
Deerfield
Durham
Eliot
Nottingham
Lee
Newington
Kittery
Newmarket
Epping
Newfields
Raymond
Portsmouth
Greenland
Stratham
Rye
Chester
Fremont
Brentwood
Exeter
North Hampton
Sandown
Danville
Kingston
Kensington
Hampton Falls
Hampton
Seabrook
Newton
USFWS New England Cottontail Focus Areas
Great Bay National Estuarine Research Reserve
Great Bay Resource Protection Partnership
Piscataqua Region Estuaries Partnership

Land Use Trends

Despite the network of conservation lands in the Great Bay watershed, future growth is a concern, especially in the northern portion of the watershed on those lands not protected. As the population of the region increases, there is an associated increase in sources of pollution. Developed lands also reduce or fragment wildlife habitat. Development creates more impervious surfaces, such as paved roads, parking lots, and buildings. Impervious surfaces increase the volume and velocity of stormwater runoff and the sediment and pollutant load flowing into the estuary. Because of this, the amount of impervious surface in a watershed is a good indicator of stream and water quality (PREP 2009). Generally, water quality deterioration is expected in watersheds with greater than 10 percent impervious surface. According to PREP, 7.5 percent of the land area of the Piscataqua watershed was covered with impervious surface in 2005. Impervious surfaces continue to be added to the watershed at a rate of approximately 1,500 acres a year (PREP 2009). The town of Newington, where the refuge is located, has one of the highest levels of impervious surfaces in the watershed; increasing from 18 percent in 2000 to over 20 percent in 2005 (PREP 2009).

Climate

Along the coastal lowlands, winter temperatures average about 30°F and summer temperatures average about 80°F. At higher elevations and further inland, winter temperatures are often 10 to 12°F cooler. Afternoon sea breezes affect the refuge in spring and summer, with noticeable wind shifts at about 11 a.m. and again just before sunset. Further inland, low elevation areas can be 5 to 10°F warmer during summer, but cooler as elevation rises. Annual precipitation is uniform throughout the year with the wettest month being November (greater than 5 inches on average). Total annual precipitation Statewide is about 45 inches. Annual snowfall for coastal areas is 50 inches and higher elevations can receive 150 inches. Much of the precipitation is the result of cooler air from the polar region meeting a warmer, moist southerly air mass riding the Atlantic seaboard northward (Schroeder 1970). The resulting storms can be quite severe and can occur year-round.

Air Quality

The Clean Air Act requires the EPA to set National Ambient Air Quality Standards for pollutants considered harmful to public health and the environment. The Clean Air Act established two types of national air quality standards: primary and secondary standards. Primary standards set limits to protect public health, including the health of sensitive populations such as people with asthma, children, and the elderly. Secondary standards set limits to protect public welfare, including protection against decreased visibility, and damage to animals, crops, vegetation, and buildings. The EPA has set standards for six principal pollutants: carbon monoxide, nitrogen dioxide, ozone, lead, particulates, and sulfur dioxide (*http://www.airmap.sr.unh.edu/background/naaqs2.html;* accessed May 2011).

During summer, most of southern New Hampshire and coastal Maine experiences ozone events that are considered “very unhealthy” for humans and the environment. Acid rain also impacts the region. These and other air quality issues in the region are largely the result of the influx of airborne pollutants originating from industrial regions, metropolitan centers, and transportation corridors located upwind, and primarily from the Midwest and Mid-Atlantic regions. Industrial and transportation sources within New England also contribute to air quality issues (Wake et al. 2004).

Ozone at ground-level is a pollutant that forms in the atmosphere as a by-product caused by the release of volatile organic compounds and nitrogen oxides emitted from automobiles, diesel trucks, and industrial sources. Several areas, including the Dover-Portsmouth-Rochester region, are designated as “serious

non-attainment zones" for ozone by the EPA. Very high ozone levels occur in the seacoast regions of Maine, New Hampshire, and Massachusetts during the summer due to a combination of factors (e.g., dense population, local pollution sources, and being downwind of sources outside the region). On average, southern New Hampshire and coastal Maine experience 3 to 5 days per year of very unhealthy ozone levels, with some years (e.g., 1988) that are much worse. Many unknowns still exist about air quality in New England, including the specific sources of pollution, and effects of weather patterns and climate changes (Wake et al. 2004).

Every year, Public Service of New Hampshire (PSNH) uses 400,000 tons of low-sulfur coal to fuel their Newington, New Hampshire Schiller Station's three 50-megawatt steam boilers. In 2006, they converted one of the coal boilers to a wood burning boiler, reducing coal burning by about 130,000 tons a year. The new boiler is expected to annually consume more than 400,000 tons of wood, most of which will come from suppliers in the New Hampshire area. According to PSNH, the wood-burning boiler emits 70 percent less nitrogen oxide, 90 percent less mercury, and 95 percent less sulfur dioxide than the coal plant (*http://www.psnh.com/RenewableEnergy/About-PSNH/Northern-Wood-Power.aspx;* accessed May 2011*)*.

The Historical Picture

After the Ice Age

New England emerged from an ice age 12,000 years ago. A 1-mile thick glacier scraped and molded the valleys, slopes, and mountain tops, leaving behind a landscape bare of vegetation. At the southern edge of the glacier, however, plants survived and immediately began to recolonize the newly exposed soils (Marchand 1987). Large mammals, including mastodons, wandered the spruce parkland and grassy savanna, but disappeared quickly at the same time the glacier receded and humans advanced across the region.

Continual weathering and erosion of rock over time released nutrients and created new soils for plants to grow. Hardwood and softwood tree species advanced independently of one another creating different forest communities through time (Davis 1983). The sequence of plant species' arrivals as the glacier receded was also different at different sites (Davis 1981). In a relatively short time period (about 2,000 years), the land cover changed from tundra to woodland with scattered trees, and then to closed canopy forest. Pine and oak arrived around 11,500 years ago with a warmer and drier climate. Eastern hemlock became more prevalent around 10,000 years ago with a wetter climate (Manomet Center 2010). Graham (1992) reported similar species-specific responses by mammals to post-glacier climate changes.

Native People

Prior to European arrival, coastal southern New England likely supported a "shifting mosaic" of open land habitat within a mostly forested landscape. The open lands were a result of native heathlands, grasslands and shrublands, extensive beaver meadows, periodic fires, shifting agriculture by Native Americans, and occasional hurricanes (Cronin 1983, DeGraaf and Yamasaki 2001). DeGraaf and Yamasaki (2001) and Askins (2000) reported broad evidence for the presence of extensive grasslands along the coast and major rivers in pre-European New England.

Native Americans in southern New England fished and shellfished for much of their food, as well as hunting birds and trapping and hunting small game. When colonists landed on Massachusetts shores in the early 1600s, they saw large clearings and open woodlands. Waterfowl, deer, ruffed grouse, wild turkey, and wild pigeons were abundant (Marchand 1987, Foss 1992, DeGraaf and Yamasaki 2001). Colonists found old growth forests not far inland, including old stands of

mixed hardwoods, white pine, and hemlock at low elevations, and spruce and fir in the mountains (Marchand 1987).

European Settlement

European contact (e.g., explorers and traders) with native people began during the 16th century in New England. Foster and Motzkin (2003) suggested that European arrival prompted such rapid and profound changes to the lifestyle and land use practices of indigenous people that by the time colonists began to settle here, the landscape was already altered. Foster and Motzkin (2003) suggested that expansive clearing for agriculture and semi-permanent (rather than mobile) villages were a new phenomenon and resulted from European influence.

European colonists brought new land use concepts such as permanent settlements and political boundaries. They shifted land use from primarily subsistence farming and gathering to harvesting and export of natural resources (Foss 1992). Just 100 years after the colonists arrived, the forests were rapidly being logged. By 1830, central New England was 80 percent cleared (Marchand 1987).

However, shortly after this, many people began leaving the rough, rocky New England landscape for other opportunities. The abandonment was due to a variety of factors, including the California Gold Rush, the Industrial Revolution, new railroads, richer midwestern soils, and the Civil War. Abandoned farm fields began reverting back to forest. White pine seeded into the fields and pastures and by 1900 was ready for harvest. An understory of hardwoods, released from the shade of white pine, emerged as the new dominant vegetation. This is a legacy that remains today (Marchand 1987, DeGraaf and Yamasaki 2001).

The Great Bay Estuary was long a center of commerce for natural resource based industries including fishing and logging. Early settlers exploited the region's extensive forests and abundant populations of salmon, shad, sturgeon, alewife, blueback herring, and shellfish. Flat-bottomed gundalows, a type of sailing barge, were used to transport cargo up and down the swift-current and shallow waters of the Piscataqua River to and from the towns on Little Bay and Great Bay. Shoe and textile mills were built on the water's edge of the towns within the estuary (Jones 2000). By 1790, Portsmouth, New Hampshire was the 14th largest city in the country, known for its shipping and fishing industries (Bolster 2002). Growing human populations, accompanied by unchecked sewage disposal and dumping of industrial wastes degraded the water quality in the estuary, led to population declines of fish and shellfish. Beginning in the 1940s, pollution controls began to improve water quality and habitats in Great Bay (Jones 2000).

Climatic Effects and Natural and Human Disturbances

The Northeastern United States is particularly cold, given its latitude (Marchand 1987). The reason for the region's cold climate is partly a result of the pattern of atmospheric circulation in this hemisphere. Low pressure systems all converge on New England, regardless of their origin, and pull cold Canadian air in behind as they pass over the Northeast (Marchand, 1987). New England weather conditions are influenced more by the North American landmass than by the Atlantic Ocean except along the coastline (Taylor et al. 1996). Forty to 45 inches of precipitation fall about evenly throughout the year, although drought periods occur in some years (Patterson and Sassaman 1988).

Natural disturbances vary across New England, depending on geographic location, forest type, and local conditions. In presettlement times, coastal regions experienced the highest rates of disturbance because of the prevalence of fire-dependent sandy pine-oak barrens, higher densities of Native Americans, higher frequencies of hurricanes, and longer snow-free periods. These disturbance regimes may have maintained about 1 to 3 percent of the inland northern

hardwoods forests and greater than 10 percent of the coastal pine-oak barrens, in early successional habitat (Lorimer and White 2003).

Native insects and disease, ice storms, droughts, and floods have caused both minor and major disturbances. Lorimer and White (2003) depicted hurricane frequencies as varying from 85 years in southeastern New England, 150 years through central Massachusetts and the southeast corner of New Hampshire, to 380 years or more in northern New England. Lorimer (1977) estimated catastrophic disturbances from fire and wind at intervals of 800 and 1,150 years, respectively.

Agriculture, logging, fire, wind, exotic pests and diseases, and development have significantly altered the New England landscape. Agriculture had the greatest effect on New England's forests, causing major changes in cover types and soils over a vast area. Although most of the region's forests were cut at least once, most logging did not affect succession or impact soils (DeGraaf and Yamasaki 2001). Human settlements are emerging as the major cause of permanent habitat loss compared to previous impacts from agriculture and logging.

Climate Change

Climate changes are predicted to affect climate patterns over time (Lorimer 2001). The greatest effects of climate change will be on regional air and water temperatures, precipitation patterns, storm intensity, and sea levels. In the Northeastern United States, the average air temperature is expected to rise by 8°F by 2100, with the greatest increase during winter months (Frumhoff et al. 2007). New Hampshire's summers are anticipated to be similar to those currently experienced in Virginia (Frumhoff et al. 2007). Climate change is anticipated to influence natural disturbances patterns and result in a decrease in freeze periods, decreased snow cover, increased storm intensities and frequencies, increased intensity and frequency of summer droughts, damaging ozone, and an increase in the spread of invasive species and disease (NHFG 2005, Manomet Center 2010). The resulting effects on wildlife and habitats are expected to be variable and species-specific, with a predicted general trend of ranges shifting northward by 350 to 500 miles (Frumhoff et al. 2007).

Tidal marshes are among the most susceptible ecosystems to climate change, especially rapid sea level rise. In an effort to address these potential effects on national wildlife refuges, the Service ran Sea Levels Affecting Marshes Model (SLAMM) 5.0 analyses to estimate the impacts of sea level rise for all coastal refuges, including Great Bay Refuge. The model predicted that the salt marshes at Great Bay Refuge would be resilient to the effects of sea level rise, with very little conversion of upland to wetland (Clough and Larson 2009). The majority of the refuge is dominated by oak-hickory forest, which is at the northern edge of its range. Under climate change scenarios, this forest type is expected to persist and expand northwards. Increasing summer droughts and disease is expected to increase the likelihood of forest fires, which the oak-hickory habitat is adapted to. Two habitats on the refuge that are vulnerable to climate change are hemlock communities and forested wetlands. The hemlock woolly adelgid, an invasive pest, is currently at the northern edge of its range in southern New Hampshire, and is expected to expand northwards with increasing winter temperatures. Earlier flooding and prolonged summer drought may result in a reduction of forested wetlands on the refuge and decrease both the quantity and quality of these habitats for wetland-dependent species, such as northern leopard frog and willow flycatcher. The main guiding principal of the Service's climate change adaptation planning is to maintain or increase resiliency of the refuge's habitats and ecological process. The uncertainty about the future effects of climate change also requires refuge managers to use adaptive management to maintain healthy ecosystems in light of the unpredictability (Inkley et al. 2004).

Wildlife Changes

Wildlife populations ebb and flow as habitat conditions vary in space and time. Natural and human disturbances intervene, shifting species abundance and diversity. Some species, such as alpine plants, have been here for 10,000 years or more. Others, like the coyote, arrived in the last 75 years. Change is inevitable and natural, although human activities in the last 400 years have significantly altered the landscape compared to the previous 10,000 years when humans first colonized the northeast (Foss 1992).

During the 1800s, many wildlife species declined because of habitat loss (e.g., forest clearing), bounty and market hunting, millinery trade (for feathers to use in hats), and natural history specimen collecting (Foster et al. 2002). The millinery trade in the late 1800s, and hunting and egg collecting (for food and bait) decimated Arctic, common, and roseate tern populations in the Gulf of Maine (Drury 1973). Mountain lion, gray wolf, elk, and caribou were extirpated from the area by the mid-1800s or early 1900s and have not recolonized the region. Heath hen, passenger pigeon, great auk, Labrador duck, and sea mink became extinct at the hand of humans during the same period (DeGraaf and Yamasaki 2001, Foster et al. 2002).

The historical record is unclear on the abundance and distribution of open land plant and animal species in the Northeast prior to European settlement (Foster and Motzkin 2003). Scattered large grasslands occurred in coastal areas including the approximately 59,300-acre Hempstead Plain on Long Island and the blueberry barrens along the Maine coast (Askins 1997, Winne 1997). Smaller, more temporary grasslands were created when beavers abandoned their dams, or by fires set by lightning or humans (Askins 1997). Some grassland bird species, such as horned lark and dickcissel, likely spread eastward from the Midwest as lands here were cleared for agriculture. However, some grassland birds, including bobolink, eastern meadowlark, and upland sandpiper, may have existed here long before European settlement in these coastal barrens, heathlands, and grasslands (Askins 1997). Populations of grassland birds have declined significantly across their range in the last 40 years (Askins 1997, Norment 2002). After farm abandonment escalated in the early 1900s, wildlife species that prefer thickets, brush lands, and young forests increased (Litvaitis 2003).

The young hardwood forests that emerged in the 1920s and 1930s provided premier habitat for ruffed grouse (DeGraaf and Yamasaki 2001). The succession of that forest into mature hardwood forests in the late 1900s caused a decline in the grouse population but an increase in other species that prefer more mature forests. Abundances of early successional species declined to levels approaching presettlement levels (Litvaitis 2003).

Opossum

Tim Williams.

Eastern coyotes were first sighted in New Hampshire and Vermont in the 1940s, in northern Maine in the 1930s, and in Massachusetts in the 1950s. DeGraaf and Yamasaki (2001) reported three major trends in New England's wildlife: forest species are increasing (e.g., American black bear, beaver, deer, wild turkey, pileated woodpecker), grassland and shrubland species are declining (e.g., grasshopper sparrow, bobolink, upland sandpiper, whip-poor-will), and many southern species are expanding their ranges northward (e.g., glossy ibis, willet, Carolina wren, northern cardinal, northern mockingbird, Virginia opossum). A few species, such as common raven, fisher, and moose are expanding southward. A group of species remains regionally extirpated, including wolverine and mountain lion, although Canada lynx have returned to northern Maine and New Hampshire (DeGraaf and Yamasaki 2001).

Regional Demographics and Economic Setting

Population and Demographics

Great Bay Refuge is located in southern New Hampshire in the town of Newington in Rockingham County. Its close proximity to metropolitan areas, including Boston, Massachusetts, and Manchester, New Hampshire, expose the refuge to the effects of urban sprawl. As real estate in cities and their outskirts becomes scarce and more expensive, city residents look outward for more affordable housing. In addition, New Hampshire offers numerous scenic and natural areas, and opportunities for outdoor recreation.

An analysis of population data by the New Hampshire Office of Energy and Planning (NHOEP) shows the State divided into the slow-growing north and the fast-growing south. Since 1960, New Hampshire's population has increased by about 703,000 people. More than 60 percent of that growth occurred in Rockingham and Hillsborough Counties. This growth is expected to shift away from Rockingham County because of the decreasing availability and increasing cost of land, and the greater freedom to reside in and commute from more remote communities. In contrast, Merrimack County is expected to gain in the State's future share of growth (NHOEP 2006).

Rockingham County's 695 square miles of land area contained 426 persons per square mile in 2007. The estimated 2007 population of Rockingham County is 296,543, an increase of 19,184 people since 2000. Rockingham County was the second most populated county in the State in 2007, accounting for about 23 percent of New Hampshire's total population. From 2005 to 2007, the median age in Rockingham County was 40.2 years. Persons under 18 years accounted for 24 percent of the population, while 11 percent were 65 years or older (USDOC 2007). Table 2.3 presents the population trends for Rockingham County and the communities surrounding the refuge.

Table 2.3. Population Trends for Communities and the County Around Great Bay Refuge

	Population in 2007			Percent Population Change	Projected Population
	Residents	Persons per Square Mile	Median Age	1990 to 2000	2020
New Hampshire	1,315,828	146.7	39.3	+11.4	1,470,010
Rockingham County, NH	296,543	426.7	40.2	+12.8	331,190
Newington, NH	803	96.0	42.6	-21.7	900
Greenland, NH	3,395	322.2	38.1	+15.9	3,880
Portsmouth, NH	20,495	1,312.7	36.6	-19.8	22,730

Source: U.S. Census Bureau (2007), New Hampshire Office of State Planning (based on 2000 US Census data), and New Hampshire Office of Energy and Planning (projections compiled Jan 2007 based on past trends).

Environmental Justice

Executive Order #12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low-income Populations," (dated February 11, 1994) requires Federal agencies to identify and address any potential disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority and low-income populations. The Presidential Memorandum accompanying this order further

directs Federal agencies to improve opportunities for community input and the accessibility of meetings, documents, and notices (CEQ 1997). To facilitate this, Federal agencies should also consider if a significant portion of the affected community is linguistically isolated, and as warranted, provide translated documents and other appropriate outreach materials.

In creating table 2.4 below, we used the following definitions:

- **Minority population** includes persons who are members of the following groups: American Indian or Alaskan Native; Asian or Pacific Islander; Black, not of Hispanic origin; or Hispanic.
- **Low-income population** includes persons living below the poverty line.
- **Linguistically isolated population** includes persons who speak English less than "very well."

Table 2.4. Regional Environmental Justice Characteristics.

	Rockingham County, NH	Town of Newington, NH
Minority Population (as percent of total population)	4.8 percent	4.0 percent
Low-income Population (as percent of total population)	4.8 percent	4.6 percent
Linguistically Isolated Population (as percent of total population)	1.6 percent	3.4 percent

Business and Economic Climate

New Hampshire has made several economic transitions in the past. Historically, the area was agriculturally based. The economy later shifted to textile and leather goods manufacturing during the industrial era and then shifted again to the manufacturing of higher valued goods such as fabricated metal and electrical goods. Currently, the State is in transition to a post-manufacturing, service-based economy (NHOEP 2006).

New Hampshire has a 70 percent "labor force participation rate." This means that 70 percent of the population age 16 and older is either employed or unemployed but able to work and looking for a job. In 2007, retail was the largest employing industry in the State, providing jobs for 97,700 workers (NHES 2009). New Hampshire does not tax personal income, sales, inventory, capital gains, personal property, machinery, or equipment. This contributes to its competitive status in the retail industry. In 2007, the State median income was $67,576 (NHES 2009).

In 2007, 38 percent of the workforce in Rockingham County was employed in management, professional, and related occupations, while 27 percent filled sales and office occupations. The remaining workforce was divided among service occupations including production, transportation, and material moving; and construction, extraction, maintenance and repair occupations. The primary industries in the county are educational services, health care, and social assistance, and retail. The Great Bay Estuary is important to local and regional recreational and commercial fisheries (Jones 2000). In 2007, the median household income in Rockingham County was $72,600 in 2007 (USDOC 2007).

In the region around Great Bay Refuge, the major economic participant is the Pease International Tradeport. The Tradeport is a 3,000-acre business and aviation industrial park located at the former Air Force Base that was developed by the Pease Development Authority (PDA) after the closure of the base in 1991. It has more than 200 tenants, 5,100 employees, and 3.9 million square feet of new construction and renovated space for businesses (Greater Portsmouth Chamber of Commerce 2006). The Tradeport also includes the Portsmouth International Airport at Pease which is used both for military aviation by the New Hampshire Air National Guard and for civilian aviation.

The PDA has marketed the Tradeport as an ideal location for businesses interested in global trade because of to its proximity to major highways, an international airport, and the marine Port of New Hampshire. Companies located at the Tradeport also benefit from the State's lack of a broad-based tax system. Some of the amenities provided by the Tradeport include hotels, restaurants and banquet facilities, golfing, personal and commercial banking, copy and printing services, job training and continuing education (PDA 2006).

The expanding business center of the city of Portsmouth is less than 1 mile away from the Tradeport. Portsmouth is a significant commerce center in New England (GPCC 2006). In addition to being accessible by five major highways, Portsmouth is served by the Boston and Maine Railroad. It is New Hampshire's only ice-free deep-water port with a Foreign Trade Zone, and lumber, fuel oils, salt, gypsum, scrap metal, and other materials are shipped from here.

PSNH's wood burner along the Piscataqua River in Portsmouth is another major part of the economy. As mentioned before, it uses over 400,000 tons of wood chips annually to run, most of which comes from suppliers in New Hampshire (*http://www.psnh.com;* accessed May 2011*)*.

Portsmouth is also home to many shops, businesses, galleries, museums, restaurants, and the Portsmouth Naval Shipyard, which has been in operation since 1800. As the second oldest city in the State, Portsmouth has a prominent cultural heritage that attracts many visitors to historic sites such as Strawberry Banke. In nearby Durham, UNH adds to the vitality of the area's social and cultural resources.

Resource-based Recreation and Tourism

The natural beauty of New Hampshire has attracted many visitors to its mountains, forests, lakes, and seashore. Visitors to the State have cited visiting beaches, State parks or national forests, and opportunities for hiking, skiing, wildlife watching, and outdoor recreation as reasons for visiting New Hampshire (INHS 2009a). Tourism is an important economic contributor in New Hampshire, as 10 percent of private sector employees work in the "accommodation and food services" sector (NHES 2009). The tourism industry has seen a recent slowing due to the larger economic slowing of the country, however, meals and rooms taxes paid by tourists grew 2.3 percent in 2008, totaling $132.9 million (INHS 2009b).

The conservation of open spaces and their associated wildlife recreation activities provide economic benefits to the local and regional community. A report by the Trust for Public Land (TPL) titled "The Economic Benefit of Parks and Open Spaces" found that throughout the nation, parks, protected rivers, scenic lands, wildlife habitat, and recreational open space help support a $502-billion tourism industry (Trust for Public Land 1999). Another report by the Service found that national wildlife refuges in the lower 48 States attracted 34.8 million visitors in 2006 and generated $1.7 billion of sales in regional economies (Carver and Caudill 2007). In New Hampshire, the estimated annual value of open space

to the economy totaled $8 billion, representing 25 percent of the State's local economy and contributing $891 million in State and local taxes (Trust for Public Land 1999). Wildlife refuges, such as Great Bay Refuge, provide an opportunity to generate revenue through recreational activities. In 2006, the combined total revenues from wildlife watching, fishing, and hunting in New Hampshire was $520 million (USFWS and USDOC 2007) (table 2.5).

Table 2.5. Revenues from Wildlife-associated Recreation by Residents and Non-residents in New Hampshire

Activity	Total Participants	Total Expenditures	Total Participants	Total Expenditures
	2001		2006	
Wildlife watching	450,000	$200,010,000	710,000	$273,769,000
Fishing	164,000	$186,436,000	230,000	$172,413,000
Hunting	53,000	$55,775,000	61,000	$74,467,000
Totals	**667,000**	**$442,221,000**	**1,001,000**	**$520,649,000**

From the U.S. Fish and Wildlife Service and U.S. Department of Commerce, U.S. Census Bureau. 2001 and 2006 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation.

Woodman Point

USFWS

Part II. The Refuge and its Resources

Refuge Administration

Staffing and Budget

When the refuge first opened in 1992, its staff consisted of a refuge manager, assistant manager, and an office administrative assistant. A biological technician was also on staff for a few years. In 2006, the Service implemented a Regional Workforce Plan which included a decision to de-staff Great Bay Refuge. Since 2008, Great Bay Refuge has been administered by Parker River Refuge in Newburyport, Massachusetts, (see table 2.6).

Table 2.6. Refuge Staffing and Budget, 2005 to 2010

Fiscal Year	Total Budget (Including Salaries)	Full-Time Staff
2005	$135,800	1
2006	$159,410	1
2007	$264,336	1
2008	$124,857	0.33
2009	$61,108	0*
2010	$67,740	0*

**Note: Staff from Parker River Refuge administers Great Bay Refuge.*

Refuge Facilities

From 1992 through the summer of 2001, the refuge headquarters was located on the second floor of the former Newington Town Hall on Nimble Hill Road in Newington. The current headquarters was built in 2001, and is located past the electronic gate at the refuge entrance on Merrimack Drive, next to the former Weapons Storage Area. The automated entrance gate is timed to be open from dawn to dusk. The headquarters building houses staff space, a reception area, and a small meeting room. This office also provides office space for two regional Service staff: the regional wildlife biologist and a regional Geographic Information Systems (GIS) specialist. Map 2.2 displays the existing location of facilities.

Other refuge facilities include a house, maintenance building, and a visitor parking lot with adjacent interpretive kiosk, public restroom facility, and bicycle rack. Two pedestrian trails leave from the parking lot. These trails are described in more detail under the subheading “Public Use Programs” below.

Refuge Revenue Sharing

National wildlife refuges contribute to local economies through shared revenue payments. Federally owned land is not taxable; but, under the provisions of the Refuge Revenue Sharing Act, the Service pays annual refuge revenue sharing payments to municipalities or other local units of government where there are national wildlife refuges. Land in public ownership requires little in the way of services from municipalities, yet it provides valuable recreational opportunities for local residents. Table 2.7 lists the payments made to the town of Newington since 2000.

Great Bay National Wildlife Refuge - Comprehensive Conservation Plan
Great Bay National Wildlife Refuge
Existing Conditions
Pease Tradeport Runway
Electric Gate
Parking Lot
Keys Gate
Caretakers House
Herrick Cove
Fabyan Point
Structure
Right of Way
Admin only Road
Entrance Road
Non-FWS Road
Public Trail
Chain link Fence
Miles
Kilometers

Table 2.7. Great Bay Refuge's Refuge Revenue Sharing Payments to the Town of Newington, 2000 to 2009

Fiscal Year	Newington, NH
2000	$36,277
2001	$37,028
2002	$41,550
2003	$39,935
2004	$35,323
2005	$39,892
2006	$36,922
2007	$35,702
2008	$27,699
2009	$26,028

Special Use Permits

The refuge manager issues special use permits on a case-by-case basis after determining whether a use is compatible with refuge purposes. All special use permits have a 1-year term. The refuge has issued special use permits for the following types of activities:

- Wildlife Inventories and Research
  - Christmas Bird Counts (NH Audubon)
  - Wood wasp trapping (U.S. Forest Service)
  - Dragonfly surveys
  - Study of contaminant effects on frog development (UNH)
  - Owl surveys (NH Audubon)
  - Research on prescribed burns and mowing (UNH Graduate student)

- Educational Programs
  - Cub scout merit badge tour
  - UNH Video Services for educational films and television programs
  - UNH Fire Ecology class field trip
  - UNH Geology class field trip
  - UNH Wetlands Delineation class
  - Nashua Fish Hatchery education exhibit collecting fish and vegetation

Research

Refuge staff, graduate students, conservation organizations, and others have conducted numerous studies on the refuge. A sampling of those efforts follows. Additional information on these studies can be obtained from refuge headquarters.

Great Bay National Wildlife Refuge Fish Survey Report (Brown 2008)
In the fall of 1992, the Service's Laconia Office of Fishery Assistance conducted a survey of fish present in the refuge's three ponds. They conducted surveys at Upper Peverly, Lower Peverly, and Stubbs Ponds using an 18.0 foot long (5.5 m) electrofishing boat (boom-type with direct current). In 2007, they repeated the survey to determine if there were any significant changes in fish species composition and abundance.

Forest Health Assessment of Great Bay National Wildlife Refuge (2007)
In the summer and fall of 2006, the USDA Forest Service, Durham Field Office–Forest Health Protection staff conducted an assessment of the general overall health and condition of the refuge's forested areas. Appendix H includes their final Forest Health Assessment report.

Geological Assessment of Cores from the Great Bay National Wildlife Refuge (2007)
In 2006, U.S. Geological Survey (Foley et al. 2007) sampled two wells on the refuge to analyze geological sources of arsenic and zinc in ground and surface waters.

Estimating Egg Mass Abundance of Pool-breeding Amphibians (2003)
In 2002 to 2003, a regional study used a dependent double-observer method to estimate numbers of wood frog and spotted salamander egg masses in three to four pools on the refuge. (Evan H. Campbell Grant et al. 2003).

Investigation of Frog Abnormalities on National Wildlife Refuges in the Northeast U.S (2003)
From 1997 to 2001, the Service conducted a regional study to determine any national wildlife refuges had sites with frequently observed frog abnormalities. The study evaluated if the prevalence of abnormalities at a site was consistent within a season and among years, as well as investigated possible causes for abnormalities.

Field Metabolic Rate of Wild Turkeys in Winter (Coup and Perkins 1999)
Coup and Perkins (1999) used the refuge as the primary study site to investigate the field metabolic rate of free-ranging eastern wild turkeys.

Refuge Natural Resources

Topography and Soil

The refuge's topography is typified by gently rolling coastal hills ranging in elevation from sea level to 100 feet above sea level. The refuge has a variety of soil types, mostly from marine and glacial parent materials. The most common soil type on the refuge is Boxford silt loam, and much of the rest of the refuge is sandy and silty loams. Table 2.8 describes the major soil types on Great Bay Refuge.

For more detailed information on the area's soils, visit the Web Soil Survey online at: *http://websoilsurvey.nrcs.usda.gov/app/HomePage.htm* (USDA-NRCS 1994; accessed November 2011). The Web Soil Survey application allows users to generate soil maps for locations throughout the United States, as well as read detailed soil descriptions.

Greg Thompson/USFWS

Beaver pond on the refuge

Table 2.8. Major Soil Types on Great Bay Refuge from the Soil Survey of Rockingham County (USDA-NRCS 1994)

Soil Name	Soil Use and Vegetation	Soil Composition	Parent Material	Slope	Drainage
Boxford	Most areas are either forested or used for growing forage crops for livestock, silage corn, and vegetables. Some areas are used for urban structures. Dominant tree species are white pine and a mixture of northern hardwoods.	Silt loam	Marine	0 to 8 percent	Moderately well-drained
Smoothed Udorthents	Most areas are used for urban development, landfills, or left idle.	–	Anthropogenic	–	Not rated
Pennichuck Channery	Gently sloping areas are used for row crops, truck, farming, grassland, and orchards. Sloping areas are used as orchards, grassland, and woodland. Forested areas are mostly white pine, red oak, white oak, red maple, and sugar maple.	Very fine sandy loam	Glacial till	0 to 15 percent	Well drained
Hoosic	Most areas have been cleared and are used for pasture or to grow hay, corn, small grains, vegetable crops, and deciduous fruit. Forested areas contain sugar maple, oak and hickory species, and American beech.	Fine sandy loam	Glacial outwash	3 to15 percent	Somewhat excessively drained
Squamscott	Most areas are forested. Principle trees are white pine and red maple. Some areas that are drained are in cropland.	Fine sandy loam	Marine	0 to 5 percent	Poorly drained

Habitat Types and Associated Wildlife

Despite its relatively small size, Great Bay Refuge supports a diversity of habitat types (table 2.9). The refuge has 2 acres of rocky shoreline, which is important to maintaining the health of the habitats of the Great Bay Estuary, including channel bottom, eelgrass meadows, mudflats, salt marsh, and rocky intertidal. The upland and freshwater habitats of the refuge include oak-hickory forest, shrublands, grasslands, forested and shrub wetlands, and impounded wetlands. The refuge is 60 percent upland forest or rocky upland, 18 percent grassland or shrubland, and 22 percent freshwater or saltwater wetland, including open water and forested wetlands.

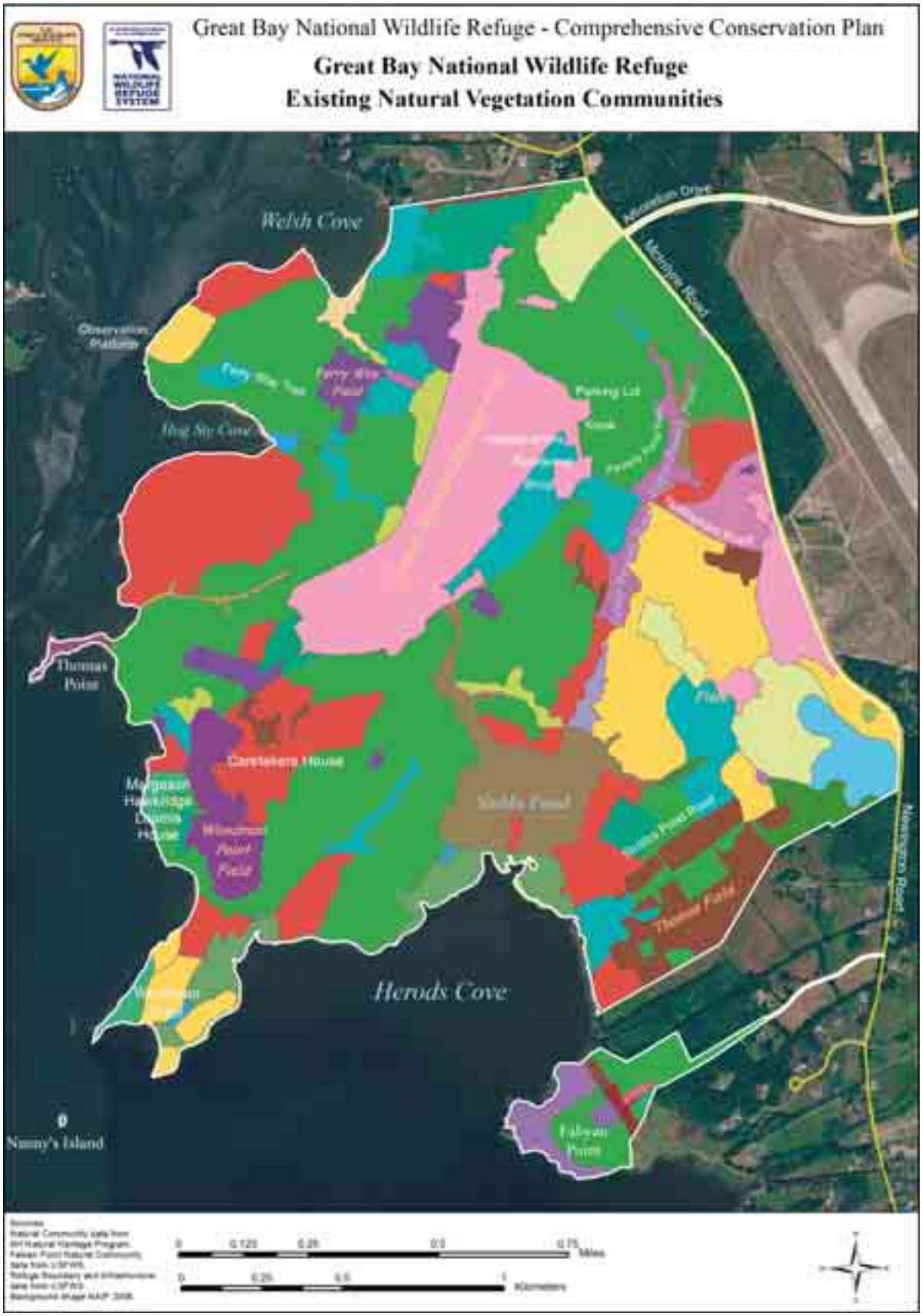
Tim Williams

Red fox

Table 2.9. Natural Community Types and Associated Habitats on Great Bay Refuge.

Habitat	Habitat Acres	Natural Community Type	Acres
Salt marsh	36	High salt marsh	23
		Low salt marsh	6
		Low/high salt marsh complex	5
		Brackish marsh	2
Rocky shoreline	2	Coastal rocky headland	2
Freshwater impoundments	62	Open-basin cattail marsh	45
		Open water/beaver impoundment	14
		Tall graminoid emergent marsh	3
Forested and scrub-shrub wetlands and vernal pools	149	Low red maple–elm/musclewood/ladyfern silt forest	69
		Seasonally saturated red maple swamp	38
		Black gum–red maple basin swamp	14
		Speckled alder basin/seepage shrub thicket	12
		Red maple–sensitive fern-tussock sedge basin/ seepage	12
		Graminoid-forb-sensitive fern seepage marsh	2
		Wet gravel pit-artificial pondshore	<1
		Short graminoid-forb meadow marsh/ mudflat	<1
Oak-hickory forest	659	Mesic Appalachian oak–hickory forest	375
		Dry mesic Appalachian oak–hickory forest	147
		Dry Appalachian oak-hickory forest	90
		Plantation	25
		Forest on fill	12
		Red pine forest woodland	8
		Dry-mesic field/shrubland; reverting to forest	2
Shrubland	26	Dry-mesic field/shrubland	23
		Mesic field/shrubland	3
Grassland	169	Dry field	95
		Dry to wet field mosaic	19
		Dry-mesic field	55
		TOTAL	**1,103**

**Table summarized by refuge staff based on field visits by Sperduto (2000, 2010) and GIS analysis. Acres rounded up to nearest whole number.*


Great Bay National Wildlife Refuge - Comprehensive Conservation Plan
Great Bay National Wildlife Refuge
Existing Natural Vegetation Communities
Welsh Cove
Observation Platform
Ferry River Field
Parking Lot
Thomas Point
Caretakers House
Herods Cove
Nanny's Island
Fabyan Point
Miles
Kilometers

Legend for Map 2.3.

Great Bay National Wildlife Refuge - Comprehensive Conservation Plan

Natural Communities Legend

- Alder seepage thicket
- Black gum-red maple basin swamp
- Brackish marsh
- Coastal rocky headland
- Coastal shoreline strand/swale
- Dry Appalachian oak forest
- Dry Appalachian oak-hickory forest
- Dry field/shrubland/sandpit
- Dry to wet field mosaic
- Dry-mesic Appalachian oak-hickory forest
- Dry-mesic field/shrubland
- Forest on fill
- Graminoid-forb-sensitive fern seepage marsh
- Herb-marsh/Alder thick/RM-sens-fern swamp complex
- Herbaceous seepage marsh
- High salt marsh
- Intertidal rocky shore
- Low red maple-elm/musclewood/ladyfern silt forest
- Low salt marsh
- Low/high salt marsh complex
- Mesic Appalachian oak-hickory forest
- Mesic field/shrubland
- Open water/beaver impoundment
- Open-basin cattail marsh
- Plantation
- Red maple - red oak - cinnamon fern forest
- Red maple - sensitive fern swamp
- Red maple - sensitive fern swamp (early successional)
- Red maple/sensitive fern-tussock sedge basin/seepage
- Red pine forest/woodland
- Seasonally saturated red maple swamp
- Short graminoid-forb emergent marsh/mudflat
- Speckled alder basin/seepage shrub thicket
- Tall graminoid emergent marsh
- Wet field/shrubland
- Wet gravel pit-artificial pondshore

In 2000 and 2010, the New Hampshire Natural Heritage Bureau (NHB) identified and mapped natural community types and other cover types on the refuge (Sperduto 2000 and 2010) (map 2.3). Natural communities are recurring assemblages of plants found in particular physical environments that are distinguished by three characteristics: 1) a definite plant species composition; 2) a consistent physical structure (such as forest, shrubland, or grassland); and 3) a specific set of physical conditions (such as different combinations of soils, nutrients, drainage, and climate conditions). Most wildlife species do not select habitats on as fine a scale as natural community types. Therefore, we have combined some of the natural community types with broader wildlife habitat types. Both classifications are important to understanding and maintaining the refuge's biological diversity, integrity, and environmental health.

Exemplary natural communities are those that have been minimally impacted by humans, contain a species composition representative of the type, and have intact ecological processes that maintain these species. The NHB identified the following six "exemplary" natural communities on Great Bay Refuge (*http://www.nhdfl.org/natural-heritage-and-habitats/;* accessed December 2011):

- Dry Appalachian oak–hickory forest
- Mesic Appalachian oak–hickory forest
- Coastal rocky headland
- Red maple–sensitive fern swamp
- Black gum–red maple basin swamp
- High salt marsh

Estuarine Habitats

Salt Marsh

Several areas of substantial salt marsh, totaling approximately 39 acres, occur along the refuge' shore, with the best developed occurring behind Woodman Point and Stubbs Pond. The low salt marsh is dominated by smooth cordgrass, while salt meadow cordgrass, spike grass, and black-grass are dominant in the high salt marsh. Small brackish marsh occur at the upland edge of salt marshes were where drainages meet the bay, and are dominated by narrow-leaf cattail and sedge species. The NHB reported several rare plants in the refuge's salt marsh, including seaside mallow, a State-listed threatened species (NHNHB 2009). Estuarine communities are uncommon in New Hampshire because of the limited shoreline within the State and the intense development and disturbance near much of the coastal salt marsh.

In 1992, prior to refuge establishment, the town of Newington hired a contractor to spray the pesticide *Bacillus thuringensis* serotype *israelensis* (Bti) on marshes to control the extensive mosquito breeding occurring in areas of the marsh heavily impacted by humans. Beginning in 1996, in an effort to eliminate chemical application on the marshes and restore fish and wildlife habitat, the refuge initiated four open marsh water management (OMWM) projects. In total, 16.3 acres were completed at Herods Cove, 9.9 acres at Woodman Point, and 3.4 acres at Welch Cove.

OMWM objectives included elimination of invasive plants (e.g., *Phragmites*, cattail); restoration of native salt marsh vegetation, such as wigeongrass; and creation of refugia habitat for the mummichog minnow. This minnow is a predator of mosquito larvae and its presence could eliminate the need to spray Bti for mosquito control. Various techniques were used. Ditch plugs were constructed to block man made drainage ditches and create open water habitat. Pannes (beginning at 2 inches and gradually sloping to 24 inches in depth) were excavated to increase open water habitat and to facilitate wading bird access. Sumps (2-foot-deep depressions) were excavated within pannes to ensure minnow

survival during drought conditions. In some areas, shallow connector ditches were also excavated to allow minnow access between pannes.

Rocky Shoreline
Woodman Point and Thomas Point support approximately 2 acres of southern New England coastal rocky headland, considered an unusual but exemplary community type by the NHB. The headlands have a largely natural character with narrow vegetation zones representing both estuarine and upland plant associations. The upland portion at Thomas Point is dominated by red cedar and some black oak, red oak, alders, bayberry, and common juniper. The salt marsh and rocky areas of the point support estuarine plants such as seaside goldenrod (NHNHB 1990).

Large red and white pines grow on the headlands, providing important perch and roost trees for bald eagles wintering on Great Bay. The refuge has suitable eagle nest sites, although it was not until this year that eagles have nested on Great Bay. Two red pine forests (approximately 4 acres each) are found by Woodman Point and west of the Margeson Estate. These pines are estimated to be about 150 years old and are natural communities disjunct from larger patches found primarily in the White Mountains region (Sperduto 2010).

The 0.25-acre Nannie Island off Woodman Point is the only island on Great Bay Refuge. A mallard pair occasionally nests on the island. Some invasive plants are present. The island was evaluated for tern nesting possibilities but was deemed not suitable due to its small size and susceptibility to predation and human disturbance.

Eelgrass and Shellfish Beds
Two other regionally significant habitat types lie just off the refuge boundary in State waters: eelgrass beds and shellfish beds. Their protection is a priority amongst partners in the Great Bay Estuary. Refuge staff, as a partner in these protection efforts, conduct informal monitoring to evaluate if refuge management actions are impacting these habitats.

Eelgrass beds are an essential habitat in the Great Bay Estuary and the basis of an estuarine food chain, providing food for migrating and wintering waterfowl and habitat for juvenile fish and invertebrates. Eelgrass beds are particularly important to juvenile rainbow smelt, Atlantic silversides, nine-spined sticklebacks, alewife, and blueback herring. Eelgrass leaves slow water flow, filtering suspended sediments from the water column (Short et al. 1992a). A dramatic decline in eelgrass beds in 1989, to only 300 acres, was linked to an outbreak of the *Labryrinthula zosterae* slime mold, commonly called "wasting disease." Eelgrass populations recovered from the disease but have been showing a slow steady decline since 1990 (PREP 1999). Reduced water clarity from suspended sediments, nutrient loading, and decreased filtering capacity may be contributing to eelgrass populations decline. This is an ongoing management issue in Great Bay (Short et al. 1992b). A significant eelgrass bed exists in Herods Cove, part of which is within the refuge boundary.

The Great Bay Estuary and its tributaries support 52 acres of oyster beds, over 2,500 acres of scattered clam flats, and significant areas with blue mussel beds, razor clams, and scallops. Softshell clams are an important food source for wintering black ducks. The estuarine habitat extending from Herods Cove to Nannie Island is an important nursery area for oysters and clams, supporting more than half of the spawning oyster population in the bay (PREP 2009).

Freshwater Impoundments

Historical Uses

The refuge has five freshwater impoundments: Lower Peverly Pond, Upper Peverly Pond, Stubbs Pond, and two small impoundments in the Weapons Storage Area and along Ferry Way Trail. Upper Peverly Pond (12 acres), Lower Peverly Pond (7 acres), and Stubbs Pond (44 acres) are interconnected by Peverly Brook and fed by springs and small tributaries. These impounded wetlands are part of the 907-acre Peverly Brook watershed.

Upper and Lower Peverly Ponds were constructed as a water supply for the city of Portsmouth around 1900. During 1956 to 1959, the dike between the two ponds was improved with a spillway and a new dam. At the same time, Lower Peverly Pond was dredged to provide a swimming area and the water control structure boards were raised 3 feet. Maps 2.4 through 2.6 are aerial photographs that show these changes to the freshwater impoundments from 1952 to 1998 (Public Archaeological Laboratory, 2010).

The Air Force used Upper Peverly Pond for boating and angling, and used Lower Peverly Pond as a recreational swimming pond. Stubbs Pond area was a salt marsh until it was diked for mosquito control in 1963. Several years later, the dike was raised to provide for a warm water fishery and the pond was named after General Stubbs. The Air Force managed vegetation in all three ponds to improve recreational fish habitat. They also stocked the three ponds with recreational fish (table 2.10). No stocking has occurred since the refuge was established in 1992. Table 2.17 provides a description of the current fisheries resources in these ponds.

Prior to 1980, the Air Force's impoundment management generally consisted of herbicide application. Records indicate that Upper and Lower Peverly Ponds were treated with Diquat in 1966. Generally, management activities were not documented; however, a 1980 Fishery Management Plan by the Air Force stated that annual programs to control algae growth in all three ponds were implemented. The 1980 plan recommended minimizing the application of herbicides and suggested mechanical control instead. In 1979, 7 acres of Stubbs Pond were mechanically cleared. In the 1980s, plastic tarps were placed over weed growth in Stubbs Pond. It appears that the tarps were largely ineffective. During the 1980s, vegetation (documented as *Chara spp.*) was estimated to be covering 90 percent of the surface area of Stubbs Pond.

Table 2.10. Fish Stocking During Air Force Management of Upper Peverly, Lower Peverly, and Stubbs Ponds

Pond	Year Stocked	Species
Upper Peverly	1956	Rainbow and brook trout
	1965 and 1966	Largemouth bass
	1972	Crayfish
Lower Peverly Pond	1956	Rainbow and brook trout
	1965 and 1966	Largemouth bass
Stubbs Pond	1965 and 1966	Largemouth bass
	between 1971 and 1981	Alewife (stocked 4 times)
	1972	Crayfish

Source: Great Bay Refuge Fisheries Management Plan, 1994

Great Bay National Wildlife Refuge - Comprehensive Conservation Plan
Great Bay NWR Area - July 1952

Great Bay National Wildlife Refuge - Comprehensive Conservation Plan
Great Bay NWR Area - October 1962
Upper Peverly Dam
Lower Peverly Dam
Sawyer Point Dam

Great Bay National Wildlife Refuge - Comprehensive Conservation Plan
Great Bay NWR Area - Circa 1998
Upper Peverly Dam
Lower Peverly Dam
Stubbs Point Dam

Stubbs Pond (Recent Management)
The 44-acre Stubbs Pond is a freshwater impoundment currently managed primarily for migratory birds, with a focus on spring and fall migrating waterfowl. The goal is to control the monoculture of cattail vegetation, and to increase vegetation diversity by opening up areas and increasing the ratio of open water to emergent vegetation while controlling invasive purple loosestrife and phragmites. Water level management has fluctuated from year to year, in part because of the complexities in managing Stubbs Pond to address multiple concerns. Large bur-reed, a State threatened species, has been found in the pond.

Since the installation of a new water control structure in 1996, cattail growth has been excessive, reducing the proportion of open water to vegetation. Mowing and re-flooding were used beginning in 1997 to reduce cattail coverage. In 1999, water levels were not dropped until August, and moist soil vegetation production was poor. Subsequently in 1999, the tidal gates were opened October 26th and closed on December 1st to coincide with extremely high tides to create a tidal flush as recommended by Leigh Fredrickson (University of Missouri, personal communication with refuge manager at the time). Fredrickson also recommended treating a small (10 acre) area of cattails with glyphosate. However, due to permits required by the State of New Hampshire, the planned glyphosate treatment was pushed back until August of 2000.

In the summer and early fall of 2002, Stubbs Pond was drawn down to allow mowing of 4 acres of cattail along the western edge of the pond and west of the main water channel by Swamp Inc. During late fall of 2002, we blocked all three pipes that run under the dike at Stubbs Pond to allow water levels to rise and be held at higher levels than allowed by the water control structure. When the pipes are open, water levels can never exceed approximately 6 to 6.5 feet on the water control structure gauge. With all boards in place, water levels rose over the winter to around 7.0 feet. Stubbs Pond was kept as full as possible, between 7.1 and 7.3 feet, throughout the summer of 2003 in an attempt to control cattail growth. By late August the cattail stands were reduced by 25 percent. The entire southeastern quadrant of Stubbs Pond, normally full of cattail, remained almost cattail free. The western portion of the pond that was mowed in the fall of 2002 had some cattail reemerge during the summer, with some small pockets of open water. We also observed increased populations of other plant populations important for wildlife, including large bur-reed, soft stem bulrush, wild celery, and arrowhead. There were also fewer purple loosestrife plants in bloom during mid to late summer.

On September 11, 2003, the refuge staff began to lower the water level in Stubbs Pond to provide some feeding habitat for migrating birds. By mid-November the water level was 4.3 feet. Dead cattail stems were evident in many areas of the pond as water levels were drawn down. On November 18, all boards were put back in the control structure to allow water to rise to full pool over the winter.

During 2004, water levels in Stubbs Pond were again maintained at an operating level of around 7.0 feet during the spring and summer in an effort to further stress growth of cattail. This effort was apparently successful and reduced cattail populations another 25 percent. Cattail stands were now limited to several larger clumps around the center island and along the northwestern and eastern edges of the pond. On September 10, the refuge staff began lowering the water levels to provide habitat for the fall bird migration. Water levels reached a low of 3.4 feet on November 17, when all boards were put back in to allow the pond to raise to full pool over the winter.

It appears that spring drawdown of this pond allows cattail and purple loosestrife to increase, while inhibiting other more desirable species. Therefore, current plans are to keep Stubbs Pond high during the spring and summer to discourage cattail growth. A drawdown in early fall benefits migratory birds. If weather permits, it may be possible to mow, spray, or burn cattail stands in the fall before refilling the pond in the winter to early spring.

Stubbs Pond and the adjacent bay are important migratory and wintering habitat for waterfowl. It is a particularly important to area waterfowl during spring and fall staging as evidenced by the number and variety of waterfowl species observed on the pond, particularly black ducks. However, no regular or formal quantitative surveys for waterfowl use have been conducted by the refuge or the State. In winter of 2010, Parker River staff recruited volunteers to start formal surveys for all three impoundments, as well as the bay, during spring and fall waterfowl migration. Two surveys were conducted in December and four surveys in April. Table 2.11 lists the most abundant waterfowl species recorded during the survey.

Previous observational data indicates that waterfowl use of Stubbs Pond is highest in autumn (September to November). NHFG (2011) has also reported that it is common to observe more than 500 ducks and geese in Stubbs Pond in September. Due to this, NHFG and the Service use Stubbs Pond for an important waterfowl banding program during Septembers. Winter peak waterfowl use is comparatively higher in the bay (a total of 676 individuals; most common species are Canada goose, American black duck, and mallard) than in Stubbs Pond (94 individuals). However, waterfowl use of Stubbs Pond is higher than that of the bay during the springtime.

Table 2.11. Most Common Species Detected During Waterfowl Survey of Stubbs Pond, 2010.

Month	Species	Number Observed
April 2010	Ring-necked duck	100
	Ruddy duck	94
	Wood duck	14
	American wigeon	12
	Canada goose	10
December 2010	American black duck	50
	American coot	20
	Mute swan (nonnative)	17
	American wigeon	6

Between 1999 and 2003, five marsh bird surveys were completed for the refuge. Virginia rail (0 to 5 birds per survey) and marsh wren (2 to 9 birds per survey) were consistently found using the impoundments. Other species that occasionally bred in the impoundments included least bittern, sora rail, common gallinule, pied-billed grebe, and king rail. Most of the marsh and wading birds occurred at Stubbs Pond. The refuge strategy at Stubbs Pond of maintaining a balance of open water to emergent vegetation with an emphasis on vegetative diversity provides the most benefit to a majority of marsh and wading birds. The amount of emergent wetland habitat has declined significantly throughout North America

along with apparent declines of marsh-dependent birds. Changes in water levels, ratios of mud flats to open water areas, invertebrate communities, and amount of emergent plant cover in marsh habitats could affect habitat quality for marsh birds.

In 2002 and 2006, an evaluation of all three dams on Upper and Lower Peverly Ponds and Stubbs Pond occurred. According to the 2006 Safety Evaluation of Existing Dams (SEED) report, Stubbs Pond Dam is in "poor" condition. Poor condition is defined by "a potential dam safety deficiency is clearly recognized for normal loading conditions. Corrective actions to resolve the deficiency are recommended." The "poor" rating for Stubbs Pond Dam was primarily due to two deficiencies: erosion around three steel pipes embedded in the dam's embankment, and the presence of vegetation in the dam's emergency spillway. Continued deterioration of Stubbs Pond would likely jeopardize the refuge's ability to maintain the pond as open water habitat for migratory birds (Brownell, pers. comm. 2011). The following specific recommendations from the 2006 SEED report are being addressed as noted below.

Recommendations	Refuge Actions in Response
Remove 3 steel pipes that lie embedded in the embankment and backfill the area	Future project targeted by 2014
Mow embankments, remove trees and other debris from spillway	Ongoing
Remove brush and debris on dam and side slopes	Ongoing
Install riprap in emergency spillway where needed	Future project targeted by 2014
Enlarge emergency spillway and left abutment; consider doing this during brush and debris removal and riprap installation	Evaluating
Repair wave erosion on escarpment near Herods Cove	Monitoring, but repairs would conflict with horseshoe crab spawning habitat

A fish passage structure was installed in 1995 to benefit alewife and blueback herring migration, but was not operated until the spring of 2003. The fish passage is now opened in late April to allow alewife and blueback herring migration into Stubbs Pond through early July. The fish passage structure requires about 1 to 1.5 feet of running water to be effective for fish. It is primarily designed to operate at high tides since tidal mud flats in Herods Cove at low tide prevent fish reaching the ladder. Outside of fish spawning season, the fish ladder is essentially not operational by design. In fact, there are times of the year when no water is flowing through the fish ladder. We have plans to evaluate this original design to see if the existing fish ladder could be improved to enhance fish passage. Operation of the fish ladder does not impact our ability to manage water levels in Stubbs Pond for migratory birds, except possibly in extremely dry years (Brownell, pers. comm. 2011).

Upper Peverly Pond (Recent Management)
A new water control structure was installed on the 12-acre Upper Peverly Pond in 1999. The pond was drawn down several times during spring with positive vegetative and waterfowl population response to this management. During 2004, a botanist inventorying invasive species for the refuge discovered that brittle waternymph had become widely established in the pond. Brittle waternymph is an annual exotic plant with no easy control methods. The water level in the pond was held high all year to contain this invasive plant until more is determined on

how to control it. It is used by a limited number of waterfowl and marsh birds such as great blue heron, ring-neck duck, wood duck, and bufflehead for foraging and resting during migration.

According to the 2006 SEED report, Upper Peverly Pond Dam is in "fair" condition. Fair condition is defined by "no existing dam safety deficiencies are recognized for normal loading conditions. Infrequent hydrologic and/or seismic events would probably result in a dam safety deficiency." The following specific recommendations from the 2006 SEED report are being addressed as noted below.

Recommendations	Refuge Actions in Response
Remove beaver dams from spillways	Ongoing
Weld or lock cover on outward valve	Done
Back fill existing animal burrows	Not needed
Lubricate valves	Done
Monitor seepage along abutment	Monitoring
Monitor crack and depression on dam	Monitoring
Remove debris and maintain embankment	Ongoing as needed and as resources allow

Lower Peverly Pond (Recent Management)
The 7-acre Lower Peverly Pond has limited water control capabilities given that its antiquated spillway is deteriorating. In 2005, plans were developed to repair the dike; however, the State denied the permits requesting further documentation of the need for repairs versus removal of the dam. Without water control capability, this pond is used primarily to pass water from Upper Peverly to Stubbs Pond. Brittle waternymph was found in this pond in 2004. Lower Peverly Pond supports a limited number of waterfowl, notably some wood ducks and black ducks. An occasional bufflehead, common merganser, and a few ring-necked ducks can be observed during the spring and fall migration.

According to the 2006 SEED report, Lower Peverly Pond Dam is in "unsatisfactory" condition. Unsatisfactory condition is defined by "immediate actions to rehabilitate or decommission the dam are recommended." The "unsatisfactory" rating for Lower Peverly Pond Dam was primarily due to one deficiency: the deteriorating and failing spillway. The following specific recommendations from the 2006 SEED report are being addressed as noted below.

Recommendations	Refuge Actions in Response
Monitor and inspect failing spillway weekly	Ongoing, but not weekly
Monitor beaver activity and remove debris from spillway	Ongoing
Remove trees and brush from embankment	Determined not necessary
Rehabilitate or decommission dam	See chapter 3, objective 1.3 under each alternative for proposed actions

Forested and Scrub-shrub Wetlands and Vernal Pools
Several vegetated wetlands habitat types occur on the refuge as noted in table 2.9. Approximately 81 percent of the wetlands types on the refuge are dominated by trees, mainly red maple and some black gum. The remaining 19 percent of vegetated wetlands is shrub-scrub wetlands dominated primarily by speckled

alder. Map 2.3 shows the locations of the forested and scrub-shrub wetlands. Vernal pools, which are not mapped, are a critical habitat feature that is imbedded in each of these wetlands types.

Woodman Point looking north

Greg Thompson/USFWS

NHB discovered a black gum-red maple basin swamp on the refuge that contains dozens of old black gum. Some of the trees were likely more than 200 years old, although a more detailed assessment is needed. Seepage swamps on the refuge have the potential for supporting rare plants (Sperduto 2000). Seepage swamps are forested wetlands with plants indicative of groundwater seepage such as spicebush, horsetail, marsh marigold, American bittersweet, and certain sedges.

In 2001 the Northeast Amphibian Research and Monitoring Initiative was launched on a host of national wildlife refuges and state parks, including Great Bay Refuge, due to increasing concern over amphibian declines and malformations. The goal of the study was to establish baseline conditions and to assess population trends of vernal pool breeding amphibians (e.g., wood frog and spotted salamander). An annual frog and toad calling survey, following the North American Amphibian Monitoring Program (NAAMP) protocol, was begun in 2000. The surveys on the refuge have yielded spring peeper, gray tree frog, wood frog, leopard frog, and American toad. Outside of this study, there has been no formal or comprehensive survey of vernal pool locations on the refuge.

The refuge records about 6 to 12 breeding American woodcock on the refuge each year. These birds use the speckled alder-shrub thickets that are scattered around the refuge for daytime resting and foraging areas. Woodcock prefer shrublands in close proximity to young hardwood forests for use as nest sites. The willow flycatcher prefers open habitat with scattered shrubs or forest edges, including willow thickets along streams, scrub-shrub wetlands, and brushy fields.

A 1-acre wetland was created in 1995 by installing a wooden water control structure to impound several drainage ditches in the former weapons storage area. This wetland holds water during the spring and early summer and goes dry during late summer. The vegetation is predominantly cattails, which support some marshbirds, such as sora and Virginia rails, plus many species of frogs.

Upland Habitats

Oak-hickory Forest

Many of the forests on Great Bay Refuge reflect their relatively recent agricultural history and are dominated by successional white pine or hardwoods. Although pine, hardwoods, and mixed stands are native to the area, the current overstory dominant tree species are not necessarily the best indicator of what natural community types occurred on the refuge. White pine stands are common and are generally a stronger indication of past land use history than they are of the long-term potential of a site. The NHB used the total composition of

plant species, in combination with soil attributes, to indicate community type (Sperduto 2000).

In 1990, the NHB surveyed the entire former Pease Air Force Base. In that survey, Woodman Point was described as a transitional forest between central and northern hardwood regions. It has large mature red pines that appear to be natural in origin. The drier portion supports large shagbark and pignut hickories, while the more mesic area has large white and red oaks (NHNHP 1990). A 2010 survey by NHB determined that the red-pine woodland is about 150 to 170 years old and is most likely a natural occurrence.

Much of the rest of the upland area of the refuge was mapped as oak-hickory forest. The natural community types include dry Appalachian oak forest and mesic Appalachian oak-hickory forest. The refuge falls within the northern extent of the central hardwoods forest region with forests dominated by oak and pine. The dry to mesic Appalachian oak forests on the refuge are characterized by southern species that reach the northern extent of their ranges in this region. It is distinguished from dry red oak–white pine forests, which tend to lack significant representation of southern or Appalachian species such as shagbark hickory. Oak forests appear to be fire-dependant over long periods in other regions of the country. Some of these forests may succeed to other overstory species in time due to lack of adequate red oak regeneration, and from increases in American beech on drier sites, and sugar maple and American beech on more mesic sites. Repeated fire would tend to knock back fire-sensitive species like American beech and sugar maple. As such, any natural, semi-natural, and/or controlled fire regimes may be necessary for the long-term maintenance of oak and hickory on some sites (Sperduto and Nichols 2004). Under climate change projections, the range of the oak-hickory forests is likely to shift northwards, making southern New Hampshire the middle of its range. This shift may preclude succession to northern hardwood as described above. Changing climate conditions may also increase likelihood of fire, which would sustain oak-hickory forests.

Pine Plantations

There are five pine plantations of varying size on the refuge. These pines were dated to the late 1970s, and were most likely planted by the military as training exercises. The pines in these plantations are dying due to an unknown disease, and oak-hickory forest species are regenerating under the pine overstory. The conversion of these plantations to oak-hickory forest will be monitored to ensure a healthy forest ecosystem with minimum invasive plants.

Upland Shrub Habitat

The refuge maintains approximately 26 acres of shrub habitat through periodic mowing or use of a hydro-ax to prevent succession to forest cover. These are mainly small units, less than 5 acres in size, and historically maintained as woodcock singing grounds. A management issue on the refuge that particularly affects grassland and shrub management is the prevalence of invasive species that quickly invade these areas if left unmowed. Autumn olive is particularly difficult invasive plant to control as it quickly invades open land habitat. Shrub habitat provides nesting and foraging habitat for birds of conservation concern including prairie warbler, blue-winged warbler, eastern towhee, and American woodcock. It also supports other thicket-dependent native species. Over the course of the next 15 years, we would let these small forest openings revert and manage for larger patches of shrub habitat that would provide better habitat for shrub-dependent birds and New England cottontail. We would also target sites were conditions are more conducive to shrub management (e.g., wet areas that naturally support alder and dogwoods).

Grassland
The refuge manages approximately 169 acres of grassland habitat, primarily in the former Weapons Storage Area, north of Woodman Point, along Ferry Way Trail, and the Thomas Field. Many of these grassland areas have a component of little bluestem as well as nonnative grasses. The largest grassland, approximately 70 acres comprised of 8 treatment areas, is in the former weapons storage area. This grassland complex is managed using prescribed fire and mowing to control autumn olive and other woody plants. Most sections of the weapons storage area were either mowed, hydro-axed, or burned in 1999 to prepare for a 2000 herbicide application to control autumn olive. The hydro-ax was also used to expand the grassland by clearing trees and shrubs at the southwest end of the weapons storage area. The 30-acre Thomas Field and 24-acre Woodman Point Field complex are mowed and hydro-axed. A sandy field north of the Weapons Storage Area has maintained itself as a little blue stem community without active management for over 10 years. This field is south of the northern most pine plantation (15 acres), which also support sandy soils, and potentially could be managed as a 20- to 30-acre grassland unit, contiguous with the grasslands in the Weapons Storage Area. The remaining grassy areas range from 2 to 4 acres and are mowed every 1 to 2 years to benefit woodcock.

Grassland bird species recorded during surveys on the refuge from 2001 to 2003 included eastern meadowlark, bobolink, upland sandpiper, field sparrow, red-winged blackbird, American kestrel, and vesper sparrow. Brown thrasher and eastern towhee, two shrubland species, were also recorded. In 2003 and 2004, at least one pair of upland sandpipers was observed using the former Weapons Storage Area and the Thomas field during the nesting season. The Thomas field pair was observed nesting for the second year in a row.

The Pease Airport continues to support nesting upland sandpipers due to the large expanse of grassland habitat surrounding the runways. Excluding buildings, there are approximately 500 to 600 acres of grasslands surrounding the runways and taxiways. On average, a dozen pairs of upland sandpipers have nested at the airport in recent years. The only confirmed upland sandpiper breeding areas in New Hampshire are at Pease Airport and the refuge, although the species has been sighted at several other locations including Dover, Manchester, and southern Coos County (P. Hunt and D. De Luca, NH Audubon, personal communication with refuge manager).

Rare Plant Populations
The following four State-listed rare plants are documented on the refuge: large bur-reed, seaside mallow, black sedge, and wild lupine (NHNHP 2009).

Invasive Plants
Executive Order 13112 (Invasive Species, dated February 3, 1999) defines an invasive species as a nonnative species "whose introduction does or is likely to cause economic or environmental harm or harm to human health." The Executive Order requires the National Invasive Species Council (Council) to produce a National Invasive Species Management Plan (Plan) every 2 years. In January 2001, the Council released the first plan, which serves as a blueprint for all Federal action on invasive species. The plan focuses on those nonnative species that cause or may cause significant negative impacts and that do not provide an equivalent benefit to society. The unchecked spread of invasive plants threatens the biological diversity, integrity and environmental health of all refuge habitats. In many cases, they have a competitive advantage over native plants and form dominant cover types, reducing the availability of native plants as food and cover for wildlife. One report estimates the economic cost of invasive species in the U.S. at $137 billion every year (Pimentel et al. 2000). Up to 46 percent of the plants and animals federally listed as endangered species have been negatively impacted by invasive species (Wilcove et al. 1998, National Invasive Species Council 2001).

The Service's Northeast Region initiated an effort to systematically identify, locate, and map invasive plant species occurring on national wildlife refuge lands to provide a foundation for developing an effective integrated management plan. Refuges will use this information to guide the development of control, monitoring, and evaluation projects.

The Service Manual (620 FW 1.7G) provides the following guiding principles on managing invasive species on national wildlife refuges:

(1) Manage invasive species to improve or stabilize biotic communities to minimize unacceptable change to ecosystem structure and function and to prevent new and expanded infestations of invasive species.

(2) Conduct refuge habitat management to prevent, control, or eradicate invasive species using techniques described through an integrated pest management plan, or other similar management plan, the plans comprehensively evaluate all potential integrated management options, including defining threshold/risk levels that will initiate the implementation of proposed management actions.

(3) Evaluate native habitat management activities with respect to their potential to accidentally introduce or increase the spread of invasive species and modify our habitat management operations to prevent increasing invasive species populations.

(4) Refuge integrated pest management (IPM) planning addresses the abilities and limitations of potential techniques including chemical, biological, mechanical, and cultural techniques.

(5) Manage invasive species on refuges under the guidance of the National Strategy for Invasive Species Management (USFWS 2003b) and within the context of applicable policy.

Great Bay Refuge initiated a baseline inventory and mapping of invasive species in 2002. Field surveys during 2002 to 2005 and 2008 detected 34 invasive species (table 2.12). Approximately 684 acres have been mapped as infested, 13 acres are currently considered free from invasives, and roughly 230 acres still need to be mapped, which will occur by 2013. Invasive species control methods used by the refuge include hand pulling with weed wrenches, annual mowing, and chemical and biological controls (for purple loosestrife).

From Woodman Point looking south

USFWS

Table 2.12. Invasive Plant Species on the Great Bay Refuge

Common Name	Scientific Name	Approximate Number of Refuge Acres Affected
Amur honeysuckle	*Lonicera maackii*	Less than 1
Autumn olive	*Elaeagnus umbellate*	205
Black locust	*Robinia pseudoacacia*	33
Black swallow-wort	*Cynanchum louiseae*	8
Border privet	*Ligustrum obtusifolium*	Less than 1
Brittle waternymph	*Najas minor*	3
Canada thistle	*Cirsium arvense*	47
Greater celandine	*Chelidonium majus*	Less than 1
Climbing nightshade	*Solanum dulcamara*	34
Coltsfoot	*Tussilago farfara*	Less than 1
Common barberry	*Berberis vulgaris*	247
Common buckthorn	*Rhamnus cathartica*	369
Common mullein	*Verbascum thapsus*	Less than 1
Common reed, *Phragmites*	*Phragmites australis*	Less than 1
Creeping buttercup	*Ranunculus repens*	26
Creeping jenny	*Lysimachia nummularia*	Less than 1
Dames rocket	*Hesperis matronalis*	2
European privet	*Ligustrum vulgare*	105
Glossy buckthorn	*Frangula alnus*	456
Ground ivy	*Glechoma hederacea*	1
Japanese barberry	*Berberis thunbergii*	207
Japanese honeysuckle	*Lonicera japonica*	Less than 1
Japanese knotweed	*Polygonum cuspidatum*	7
Japanese wisteria	*Wisteria floribunda*	Less than 1
Leafy spurge	*Euphorbia esula*	16
Morrow's honeysuckle	*Lonicera morrowii*	57
Multiflora rose	*Rosa multiflora*	268
Oriental bittersweet	*Celastrus orbiculata*	237
Purple loosestrife	*Lythrum salicaria*	19
Reed canarygrass	*Phalaris arundinacea*	39
Rugosa rose	*Rosa rugosa*	Less than 1
Sheep sorrel	*Rumex acetosella*	76
Spotted knapweed	*Centaurea maculosa*	2
Winged burning bush	*Euonymus alatus*	Less than 1

Refuge staff released biological agents for purple loosestrife control from 1995 until about 2005 (table 2.13). The refuge used two types of insects in an attempt to reduce that amount of loosestrife on the refuge: *Galerucella* spp. beetles and *Hylobuis transversovittatus* weevils. We have discontinued the biological control program given our poor success due to low beetle and weevil survival and the fact that purple loosestrife occurs in dispersed, low density populations on the refuge.

Table 2.13. Biological Control of Purple Loosestrife on Great Bay Refuge, 1995 to 2003.

Year	Number of *Galerucella* Beetles Released	Number of *Hylobuis* Weevils Released
1995	2,000	1,000
1996	1,000	300
1997	2,000	0
1998	6,000	0
1999	5,000	0
2000	Unknown	500
2001	80	2,000
2002	Unknown	1,000
2003	400	0

Fish and Wildlife

Threatened and Endangered Species

The Great Bay Estuary provides habitat for 23 species of State threatened or endangered plants and animals. The refuge hosts several State-listed species including upland sandpiper (endangered) and bald eagle, pied-billed grebe, and common tern (threatened). Osprey populations, a State species of special concern, have been increasing on the bay since the mid-1990s, and in 2006 there were nine known pairs. Not only does the bay host a significant and growing portion of the State's breeding osprey population, it also provides valuable habitat for osprey during spring and fall migration. Statewide, the population is doing well and was recently removed from the State's threatened list.

Historically, the bay provided habitat for small colonies of common terns, although they tended to experience low productivity. With the success of the tern colony at the Isles of Shoals, the bay's colonies have become less important in the overall picture, although the colony on Hen Island continues to support roughly a dozen pairs. Pied-billed grebes have been reported from Stubbs Pond.

Birds

The estuary is recognized as a New Hampshire Important Bird Area (IBA). The New Hampshire IBA program began in 2002 as a partnership among New Hampshire Audubon, NHFG, and UNH–Cooperative Extension. Since its inception, the New Hampshire program has identified 17 IBAs within the State, ranging from the seacoast to the Canadian border and up to the tops of the White Mountains. The IBA designation supporting Great Bay Estuary provides critical habitat to bird species (NH Bird Records 2009). The Great Bay IBA was identified based on three criteria: the presence of threatened and endangered bird species, the presence of other bird species and habitats of conservation concern, and the provision of areas where bird species congregate during breeding, migration, or overwintering. As highlighted above, the Great Bay Estuary and refuge provide habitat for four State-listed bird species. Other bird species of conservation concern in the estuary include the American black duck,

Tim Williams

Great blue heron

salt marsh and Nelson's sparrows, Virginia rail, and least bittern. Major habitats of conservation concern include estuary, salt marsh, mudflats, and emergent freshwater marsh.

The Great Bay Estuary and adjacent habitats provide a major wintering and migration stopover for 20 species of waterfowl, 27 species of shorebirds, and 13 species of wading birds. Over 80 percent of all waterfowl that winter in New Hampshire coastal areas are found in Great Bay. Great Bay is the primary wintering area for black ducks in New Hampshire, with 1,000 to 2,000 ducks usually tallied on the Christmas Bird Count. In contrast, the rest of the State combined supports 500 to 1,000 black ducks. It is also an important wintering area for bald eagles, and a breeding area for osprey. Although it supports much less salt marsh than the New Hampshire coast, the bay's marshes are home to most of the State's populations of Nelson's sparrow. Great Bay Refuge is at the southern edge of the sparrow's global range (*http://iba.audubon.org/iba/viewSiteProfile.do?siteId=2414&navSite=state;* accessed May 2011*)*.

The bay is one of the primary bald eagle wintering areas in New Hampshire. Eagles use large trees on the refuge, particularly dead or alive white and red pine on Woodman Point and Thomas Point, as daytime perch sites or as occasional roost sites. In 2011, a pair of bald eagles nested on the refuge adjacent to the bay, and successfully fledged one chick. The oak-hickory forests and shrub habitats support many breeding and migrating landbirds of conservation concern. The State endangered upland sandpiper nests on the adjacent Pease International Tradeport and has recently appeared on the refuge during breeding season.

Breeding bird surveys were conducted intermittently from 1994 to 2008. Table 2.14 below summarizes some of the more common species during June surveys. The species are organized from highest to lowest average relative abundance. Grassland breeding bird surveys have also been conducted. Table 2.15 summarizes the relative abundance of grassland breeding bird species detected during surveys in refuge grasslands between 1999 and 2010. Again, the species are organized from highest to lowest average relative abundance. See appendix A for a complete list of bird species of concern on the refuge.

Table 2.14. Relative Abundance* of Birds Detected During Breeding Bird Surveys on Great Bay Refuge from June 1994 to 2007.

Species	1994	1995	1996	1997	1998	2003	2006	2007	Average
Red eyed vireo	1.50	1.08	1.24	1.00	0.74	1.22	0.64	1.02	1.05
American crow	1.54	1.10	0.74	0.82	0.48	0.20	0.58	0.72	0.77
Blue jay	1.02	0.83	0.52	0.63	0.60	0.78	0.94	0.86	0.77
Common yellowthroat	1.11	0.54	0.80	0.92	0.86	0.53	0.36	0.56	0.71
Black-capped chickadee	0.91	0.69	0.84	1.04	0.38	0.49	0.60	0.40	0.67

Species	1994	1995	1996	1997	1998	2003	2006	2007	Average
Ovenbird	0.78	0.46	0.68	0.53	0.54	0.45	0.76	0.88	0.64
Red-winged blackbird	0.43	0.54	0.40	0.49	0.36	0.59	0.86	1.08	0.60
American goldfinch	0.17	0.63	0.44	0.22	0.30	1.22	0.80	0.82	0.58
Tufted titmouse	0.52	0.52	0.28	0.45	0.32	0.24	0.52	0.40	0.41
Gray catbird	0.50	0.42	0.38	0.47	0.50	0.22	0.34	0.30	0.39
American robin	0.33	0.15	0.46	0.29	0.26	0.43	0.48	0.64	0.38
Eastern wood pewee	0.39	0.35	0.24	0.41	0.34	0.47	0.44	0.28	0.36
Scarlet Tanager	0.17	0.52	0.50	0.31	0.26	0.39	0.40	0.34	0.36
Mourning Dove	0.35	0.31	0.42	0.37	0.50	0.29	0.32	0.24	0.35
Baltimore oriole	0.26	0.31	0.40	0.24	0.26	0.27	0.40	0.42	0.32
Black and white warbler	0.19	0.39	0.40	0.34	0.28	0.30	0.30	0.34	0.32
Wood thrush	0.35	0.17	0.12	0.22	0.42	0.29	0.60	0.34	0.31
Great crested flycatcher	0.43	0.46	0.34	0.29	0.20	0.45	0.08	0.20	0.30
Song sparrow	0.43	0.27	0.16	0.29	0.28	0.39	0.30	0.26	0.30
Cedar waxwing	0.00	0.33	0.24	0.22	0.28	0.12	0.34	0.54	0.26
Pine warbler	0.33	0.31	0.20	0.29	0.24	0.20	0.24	0.28	0.26
Northern Cardinal	0.39	0.33	0.06	0.22	0.16	0.35	0.24	0.28	0.25
Brown-headed cowbird	0.22	0.38	0.38	0.33	0.08	0.08	0.28	0.16	0.24
European starling	0.11	0.29	0.28	0.16	0.28	0.14	0.22	0.22	0.21
Rose-breasted grosbeak	0.20	0.27	0.12	0.24	0.14	0.29	0.24	0.20	0.21
Black throated green warbler	0.39	0.29	0.24	0.27	0.18	0.10	0.06	0.00	0.19
Eastern kingbird	0.28	0.21	0.16	0.18	0.10	0.20	0.16	0.22	0.19
Eastern towhee	0.24	0.23	0.14	0.20	0.16	0.20	0.16	0.20	0.19
Bobolink	0.17	0.33	0.06	0.06	0.40	0.04	0.20	0.14	0.18
Common grackle	0.04	0.29	0.18	0.02	0.00	0.29	0.40	0.22	0.18
Field sparrow	0.17	0.21	0.12	0.31	0.28	0.18	0.06	0.10	0.18

Species	1994	1995	1996	1997	1998	2003	2006	2007	Average
Yellow warbler	0.24	0.13	0.24	0.24	0.16	0.12	0.08	0.20	0.18
Chestnut sided warbler	0.35	0.25	0.16	0.18	0.14	0.10	0.02	0.02	0.15
Downy woodpecker	0.22	0.17	0.08	0.10	0.32	0.06	0.22	0.06	0.15
Hairy woodpecker	0.04	0.17	0.06	0.12	0.14	0.10	0.22	0.26	0.14
Northern flicker	0.13	0.23	0.20	0.22	0.20	0.08	0.00	0.00	0.13
White-breasted nuthatch	0.00	0.13	0.04	0.14	0.14	0.16	0.26	0.06	0.12
Indigo bunting	0.04	0.08	0.14	0.14	0.04	0.04	0.16	0.14	0.10
Chimney swift	0.00	0.52	0.08	0.00	0.00	0.00	0.00	0.16	0.09
Eastern meadowlark	0.15	0.10	0.04	0.04	0.02	0.06	0.12	0.16	0.09
Eastern phoebe	0.20	0.19	0.08	0.10	0.02	0.02	0.02	0.08	0.09
House finch	0.17	0.33	0.12	0.04	0.04	0.00	0.04	0.00	0.09
Mallard	0.00	0.00	0.00	0.16	0.00	0.04	0.42	0.10	0.09
American black duck	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.60	0.08
American redstart	0.11	0.06	0.08	0.14	0.08	0.10	0.02	0.04	0.08
Killdeer	0.11	0.15	0.06	0.06	0.02	0.04	0.02	0.16	0.08
Barn swallow	0.00	0.13	0.10	0.04	0.00	0.06	0.02	0.18	0.07
Canada goose	0.00	0.00	0.00	0.00	0.00	0.08	0.06	0.42	0.07
Northern mockingbird	0.04	0.02	0.08	0.12	0.14	0.04	0.02	0.00	0.06
Chipping sparrow	0.07	0.00	0.10	0.04	0.02	0.02	0.06	0.10	0.05
Osprey	0.00	0.00	0.00	0.06	0.00	0.04	0.12	0.18	0.05
Tree swallow	0.00	0.10	0.14	0.02	0.02	0.10	0.02	0.00	0.05
Veery	0.07	0.06	0.06	0.02	0.08	0.02	0.00	0.08	0.05
Willow flycatcher	0.02	0.02	0.10	0.12	0.08	0.04	0.02	0.00	0.05
Wild Turkey	0.00	0.00	0.00	0.00	0.02	0.02	0.04	0.20	0.04
Black-billed cuckoo	0.00	0.04	0.02	0.04	0.00	0.06	0.04	0.02	0.03
Brown creeper	0.04	0.02	0.04	0.08	0.04	0.00	0.02	0.00	0.03

Species	1994	1995	1996	1997	1998	2003	2006	2007	Average
Brown thrasher	0.07	0.06	0.02	0.02	0.00	0.00	0.04	0.02	0.03
Great blue heron	0.00	0.00	0.00	0.06	0.02	0.06	0.08	0.04	0.03
Prairie warbler	0.04	0.06	0.04	0.04	0.02	0.00	0.02	0.00	0.03
Warbling vireo	0.04	0.04	0.02	0.00	0.02	0.00	0.06	0.02	0.03

**Relative abundance is the average number of birds per species detected per survey point per survey. Only species that are detected consistently from year to year are represented in the table.*

Table 2.15. Relative Abundance of Grassland Breeding Birds Detected During Surveys Conducted on Grassland Management Units from 1999 to 2010 on Great Bay Refuge.

	Relative Abundance*						
Species	1999	2000	2001	2002	2003	2010	Average
Red-winged blackbird	0.50	1.64	1.50	2.42	1.91	2.43	1.72
Bobolink	0.06	1.68	0.89	1.46	0.87	0.00	1.01
Field sparrow	1.75	0.64	1.00	0.65	0.52	0.57	0.84
Eastern meadowlark	0.00	0.48	0.32	0.50	0.70	0.00	0.40
Upland sandpiper	0.00	0.04	0.11	0.00	0.04	0.00	0.04
American kestrel	0.00	0.04	0.04	0.08	0.00	0.00	0.03
Savannah sparrow	0.19	0.00	0.00	0.00	0.00	0.00	0.02
Vesper sparrow	0.00	0.00	0.04	0.00	0.00	0.00	0.01

**Relative abundance is the average number of birds per species detected per survey point per survey.*

Mammals

Numerous mammals also occur on the refuge. Common species include gray squirrel, shorttail shrew, Eastern cottontail, beaver, red fox, muskrat, and white-tailed deer. The size of the deer population is unknown as they can move freely on and off the refuge. A moose was seen and photographed on the refuge in June 2009. See appendix A for a complete list of mammal species of concern on the refuge.

At least six species of bat also occur on the refuge. Great Bay Refuge is within the historical range of the federally endangered Indiana bat and supports suitable habitat; however, this species has no current records from New Hampshire. From 2009 to 2011, the Service hired Biodiversity Research Institute (BRI) to survey for bats at Great Bay Refuge. Bat capture and echolocation data was collected at the wetland on the Ferry Way Trail. Mist nets and Pettersson ultrasonic detection equipment were used to monitor bat activity in fall (September) 2009 and summer (July) 2010 and 2011 BRI captured multiple bat species in mist nets on the refuge (table 2.16). Migratory species included

northern myotis, eastern small-footed bat (State-listed endangered), and little brown bats. Breeding species (lactating females caught) include northern myotis, big brown bat, eastern small-footed bat, and red bat. (Yates and Meattey 2010). Acoustic monitoring also detected hoary bat during migration. Another mistnetting and acoustic survey is planned for fall of 2011.

Table 2.16. Bats Detected on Great Bay Refuge in 2009 and 2011

Common Name	September 2009	July 2010	July 2011
	2 nights	3 nights	3 nights
Big brown bat	0	10	7
Eastern red bat	0	3	1
Eastern small-footed bat	4	2	1
Hoary bat	0	0	0
Little brown bat	1	0	1
Northern myotis	10	19	19

Lower Peverly Pond looking south

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Conservation focus on bats have been increasing in the past few years due to high population declines for multiple species associated with white-nosed syndrome. The Service is currently conducting a 90-day review to determine if listing of the northern myotis and the eastern small-footed bat. The Refuge is also working with a diverse consortium of Federal, State, and academic bat experts and land managers to adapt old military bunkers to bat hibernacula (see Objective 2.3 for more details).

Fish

In the fall of 1992, the Service's Laconia Office of Fishery Assistance conducted a survey of the fishes present in three ponds on the refuge. Surveys were conducted on Upper Peverly Pond, Lower Peverly Pond, and Stubbs Pond using an 18.0 foot (5.5 m) boom-type direct current electrofishing boat. This survey was repeated in 2007 (Brown 2008). Generally, the species composition and relative abundance remained consistent between surveys (table 2.17). The following exceptions were observed. A few chain pickerel and rainbow trout were observed in 1992, but not in 2007 in Upper Peverly Pond. American eel and sunfish were more abundant in 2007 than in 1992 in Lower Peverly Pond. American eel, sunfish and yellow perch were more abundant in Stubbs Pond in 2007 than in 1992. As in 1992, the greatest species diversity was encountered in Stubbs Pond. In 2007, Stubbs was the only pond where chain pickerel, brown bullhead and golden shiner were captured. Golden shiners were captured in only two small areas in the pond. In all three ponds, there has been a shift toward a greater proportion of larger quality sized largemouth bass in 2007 relative to 1992 (USFWS 1994, 2010). See appendix A for a complete list of fish species of concern on the refuge.

Table 2.17. Fish Species Composition and Abundance in Upper Peverly, Lower Peverly, and Stubbs Ponds in 1992 and 2007

	Upper Peverly Pond		Lower Peverly Pond		Stubbs Pond	
Species	1992 Survey	2007 Survey	1992 Survey	2007 Survey	1992 Survey	2007 Survey
American eel	F	F	F	M	F	A
Largemouth bass	A	A	A	A	A	A
Sunfish	A	A	F	A	M	A
Alewife	N	N	N	N	N	N
Golden Shiner	N	N	N	N	F	F
Mummichog	N	N	N	N	N	N
Banded Killifish	N	N	N	N	N	N
Chain Pickerel	F	N	N	N	F	F
Brown Bullhead	N	N	N	N	F	F
Yellow Perch	N	N	F	F	M	A
Rainbow Trout	F	N	N	N	N	N
Brook Trout	N	N	N	N	N	N

Note: A = abundant, M = moderate, F = few, N = none

Amphibians and Reptiles

Several surveys and studies have officially documented 15 species of reptiles and amphibians on Great Bay Refuge (table 2.18). Appendix A lists the reptile and amphibian species of concern known, or likely, to occur on the refuge and the Karner blue butterfly easement.

Table 2.18. Amphibians and Reptiles Documented on Great Bay Refuge

Species	Sighting	Sources*
Frogs and Toads		
American toad	calling, observed	Suomala 1995, 1996; Taylor 1994
Bullfrog	observed	Taylor 1994
Gray tree frog	observed	Taylor 1994
Green frog	observed	Suomala 1995, 1996; Taylor 1994
Leopard frog	observed	Suomala 1995, 1996
Pickerel frog	observed	Taylor 1994
Spring peeper	calling,	Suomala 1995, 1996; Taylor 1994
Wood frog	calling, observed	Suomala 1995, 1996; Taylor 1994
Salamanders		
Red-backed salamander	observed	Taylor 1994
Turtles		
Painted turtle	observed, nest found	Suomala 1995, 1996; Taylor 1994
Snapping turtle	observed	Suomala 1995, 1996; Taylor 1994
Snakes		
Common garter snake	observed	Kjoss 1999; Taylor 1994
Northern brown snake	observed	Kjoss 1999
Northern red-bellied snake	observed	Kjoss 1999
Smooth green snake	observed	Kjoss 1999

**Kjoss, V. A. 1999. UNH Masters of Science research study*

**Suomala, R. Reptiles and amphibians recorded at Great Bay Refuge, 1995 and 1996*

**Taylor, J. Checklist of amphibians and reptiles for Great Bay Refuge, June 15, 1994*

Forest Health, Including Forest Pests

The U.S. Forest Service's Durham Field Office assessed the health of Great Bay Refuge's forests in 2006. Their assessment (Dodds and Cooke 2006) provides the following information:

- A general overview of the conditions of forested areas
- The "health" of overstory trees (e.g., crown condition, growth form, etc.)
- The amount of regeneration occurring in stands
- The presence/absence of native insects at damaging levels
- The presence of exotic or invasive species that could threaten the integrity of native ecosystems

We plan to use the results of their assessment to guide our forest management decisions and identify any potential health concerns for the refuge's forests. The assessment found some stands, particularly the pine plantations, to be overstocked. They also found numerous cavity trees throughout the refuge in both live and dead hardwoods and conifers. They also conducted visual surveys for nonnative insects on inventory plots and on transects through the stands. A total of 61 stands were mapped on the original natural community map that consisted of 10 forest community types. Of the 61 forest stands, 18 were inventoried (29.5 percent) for a total of 399.7 acres of the 763 acres total of forested cover type (52.4 percent) (Dodds and Cooke 2006).

Although they found no nonnative insects during their 2006 survey, in 2010, the hemlock woolly adelgid was found along McIntyre Road. We will continue to monitor for nonnative insect pests, particularly Asian long-horned beetle, emerald ash borer, and *Sirex noctilio*, which have been found in the Northeast and have caused serious economic and ecological impacts.

The Forest Service also conducts annual aerial surveys to assess forest health condition. In 2007, they mapped 5 acres of tree damage on the refuge, likely related to ice storms. Their 2008 survey detected no damage on the refuge. Their 2009 survey documented discoloration, dieback, and branch breakage on 5 acres of pine plantation located west of the refuge entrance on Merrimack Drive. However, in 2010, the refuge biologist and Dan Sperduto of NHB visited this pine plantation site and found no evidence of a pathogen on the trees. While the native oak-hickory species were germinating in the understory, only the planted Scots pine showed signs of dieback.

Invasive Animals

The mute swan is a Eurasian species that is not native to North America. It was introduced to the U.S. n the late 1800s as a decorative waterfowl for parks, zoos, and private estates. By the early 1900s, small numbers of birds had escaped into the wild, began nesting, and soon established feral populations. Currently, mute swan populations are well established in many states, mainly along the North Atlantic Coast. Populations in the Atlantic Flyway have grown dramatically, from less than 1,000 in the mid-1950s, to more than 14,000 in 2002. Mute swans are highly invasive in wetland habitats, impact native species of fish and wildlife, damage commercial agricultural crops, and pose a threat to human health and safety. Because they consume large quantities of submerged aquatic vegetation and are aggressive, mute swans compete directly with many other waterbird and fish species for critical habitats. Mute swans are highly territorial, and will often vigorously defend nest and brood sites from intrusion by other wildlife, causing serious harm. Some have also attacked humans (Atlantic Flyway Council 2003). The Service continues to work with the NHFG to control this nonnative species within Great Bay Estuary.

Environmental Contaminants

Since Great Bay Refuge is part of the former Pease Air Force Base, the Air Force continues to conduct long-term monitoring of groundwater, surface water, sediment, and fish tissue on the refuge. The original Air Force Base landfill, operated from 1953 to 1961, is within the boundaries of the refuge lying east of Upper Peverly Pond. According to base records, the types of material dumped in this landfill include construction debris, domestic solid waste, and shop waste. The Peverly Brook drainage system receives surface water and sediment from the former landfill, the former Weapons Storage Area, and other dump sites. The primary contaminants from these discharge areas are metals (e.g., aluminum, arsenic, iron, lead, manganese, nickel, zinc), and pesticides (e.g., DDT-related compounds and lindane) (Department of the Air Force 2001). The levels of DDT in the sediments of the Peverly Brook drainage system, especially Stubbs Pond, may pose a risk to fish. The Air Force believes that it may be safer to leave

the contaminated sediments in place, rather than risk re-suspending them in the water while trying to remove them. Currently, the Air Force and the EPA disagree on the need for continued fish sampling (Memorandum from the Air Force to EPA and NH DES dated April 11, 2003). The Pease International Tradeport also continues use urea as a de-icing agent, which may cause elevated levels of nutrients in refuge ponds and the Peverly Brook system (*http://ecos.fws.gov/cap/*; accessed May 2011). Appendix I is a retrospective review of sampling plans and data relating to the clean-up of the Peverly Brook drainage by the Air Force.

Mercury in the blood collected from osprey chicks on the refuge in 2000 was elevated, as compared to other osprey from New England. This is part of a larger trend of elevated mercury levels in wildlife in southeastern New Hampshire, considered a "hotspot" due to prevailing weather patterns (*http://ecos.fws.gov/cap/*; accessed May 2011).

The Service's Northeast Region has conducted studies to determine the extent and magnitude of the "abnormal frog" phenomenon on national wildlife refuges since 1987. Frog sampling since 1998 at the refuge has shown varying levels of abnormalities, but in general abnormalities are below 3 percent of the frogs sampled (Pinkney et al. 2005). In addition to participating in the regional study, Dr. Kim Babbitt from UNH investigated the potential effects of contamination on frog development at the refuge in 2003.

Cultural and Historic Resources

Historic Structures

The refuge includes three areas that contain historic or potentially historic structures:

- The Margeson Estate
- The 1950s-era Weapon Storage Area
- The Fabyan Point cabins

The Margeson Estate is located on Woodman Point in a section of the refuge that is closed to the public. The estate's main house (1894) and caretaker's cottage (circa 1920s) are listed on the National Register of Historic Places (National Register). Since the refuge's establishment in 1992, the main house has remained unoccupied. In 1994 through 1995, a new roof was installed on the main house. It was also tested for hazardous materials (e.g., asbestos and lead paint) in 1994 and 1998. From 1992 to 2002, the refuge used the caretaker's cottage for housing. In 1994 through 1995, the cottage's exterior was painted and new roof was installed. 1998, it was tested for lead paint and in 1999, the window sashes on its first story were replaced.

The Margeson Estate's main house is in poor condition due to deterioration that has taken place over at least the past three decades, with extensive moisture damage to the structure and finishes that occured prior to the roof replacement. There is also pervasive mold throughout the building. The caretaker's cottage is in good condition, but also has pervasive mold. Both buildings are uninhabitable in their current condition. The refuge does not have a potential use for either building.

The former Weapons Storage Area is located east of the refuge visitor contact station. It is surronded by a fence and is also closed to the public. The area was used by the Air Force as a highly secure site for storaging and maintaining various types of munitions (e.g., small arms ammunition) and weapons systems (e.g., conventional and nonconventional missiles and bombs). In developing the area, the Air Force heavily manipulated the site. They constructed drainage

ditches throughout the area to try to improve drainage around their structures. Based on 1952 aerial photos, it does not appear that natural wetlands were present on the site prior to their construction of the Weapons Storage Are. When it was in use, the area covered 50 acres and was surronded by an 8-foot high chainlink fencing topped with barbed wire. Facilities within the area included 15 earth-covered storage bunkers and various nondescript one-story concrete-block storage, support, and administrative buildings. The barrel-vaulted bunkers are made from reinforced concrete and are covered with about 2 feet of soil and vegetation. Two of the bunkers were built for storage of capsules for early nuclear weapon designs. Each bunker has several ventilation holes and two, large steel doors at the front.

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Former Weapons Storage Area

Since acquiring the refuge in 1992, we have removed five buildings, the razor wire off the perimeter fence, and over 100 telephone and light poles from the Weapons Storage Area. We have also been removing and recycling metal from the bunkers and other buildings. We had asbestos removed from the concrete block buildings between 2008 and 2009, which structurally alterned the buildings. Our intent is to remove the remaining concrete block structures, water tower, and adjacent roads and fencing, as resources allow. As strucutures are removed, we will restore the disturbed areas to native habitat. Currently, we are using some of the bunkers for storage. We are also evaluating the potential to use some of the bunkers as hibernacula for roosting bats. We do not anticipate removing the bunkers, becuase of the high estimated cost for their removal, their continued use as storage, and their potential as bat roosting habitat.

The third area that contains potentially historic structures is Fabyan Point, a peninsula at the end of Fabyan Point Road in a section of the refuge that is closed to the public. Fabyan Point has a complex of six small cabins along the Great Bay shoreline. Two cabins appear to date to the 1920s (one wood-framed and one concrete block), while the remaining four cabins date to circa 1947 (all wood-framed). Prior to the refuge's aquisition of Fabyan Point in 2003, the area was private property. By this time, the five wood-framed cabins were in poor condition. They are supported by concrete block piers that rest directly on the ground and which have heaved over the years, affecting the structure of the buildings. The buildings also suffer from pervasive mold and moisture damage. The concrete block cabin is in good condition, but also has pervasive mold. None of the buildings are inhabitable and the refuge does not have a potential use for any of the buildings. The cabins have also become a target of vandals and squatters.

Archaeological Resources

In December 1988, the Pease Air Force Base was selected as one of the 86 military installations to be closed as part of the Secretary of Defense's Commission on Base Realignment and Closure (BRAC). Archaeological resources in the refuge are mostly known from two 1991 surveys done as part of the BRAC process and from a 1999 to 2000 study undertaken for the town of Newington via a certified local government planning grant. Results of both have recently

been incorporated into an archaeological overview produced as part of the CCP process (Public Archaeology Laboratory, Inc. 2010).

Only one pre-Contact archaeological site has been identified on the refuge. However, in light of proximity to maritime resources of the bay, as well as freshwater and upland resources, other unrecorded sites of that period are very likely to be present. Fifteen Euro-American sites are recorded within the refuge. Those include the landing for a 17th century ferry to Durham, a 19th century brickyard, and a number of late 17th to 20th century farmsteads. Burials in four small cemeteries were exhumed and reburied off-refuge when the Air Force Base was constructed. It is possible that some unmarked graves were not discovered and removed. None of the cemetery locations have surface evidence today. While it is likely that all sites dating from the 18th century and later within the refuge have been identified, it is possible that additional 17th century sites exist, as those tend to be less visible on both the landscape and historic period maps.
The city of Portsmouth purchased land and water rights to Peverly Brook and its tributary streams in 1900. The brook was dammed in two places and by 1903 water was being pumped to the city's public water supply. That water system was discontinued when the Air Force acquired the lands in the 1940s (Rowe 1987). The Weapons Storage Area and a considerable area in the northeast part of the refuge were both heavily disturbed by airbase construction. In 962, the Air Force constructed Stubbs Pond impoundment. Most of the remaining refuge land was unaffected by airbase construction and use.

Public Use Programs

As an unstaffed refuge, Great Bay Refuge has had limited ability to conduct a visitor services program. Despite these limitations, the refuge is popular, especially for birders and walkers. The estimated annual visitation is approximately 30,000 visitors.

The Peverly Pond Trail (described below) is wheelchair accessible, as are the restrooms and refuge headquarters. The refuge is open from dawn to dusk, with vehicle access controlled by a timed gate along Arboretum Drive. The trails are for foot traffic only. Bicycles and motor vehicles are limited to the entrance road and parking lot. Pets are not permitted on the refuge. All other areas beyond the parking lot and the two trails are closed to the public.

Trails

Two nature trails are accessible from the visitor parking lot at the end of Merrimack Drive, adjacent to the refuge headquarters building (map 2.7).

Ferry Way Trail
The 2-mile Ferry Way Trail begins at the northwestern edge of the parking lot. It starts out as an asphalt path next to a chain link fence along the former Weapons Storage Area. After following the fence line, the trail crosses a woods road and swings left onto another old woods road. The trail passes through woods and fields, by wetlands and an apple orchard, loops down to Great Bay, then backtracks to the parking lot. A leisurely walk on this moderately difficult trail takes about 2 hours.

Peverly Pond Trail
The 0.5-mile Peverly Pond Trail begins to the east of the parking lot. This loop trail winds though an oak-pine forest, follows a portion of shoreline along Upper Peverly Pond, and passes several vernal pools. A photography blind in located along the trail and offers views of Upper Peverly Pond. A leisurely walk on this easy trail takes about 30 minutes. The trail is fully accessible.

Great Bay National Wildlife Refuge - Comprehensive Conservation Plan
Existing Trails & Infrastructure
Admiralty Drive
Electric Gate
Existing Observation Platform
Parking Lot
Residence
Shop
Thomas Point
Caretaker's House
Nobles Pond
Woodman Point
Tabyan Point
Structure
Admin Road
Entrance Road
Non-FWS Road
Public Trail
Miles
Kilometers

Fishing

Various military activities on the former Pease Air Force Base resulted in, or contributed to, contamination of sediments, water, and fish on what are now refuge lands. Over the last 10 to 15 years, studies and monitoring shows that while some contaminant issues are improving, other concerns still exist. In particular, we are concerned about contamination in the Peverly Brook drainage and the refuge's three impoundments. We are currently uncertain about the impact of this contamination on fish health and water quality, and the risks to humans from handling or consumption. Due to these concerns, the refuge is closed to fishing.

Hunting

History

Prior to Service ownership, deer and waterfowl hunting were permitted by the Air Force, but it was limited to military personnel and retirees and dependents, and only in certain areas. From 1967 to 1989, the Air Force used hunting as a management tool, due to the need to minimize aircraft strikes on the runway. It was estimated that 8 to 10 deer were taken annually from throughout the former Pease Air Force Base. The Air Force also permitted waterfowl hunting only on Stubbs Pond and only for Air Force personnel, dependents, and retirees. The former base was closed to hunting from 1989 to 1993 in advance of the land transfer to the Service (USFWS 1995).

White-tailed Deer Hunting

When the refuge was first proposed, the Service received a range of public comments on deer hunting. Some thought the hunt should continue, while others thought hunting should only occur as a biological management tool. A Hunt Plan was completed for Great Bay Refuge in 1993 (USFWS 1993). In 1995 the Service completed an EA for establishing and conducting an annual, public white-tailed deer hunting program and waterfowl hunting program on the refuge. The determination from this assessment was to open the refuge to controlled hunting of white-tailed deer and waterfowl in accordance with all Federal, State, and local regulations (USFWS 1995).

The first white-tailed deer hunt on the refuge occurred in the fall of 1996 and has been held every year since then. The hunt is a 2-day, Saturday to Sunday hunt, by permit only. A maximum of 20 permits per day are drawn from a pool of applicants each year. From 1996 to 2007 the number of hunters has ranged from 13 to 22. The number of deer harvested during a given hunt has ranged from 8 to 22 deer, with a mix of does and bucks taken.

Waterfowl Hunting

The 1995 hunting EA also provided for a waterfowl hunt program on the refuge. Waterfowl hunting is currently allowed along the shoreline of the refuge up to posted refuge boundary signs. Access is by boat only from off-refuge locations, and access through the refuge is prohibited. The 1995 EA allowed for additional restrictions if needed, including limiting the number of waterfowl hunters. Some waterfowl hunting does periodically occur along the refuge shoreline but in such low numbers that a restriction on the number of waterfowl hunters has not been necessary. Other sites around Great Bay provide greater waterfowl hunting opportunities and see more use.

No other hunting is permitted on the refuge.

Volunteer Program

Volunteers are particularly vital at Great Bay Refuge, given the lack of Service staff. The Wednesday Volunteer Group is the biggest group on the refuge that

works most of the year except winters. Their projects are many and varied. They have been salvaging scrap metal to be recycled from the Fabyan Point cabins and former military buildings on the refuge. They also maintain trails, mow to maintain grassland habitat, assist with waterfowl banding, maintain and repair equipment, monitor the fish ladder and alewife, tend the native garden outside of the headquarters, conduct invasive species inventories and control, and conduct osprey surveys. For the past three summers, a couple has been living and working on the refuge, helping to tend the gardens, perform light maintenance, and other assistance as needed. The Service has also engaged volunteers through other programs, such as Phillips-Exeter Academy classes. Volunteers contribute approximately 2,500 to 3,000 hours on the refuge each year. The refuge does not currently have an active Friends Group.

Key Refuge Partnerships

Great Bay Resource Protection Partnership
The GBRPP is a coalition of public and private conservation groups that formed in 1994 to help protect the remaining critical habitats within and around Great Bay. The GBRPP takes a comprehensive, landscape-scale approach to conservation and habitat protection by developing and implementing conservation strategies through a combination of scientific field studies and ongoing communication with local, regional, State, and national conservation representatives. So far, the partnership has been very successful in their land protection efforts.

The Partnership's primary activities include the following:

- ***Conservation Planning:*** The Partnership conducts habitat analysis studies to identify significant habitat areas to be considered for protection.
- ***Land Conservation:*** Based on the conservation planning field work, the Partnership seeks to protect large blocks of significant conservation land through working voluntarily with landowners on the purchase or donation of land or conservation easements.
- ***Stewardship:*** Partner organizations collaborate on stewardship activities such as restoration, resource management, and public access on protected lands.
- ***Education and Outreach*****:** Partner representatives provide technical assistance to communities, conservation entities, and landowners.

The principle partners, which meet quarterly in the GBRPP, are Ducks Unlimited, Inc., GBNERR, New Hampshire Audubon Society, NHFG, SPNHF, TNC–New Hampshire Chapter (lead partner), the EPA, the Service, the refuge, and the U.S. Department of Agriculture–Natural Resources Conservation Service. The partnership works closely with several regional land trusts and conservation districts including the Southeast Land Trust of New Hampshire, Bear Paw Regional Greenways, Rockingham County Conservation District, Strafford Rivers Conservancy, and Strafford County Conservation District (*http://www.greatbaypartnership.org/*; accessed May 2011*)*.

New Hampshire Coastal Watershed Invasive Plant Partnership
Great Bay Refuge, represented by the refuge manager, is a "Sustaining Partner" of the New Hampshire Coastal Watershed Invasive Plant Partnership (CWIPP). This partnership among 11 agencies and organizations concerned with invasive species was formed in 2008. The principal partners signed an agreement and created a framework of cooperation to address the effects of noxious and

invasive plants across jurisdictional boundaries. The signatories agreed that it was to their mutual benefit and in their mutual interest to work cooperatively to inventory, monitor, control, and prevent the spread of invasive plants across jurisdictional boundaries within New Hampshire's coastal watershed. The goal through this cooperative effort is to achieve better management of invasive plants while improving working relationships between the signatories and the public. Although sustaining partners are not signatories to the agreement, they, including Great Bay Refuge, have significant interests in the success of the partnership (*http://des.nh.gov/organization/divisions/water/wmb/coastal/cwipp/index.htm;* accessed May 2011*)*.

Law Enforcement

Great Bay Refuge is situated at the end of a long dead-end road. The entrance is controlled by a timed gate that opens at dawn and closes at dusk. The lack of refuge staff stationed at Great Bay Refuge and the refuge's relatively isolated location creates some law enforcement concerns. A refuge law enforcement officer is based out the Parker River Refuge Office, and serves Great Bay Refuge and Wapack Refuge. In addition, a refuge law enforcement zone officer for this region is located at Mississquoi Refuge in northwestern Vermont. Given the shortage of law enforcement capacity, Great Bay Refuge maintains a critical partnership with the town of Newington Police Department.

Pease Development Authority Wildlife/Bird Air Strike Hazard Committee

In 1992 a Memorandum of Agreement (MOA) was signed between the Service, the Federal Aviation Administration (FAA), the U.S. Department of Agriculture–Animal and Plant Health Inspection Service), and PDA. The MOA calls for coordination and quarterly meetings among the parties. Meetings are designed to review and discuss past and future wildlife management practices by the Service and PDA on the refuge and the airport facility, respectively, discuss the effects of such management practices on airport operations and on Service trust resources, and discuss airport facility aircraft operations and their potential effects on the refuge (MOA 1992). The group of representatives is referred to as the Wildlife/Bird Air Strike Hazard Committee.

Karner Blue Butterfly Conservation Easement

Great Bay Refuge also includes a 29-acre conservation easement in the pine barrens of Concord, New Hampshire, in Merrimack County (map 1.2). The property is managed primarily for the federally listed endangered Karner blue butterfly. The easement is approximately 45 miles west of Great Bay Refuge. The parcel abuts the Concord Airport and is within a fragmented, but

Karner blue butterfly displaying upperside (right) and underside (far right) coloring

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important complex of remnant pine barrens habitat that supports rare moths and butterflies. The easement land is a mix of open pitch pine-scrub oak, pine-hardwood, and other scrubland. Although not the focus of our management, the easement's habitat also supports several State-listed species and State species of concern, including hognose snake, black racer, and grasshopper sparrow. Additionally, table A.2 in appendix A list all of the species in greatest need of conservation that are potentially present on the easement and throughout the Concord pine barrens.

This easement was established in July 1992 through a cooperative agreement between the Service, the city of Concord, the CCDC, the U.S. Postal Service, and TNC. The easement lies in the Concord Airport Industrial Park and consists of two adjacent parcels on which easements were donated to the Service by the city of Concord following an exchange of airport land between the city of Concord and the non-profit CCDC. TNC agreed to serve as a managing partner with the Service while the city of Concord and CCDC agreed to cooperate in the research and management of Karner butterfly habitat in management agreement areas.

Since 2008, Great Bay Refuge and the conservation easement have been administered by Parker River Refuge staff based in Newburyport, Massachusetts. There are no refuge buildings on the easement and the property is closed to hunting. There is an unpaved right-of-way road, oriented east-west, that bisects the easement. There are gates at the entrance and the exit of the property to preclude vehicle access. This unpaved road serves as an approximately 0.4-mile wildlife observation trail and is open to pedestrian access only. An informational kiosk located at the west entrance explains management for Karner blue butterflies.

From 1992 to 1999, TNC carried out most of the management on the easement, which included removal of unwanted vegetation by mechanical methods and planting of wild lupine. In 1999, the Service conducted vegetation removal and a prescribed burn. Since 2000, NHFG has conducted the onsite management which has continued with vegetation removal, herbicide applications, prescribed burning, plantings, moth and butterfly surveys, and a captive rearing program. Table 2.19 presents a brief outline of NHFG's habitat management on the easement from 2000 to 2011. Table 2.20 includes the results of the captive rearing program and population monitoring data.

Table 2.19. New Hampshire Fish and Game Management Activities at the Concord Pine Barrens from 2000 to 2011.

Management Action	Total
Prescribed Burning	6 acres
Vegetation Removal	10 acres
Herbicide	3 acres
Planting of Seedlings	over 5, 500 seedlings
Planting of Seeds	over 6, 000 grams of seed

Table 2.20. Captive Rearing of Karner Blue Butterflies for Release onto the Service's Concord Pine Barrens Conservation Easement

Year	Brood	Number of Adults[1]	Number of Wild Adults Marked[2]	Number of Adults Recaptured[3]
2000	1	0	–	–
2000	2	0	–	–
2001	1	44	–	–
2001	2	5	–	–
2002	1	193	–	–
2002	2	102	–	–
2003	1	203	–	–
2003	2	176	–	–
2004	1	337	–	–
2004	2	1,231	31	167
2005	1	607	39	160
2005	2	1,177	149	347
2006	1	1,138	21	149
2006	2	348	49	45
2007	1	505	20	49
2007	2	968	54	301
2008	1	271	58	65
2008	2	2,136	64	404
2009	1	1,017	87	316
2009	2	3,798	260	1,006
2010	1	194	320	245
2010	2	2,609	278	394
2011	1	22	58	29
2011	2	742	90	283

[1] *Total adults enclosed in captive rearing laboratory for either breeding or release in New Hampshire and New York.*

[2] *Number of unmarked adult butterflies observed during mark recapture surveys*

[3] *Number of marked adults observed during mark recapture surveys, including adults released from captive rearing laboratory*

Additional Partnerships

There are several other crucial ongoing partnerships related to the easement and its management.

Concord Municipal Airport Development and Conservation Management Agreement.
Participants in this agreement include the city of Concord, NHFG, the Service, NH Department of Resources and Economic Development, NH Army National

Guard, and NH Department of Transportation–Division of Aeronautics. This agreement was executed in November 2000 for the purpose of managing airport lands adjacent to the Service easement in a manner that provides and enhances essential habitat for federally listed and State-listed threatened and endangered species of *Lepidoptera*, such as the Karner blue butterfly. The agreement serves as the city's compensation to offset the loss of species and habitat in the designated development zones.

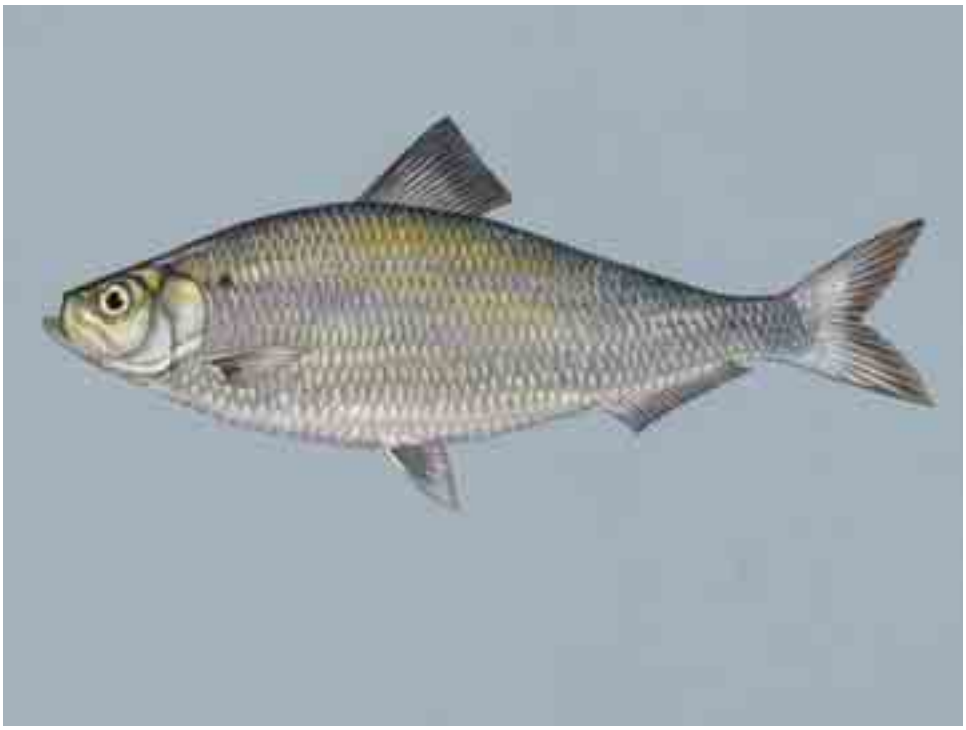
Habitat Management and Monitoring Concord Pine Barrens Memorandum of Agreement between NHFG and New Hampshire Army National Guard. This MOA and funding agreement was active through 2011 between NHFG and the New Hampshire Army National Guard and facilitated the transfer of funds for mitigation projects. The mitigation money was provided from the construction of a helicopter hangar in an area identified as habitat for the federally listed endangered Karner blue butterfly. The mitigation funds support restoration activities, including prescribed burning, mowing and forestry operations in addition to mark-recapture surveys on the Karner blue butterfly and frosted elfin butterfly, vegetation plots, lupine populations, and presence or absence of other Lepidoptera.

Kids for Karners
This program was started by the National Wildlife Federation and NHFG around 2000. Over the past 11 years, over 2,500 lupine and nectar plants have been grown by local school children and planted on the Service's Karner blue easement land. The project includes a teachers training in the winter, classroom plantings in the spring, and a field trip to the easement at the end of the school year to plant lupine and tour the Concord pine barrens.

Canada geese and full moon

Tim Williams

Chapter 3



Duane Raver/USFWS

River herring

Alternatives, Including the Service-preferred Alternative

- Introduction
- Formulating Alternatives
- Actions Common to All Alternatives
- Actions Common to Alternatives B and C
- Alternatives or Actions Considered, but Eliminated from Detailed Study
- Alternatives Analyzed in Detail
  - Alternative A–Current Management
  - Alternative B–Habitat Diversity and Focal Species Emphasis (Service-preferred Alternative)
  - Alternative C–Emphasis on Natural Processes
- Comparison of Objectives and Strategies for Great Bay Alternatives

Introduction

This chapter presents

- our process for formulating three management alternatives;
- actions that are common to all alternatives;
- actions that are common to alternatives B and C;
- actions or alternatives considered but not fully developed; and
- descriptions of the three alternatives we analyzed in detail.

At the end of this chapter, table 3.2 compares how each of the alternatives addresses key issues, supports major programs, and achieves refuge goals. Goals 1 through 4 apply to Great Bay Refuge management, while goal 5 applies to the Karner blue butterfly conservation easement.

Formulating Alternatives

Relating Goals, Objectives, and Strategies

Refuge goals and objectives define each of the management alternatives identified below. As we described in chapter 1, developing refuge goals was one of the first steps in our planning process. Goals are intentionally broad, descriptive statements of the desired future condition of refuge resources. By design, they are less quantitative, and more prescriptive, in defining the targets of our management. They also articulate the principal elements of refuge purposes and our vision statement, and provide a foundation for developing specific management objectives and strategies. Our goals are common to all the alternatives.

The next step was to consider a range of possible management objectives that would help us meet those goals. Objectives are essentially incremental steps toward achieving a goal. They also further define the management targets in measurable terms. Objectives typically vary among the alternatives and provide the basis for determining more detailed strategies, monitoring refuge accomplishments, and evaluating our success. The Service guidance in "Writing Refuge Management Goals and Objectives: A Handbook" (USFWS 2004a) recommends that objectives meet five criteria to be "SMART":

(1) Specific
(2) Measurable
(3) Achievable
(4) Results-oriented
(5) Time-fixed

A rationale accompanies each objective to explain its context and why we think it is important. We will use the objectives in the alternative selected for the final CCP in writing refuge step-down plans. We will measure our successes by how well we achieve those objectives.

We next identified strategies for each of the objectives. Strategies are specific actions, tools, and techniques that we may use to achieve the objective. The list of strategies under each objective represents the potential suite of actions that we may implement. We will further evaluate most of the strategies in refuge step-down plans, such as the HMP and Visitor Services Plan, as to how, when, and where they should be implemented.

For most objectives we also identified monitoring components. Monitoring will help us measure our success toward meeting the objective.

Developing Alternatives, including the "No Action" Alternative

After identifying a wide range of possible management objectives and strategies, we began the process of crafting management alternatives. Simply put, alternatives are packages of complementary objectives and strategies designed to meet refuge purposes and goals and the Refuge System mission,

while responding to the issues and opportunities identified during the planning process.

To develop alternatives, we grouped objectives that seemed to fit together in what we loosely called "alternative themes." For example, we considered such themes as "continuing current management," "habitat and focal species management," and "emphasis on natural processes." These were firmed up into three management alternatives after further evaluating how respective objectives would interact, their compatibility with refuge purposes, and the reality of accomplishing the objectives in a reasonable timeframe.

In this draft CCP/EA, we fully analyze three alternatives which characterize different ways of managing the refuge over the next 15 years: alternative A, alternative B, and alternative C. We believe they represent a reasonable range of alternative proposals for achieving refuge purposes, vision and goals, and addressing the issues described in chapter 1. Unless otherwise noted, all actions would be implemented by refuge staff.

Alternative A, "Current Management"
Alternative A satisfies the NEPA requirement of a "no action" alternative, which we define as "continuing current management." It describes our existing management priorities and activities, and serves as a baseline for comparing and contrasting alternatives B and C. We suggest you first read Chapter 2, "Description of the Affected Environment," for detailed descriptions of current refuge resources and programs.

Many of the objectives in alternative A do not strictly follow the guidance in the Service's goals and objectives handbook. This is because we are describing current management decisions and activities that were established prior to this guidance. Our descriptions of these activities were derived from a variety of formal and informal management decisions and planning documents, such as the draft HMP and a Fisheries Management Plan. As such, alternative A objectives are fewer and more subjective in nature than alternatives B and C. Even though there are several objectives that are not currently being implemented under alternative A, we list goals and objectives in the same sequence and with the same title under all three alternatives to facilitate their comparison. Where an objective does not apply under alternative A, we indicate "this objective is not part of current management."

Alternative B, "Habitat Diversity and Focal Species Emphasis" (Service-preferred Alternative)
Alternative B, the Service-preferred alternative, combines the actions we believe would best achieve the purposes, vision, and goals of Great Bay Refuge and the Karner blue butterfly easement, and also responds to public issues. It emphasizes the management of specific refuge habitats to support focal species whose habitat needs benefit other species of conservation concern that are found in the Great Bay region. In particular, we emphasize habitat for

- priority birds identified in BCR 30, such as the upland sandpiper;
- rare and declining species, such as the New England cottontail and Karner blue butterfly; and
- estuarine species of concern, including oysters and eelgrass that are indicators of ecosystem health.

In alternative B, we propose removing the Lower Peverly Pond Dam to restore stream habitat, while maintaining the dams at Upper Peverly and Stubbs Ponds

to benefit a range of fish and wildlife. We would expand our conservation, research, and management partnerships to help restore and conserve the Great Bay estuarine ecosystem.

This alternative would enhance our visitor services programs, which has been limited under current management due to lack of staff. On Great Bay Refuge, we propose to enhance the entrance to the refuge, create new interpretive materials, expand on an existing quality volunteer program, and offer visitors more opportunities to learn about the refuge and the surrounding area. On the Karner blue butterfly easement, we propose to install new interpretive signs, offer guided interpretive walks, and enhance our Web-based information.

Alternative C, "Emphasis on Natural Processes"
Under alternative C, we would emphasize "naturalness," with a greater reliance on natural processes such as forest succession, and where feasible, restoration of natural communities. In this alternative we would continue to manage invasive species, but would allow grasslands and shrublands to naturally succeed to forested conditions.

In addition to the removal of the Lower Peverly Pond Dam, we would remove the dike on Stubbs Pond and restore the area to salt marsh. We would also evaluate the feasibility of removing the Upper Peverly Pond Dam. All remaining structures in the former Weapons Storage Area would be removed.

Under alternative C, we would allow some additional public access into certain new areas on the refuge not currently open to the public since we would anticipate a reduction in sensitive breeding periods as fields and shrubs succeed to forest. Our objectives and strategies for managing the Karner blue butterfly easement would be the same under alternative C as proposed under alternative B.

We include a habitat map for each alternative for Great Bay Refuge to help visualize how refuge vegetation would look under each alternative (maps 3.6, 3.8, and 3.14). In addition, we include a similar comparison for the visitor services program under the three alternatives (maps 3.7, 3.9, 3.10, and 3.15). Table 3.1 compares the acreages of the habitat types under the different alternatives.

Table 3.1. Comparison by Alternative of Habitat Types Under Management for the Great Bay Refuge

Habitat Type	Alternative A	Alternative B	Alternative C
Forest	659	700	852
Shrubland	26	54	0
Grassland	169	98	0
Forested wetlands	149	158	169
Impounded freshwater wetland	62	55	0
Salt marsh	36	36	80
Rocky shore	2	2	2
TOTAL	**1,103**	**1,103**	**1,103**

**Acres estimated from GIS and rounded up to nearest whole number*

Actions Common to All of the Alternatives

There are some actions we propose for managing Great Bay Refuge over the next 15 years, regardless of which CCP alternative we select. Some of those actions are required by law or policy, or represent actions that have undergone previous NEPA analysis, public review, agency review, and approval. Others may be administrative actions that do not necessarily require public review, but we want to highlight in this public document.

It is important here to reemphasize that CCPs provide long-term guidance for management decisions through goals, objectives and strategies. They represent our best estimate of future needs. This CCP details program levels and activities that are substantially above current budget allocations and, as such, should be viewed as strategic in nature. Our budgets are determined annually by Congress, and distributed through our Washington and Regional Offices, before arriving at field stations. In summary, the actions proposed in this CCP represent our strategic vision for the future. Final CCPs do not constitute a Service commitment for staffing increases, or funding for operations, maintenance, or future land acquisition. Implementation must be adjusted annually given the reality of budgets, staffing, and unforeseen critical priorities.

All of the following actions, which we discuss in more detail below, are current practices or policies that would continue in some form under all alternatives, though they may differ in details under each alternative:

- Using an adaptive management approach where appropriate
- Reducing impact on climate change
- Developing refuge step-down plans
- Managing invasive species
- Providing refuge staffing and administration
- Findings of appropriateness and compatibility determinations
- Protecting the rocky shore
- Recognizing special designations
- Conducting wilderness and wild and scenic river reviews
- Protecting cultural resources
- Issuing special use permits
- Distributing refuge revenue sharing payments
- Conducting additional NEPA analysis when required

Adaptive Management

All of the alternatives will employ an adaptive management approach for improving resource management by better understanding ecological systems through iterative learning. In 2007, Secretary of Interior Dirk Kempthorne issued Secretarial Order No. 3270, "Adaptive Management"(dated March 9, 2007) to provide guidance on policy and procedures for using adaptive management in Department of Interior agencies. In response to that order, an intradepartmental working group developed a technical guidebook to assist managers and practitioners,"Adaptive Management: The U.S. Department of Interior, Technical Guide." It defines adaptive management, the conditions under which we should consider it, the process for implementing it, and evaluating its effectiveness (Williams et al. 2007). You may view the technical guidebook at: *http://www.doi.gov/initiatives/AdaptiveManagement/documents.html* (accessed May 2011).

The guidebook provides the following definition for adaptive management:

> Adaptive management is a decision process that promotes flexible decisionmaking that can be adjusted in the face of uncertainties as outcomes from management actions and other events become better understood. Careful monitoring of these outcomes both advances scientific understanding and helps adjust policies or operations as part of an iterative learning process. Adaptive management also recognizes the importance of natural variability in contributing to ecological resilience and productivity. It is not a 'trial and error' process, but rather emphasizes

> learning while doing. Adaptive management does not represent an end in itself, but rather a means to more effective decisions and enhanced benefits. Its true measure is in how well it helps meet environmental, social and economic goals, increases scientific knowledge, and reduces tensions among stakeholders.

This definition gives special emphasis to the uncertainty about management impacts, iterative learning to reduce uncertainty, and improved management as a result of continuous learning. This approach recognized that we can never achieve perfect understanding of the natural world and that we must implement management in the face of uncertainty. At the refuge level, adaptive management is an integral part of management planning, research design, and monitoring. Uncertainties about ecological systems are addressed through targeted monitoring of resource response to management actions and predictive models that mimic the function of the natural world.

Adaptive management gives the refuge manager flexibility to adjust management action or strategies if they do not meet goals or objectives. Significant changes from what we present in our final CCP may warrant additional NEPA analysis and public comment. Minor changes will not, but we will document them in our project evaluation or annual reports. Implementing an adaptive management approach supports all refuge goals. Furthermore, adaptive management is all the more compelling in light of climate change concerns.

Climate Change

There is consensus among the scientific community that global climate change, occurring in part as a result of emissions of carbon dioxide and other greenhouse gases from human activities, will lead to significant impacts across the U.S and the world (Joint Science Academies' Statement 2005, *http://www.nationalacademies.org/onpi/06072005.pdf*, accessed May 2011). This includes sea level rise adding stress to coastal communities and ecosystems (Wigley 2004). The effect of climate change on wildlife and habitats is expected to be variable and species-specific, with a predicted general trend of species ranges and vegetation communities shifting northward and higher in elevation.

Uncertainty about the future effects of climate change requires refuge managers to use adaptive management to maintain healthy ecosystems in light of unpredictability (Inkley et al. 2004). This involves improving or adjusting policies and practices based on the outcomes of monitoring or management activities and may result in changes to regulations, shifts in active habitat management, or changes in management objectives. A few recommendations include

- preparing for diverse and extreme weather conditions (e.g., drought and flood);
- maintaining or restoring healthy, connected, and genetically diverse wildlife populations to increase resiliency in wildlife and habitats; and
- protecting coastal habitats to accommodate marsh migration in response to sea level rise (see Inkley et al. 2004 for more recommendations).

GBNERR and the Great Bay Stewards were awarded a grant to study climate change impacts in the Great Bay Estuary in 2010. Under all alternatives, we would use results from this study to inform management decision and support Great Bay Stewards in community outreach to reduce human activities that impact wildlife or habitat migration. We would also pursue the following strategies to reduce our greenhouse gas emissions and help reduce our impact on climate change:

- Support community proposals to develop a regional bike trail. The proposal includes linking a regional trail to the entrance road to the refuge, allowing visitors to reach the refuge using alternative transportation. However, bicycling off-road is not allowed on the refuge.

- Reduce the carbon footprint of facilities, vehicles, workforce, and operations. Some examples include:
  - Use energy efficient equipment, where feasible.
  - Maintain buildings using sustainable, green building technologies.
  - Conduct an energy audit by 2012.

We will help implement the Service's Climate Change Strategic Plan and work with our State and other conservation partners on mitigating and adapting to this conservation challenge. We describe that strategic plan and other important Service guidance on climate change in chapter 1.

Step-down Plans

Service planning policy identifies 25 step-down plans that may be applicable on any given refuge. We have identified the following plans listed below as the most relevant to this planning process, and have prioritized their completion. Sections of the refuge HMP which require public review are presented within this document and will be incorporated into the final version of the HMP immediately upon CCP approval. The highest priority step-down plans, regardless of the alternative selected, are the Annual Habitat Work Plan (AHWP) and Inventory and Monitoring Plan (IMP). These are described in more detail below. They will be modified and updated as new information is obtained so we can continue to keep them relevant.

The following step-down plans are completed for the refuge and are incorporated by reference into the CCP:

- Chronic Wasting Disease Plan (2008)
- Avian Influenza Disease Contingency Plan (2006)
- Fire Management Plan (2004)
- Fishery Management Plan (1994)
- Hunt Plan (1993)

All of the alternatives schedule the completion of the following step-down management plans as shown.

- A HMP, within 1 year of CCP approval. (see discussions below on HMP and NEPA requirements; we will use the 2006 draft HMP to the extent that it is consistent with final CCP)

- An IMP, within 5 to 10 years of CCP approval (see discussion below)

- Visitor Services Plan, within 3 years of CCP approval (we will use the 1993 Public Use Plan to the extent that it is consistent with the final CCP).

- Law Enforcement Plan, within 3 years of CCP approval.

- Facilities and Sign Plan, within 3 years of CCP approval.

- Fire Management Plan (FMP), rewritten and completed by 2013.

Habitat Management Plan

A HMP for the refuge is the requisite first step to achieving the objectives of goals 1, 2, and 5, regardless of the alternative selected for implementation. The HMP will provide more details on the habitat management strategies we would use to accomplish CCP goals and objectives over the next 15 years. In particular, the HMP will detail the specific areas and habitat types we will manage for, as well as the tools and techniques we will use and the timing of our management actions. Additional analysis of the impacts of specific methods may be necessary. The HMP will also incorporate the results of appendix B, which identifies how we

derived focal species and habitats for the refuge. We will revise and update the draft HMP, developed in 2006, once the CCP is completed.

In this CCP, the goals, objectives, and of strategies 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. To facilitate our management, we will regularly maintain our GIS database, documenting any major vegetation changes on at least a 5-year basis.

Annual Habitat Work Plan
The AHWP is generated each year from the HMP, and outlines specific management activities to occur in that year. Regardless of the alternative chosen, these plans are also vital for implementing habitat management actions and measuring our success in meeting the objectives.

Fire Management Plan
According to Service fire policy, all FMPs should be reviewed annually and updated with current information. Great Bay Refuge's FMP is currently being rewritten and will be completed in 2012. Once the CCP is complete, the FMP will be reviewed and changes to FMP made, as necessary, to reflect management changes identified in the CCP.

Inventory and Monitoring Plan
The IMP will outline and prioritize inventorying and monitoring activities for the refuge. We will use our inventory and monitoring program to assess whether our original assumptions and proposed management actions are supporting our habitat and species objectives. The results of inventories and monitoring will provide us with more information on the status of our natural resources and allow us to make more informed management decisions. The Service's Inventory and Monitoring Policy is currently in draft form, and national and regional staff are currently developing a new template for IMPs. We will incorporate recommendations from the "Strategic Plan for Inventories and Monitoring on National Wildlife Refuges: Adapting to Environmental Change" (USFWS 2010) to ensure a coordinated approach to inventory and monitoring across refuges. The IMP also incorporate the monitoring elements identified under each of the biological objectives for the selected CCP alternative.

Invasive Species Management

The Service identifies an "invasive species" as a species that is nonnative to an ecosystem, and whose introduction causes, or is likely to cause, harm to the economy, environment, or human health (Executive Order 13112).

The unchecked spread of invasive plants threatens the biological diversity, integrity, and environmental health of all refuge habitats. In many cases, invasive species outcompete native species and become the dominant cover. This reduces the availability of native plants as food and cover for native wildlife. Over the past several decades, government agencies, conservation organizations, and the public have become more aware of the negative effects of invasive species. One report estimated the economic cost of invasive species in the U.S. at $137 billion every year (Pimentel et al. 2000). Up to 46 percent of the plants and animals federally listed as threatened and endangered have been negatively impacted by invasive species (Wilcove et al. 1998, National Invasive Species Council 2001).

The Service in Region 5 initiated an effort to systematically identify, locate, and map invasive plant species occurring on refuge lands leading to an effective integrated management plan. Great Bay Refuge initiated a baseline inventory and mapping of invasive species in 2002. Field surveys during 2002 to 2010 detected 34 invasive species (see table 2.10 in chapter 2). The Refuge will use this information to guide the development of monitoring, control, and eradication

projects. When control is deemed necessary, the refuge will use the most effective combinations of mechanical, biological, and chemical controls to achieve long-term control or eradication. Only herbicides approved by the regional contaminants coordinator will be used, and only in accordance with approved rate and timing of application.

Great Bay Refuge is also part of CWIPP, a partnership among 11 agencies and organizations formed in 2008 to address the effects of invasive plants across jurisdictional boundaries. The CWIPP signatories agreed that it was to their mutual benefit and interest to work cooperatively to inventory, monitor, control, and prevent the spread of invasive plants across jurisdictional boundaries within New Hampshire's coastal watershed. The goal through this cooperative effort is to achieve better management of invasive plants while improving working relationships between the signatories and the public. Great Bay Refuge, although not a signatory to CWIPP, is a "sustaining partner." Sustaining partners are organizations or agencies with a significant interest in the success of the partnership. (*http://des.nh.gov/organization/divisions/water/wmb/coastal/cwipp/index.htm*, accessed May 2011).

Under all alternatives we would continue to implement the following strategies:

- Continue to follow the national guidance on invasive species provided in the Service Manual (620 FW 1.7G).
- Complete the inventory and mapping of invasive plant species and prioritize invasive species to be controlled or eradicated. Implement controls using biological, ecological, mechanical, prescribed fire, or chemical techniques, as needed.
- Participate in the CWIPP for early detection and monitoring of invasive species, and become a signatory to CWIPP.
- Work with NHFG to control and removal of mute swan from the refuge. The Service goal is zero productivity for mute swans in the Northeast Region, due to the negative impact of this nonnative swan on native waterfowl and their habitats.

Refuge Staffing and Administration

Staffing and Operational Budgets

Staffing and operations and maintenance funds over the last 5 years are presented in chapter 2. Our objective is to sustain annual funding levels that allow us to achieve our refuge goals, objectives, and strategies. The lack of staff over the last 3 years has limited our capability to conduct priority work, such as major maintenance projects, biological inventory and monitoring, outreach, and public use programs. If our base budget were to increase and stay stable for the foreseeable future, we would propose additional staff to help us achieve our goals and objectives, as outlined for alternatives B and C below.

Appendix C includes our construction and maintenance projects currently listed in the RONS and SAMMS databases, and indicates the regional and refuge ranking for each project.

Facility Maintenance

All of the alternatives include the periodic maintenance and renovation of existing facilities to ensure the safety and accessibility for staff and visitors. Our current facilities are described in chapter 2.

Refuge Operating Hours

All of the alternatives will open the refuge for public use from sunrise to sunset, 7 days a week, with a priority to ensure visitor safety and protect refuge resources. However, the refuge manager does have the authority to issue a special use permit to allow access outside these timeframes. For example, researchers or

hunters may be permitted access at different times or in areas that may not be open to the general public. The refuge manager may also permit organized groups to conduct nocturnal activities, wildlife observation, environmental education, and interpretive programs. The Great Bay Refuge office is currently closed because the refuge is unstaffed. The office will remain closed until staff positions are filled.

Findings of Appropriateness and Compatibility Determinations

Chapter 1 describes the requirements for findings of appropriateness and compatibility determinations. Appendix C includes appropriateness and compatibility determinations consistent with implementing alternative B, the Service-preferred alternative. Some of these uses are already approved, while others are presented here in draft for public review. Our final CCP will include all approved findings of appropriateness and compatibility determinations for the alternative selected. These activities would be evaluated based on whether or not they contribute to meeting refuge purposes, goals, and objectives.

Activities Not Allowed

We occasionally receive requests for activities that we do not allow under 50 CFR on Great Bay Refuge. The refuge manager has determined that these activities are not appropriate on the refuge or are sufficiently provided elsewhere nearby on other ownerships. These activities will continue to be prohibited on refuge lands under all alternatives. The only exceptions would be at the discretion of the refuge manager, under specific, special circumstances (e.g., to accommodate visitors with disabilities), and would require the issuance of a special use permit. Appendix C documents the refuge manager's justification for why they are deemed not appropriate. The activities not allowed on refuge lands include: motorized vehicles, bicycles, pets, and horseback riding.

Protecting the Rocky Shore

Great Bay Refuge has about 2 acres of rocky shoreline. Woodman Point overlooks a portion of this shoreline and is an important roost site for bald eagles wintering on Great Bay. Thomas Point and the 0.25-acre Nannie Island off Woodman Point also support rocky shore. The objective under all three alternatives is to maintain this area as undisturbed habitat for these birds of conservation concern.

We are excited to announce that in April 2011 a new, active bald eagle nest was discovered on Fabyan Point. This nest is the first bald eagle nest for the refuge. Due to the location of the nest site, no management actions have been necessary to restrict public use or access. The only change we have made is to place a gate across the top of Fabyan Point Road, which was already closed to public access. The gate was installed to provide further protection from trespassers who might disturb the nesting pair.

We will continue to implement the following strategies:

Woodman Point

USFWS

- Evaluate the importance of Nannie Island and surrounding waters to migratory birds and other Federal trust resources to determine if the island should remain closed to public access or open for recreation or education purposes.

- Monitor the wintering and nesting bald eagle population on and around the refuge.

Special Designations

Marine Protected Areas

All coastal national wildlife refuges are part of the national system of marine protected areas (MPA). The goal of the MPA program is to conserve the nation's natural and cultural marine heritage and to ensure the sustainable production of marine resources. Specifically, Great Bay Refuge contributes to the following MPA conservation objectives:

- Provides reproductive and nursery grounds and foraging areas for fish and shellfish

- Supports areas for migratory birds

- Provides linked areas important to life histories of marine organisms

- Offers compatible opportunities for education and research

Protecting Cultural Resources

As a Federal land management agency, we are responsible for locating and protecting cultural resources, including archaeological sites and historic structures that are eligible for the National Register of Historic Places. That applies not only to resources that are located on refuge lands, but also those on lands affected by refuge activities, as well as any museum properties.

As mentioned earlier, the Margeson Estate is listed on the National Register. We have initiated consultation with SHPO to evaluate the structures in the former Weapons Storage Area and on Fabyan Point to determine their eligibility for the National Register.

Under all alternatives, we would conduct an evaluation of the potential for our projects to affect archaeological and historical resources, and would consult with our Regional Historic Preservation Officer (RHPO) and the SHPO, as appropriate. In particular, we would consult with the RHPO and SHPO on actions such as

- the rehabilitation, moving, or demolition of historic structures;

- the construction of new buildings in the "area of potential effect" of the historic structures; and

- projects that include moving or displacing soil.

Pre-project consultation with SHPO staff will ensure that we comply with section 106 of the National Historic Preservation Act, regardless of the alternative implemented. Section 106 Review involves consultation between the Service's cultural resource staff and the SHPO project review staff, and a section 106 review report generated by the Service that describes the undertaking, the historic resources, the effect of the project on the historic resources, recommendations for avoiding adverse effect to the historic resources, and mitigation measures in the case where adverse effect cannot be avoided. Mitigation measures may include photographic and written documentation, interpretive exhibits, and archaeological surveys. The section 106 review process also includes public involvement, with information on the undertaking submitted

to the Newington Certified Local Government and Newington Historical Society for comment.

Special Use Permits

All of the alternatives would require the refuge manager to evaluate activities that require a special use permit for their appropriateness and compatibility on a case-by-case basis. All research, commercial, and economic uses, and groups of 10 or more people, require special use permits. In the past the refuge manager has issued special permits for wildlife inventories, research, hunting and partner-led educational programs.

Refuge Revenue Sharing Payments

National wildlife refuges contribute to local economies through shared revenue payments. Federally owned lands are not taxable; but, under the provisions of the Refuge Revenue Sharing Act, the municipality or other local unit of government receives an annual refuge revenue sharing payment to offset the loss of property taxes that would have been collected if the land had remained in private ownership. In addition, federally owned land requires few services from municipalities, yet it provides valuable recreational opportunities for local residents. As we describe in chapter 2, we pay the town of Newington annual refuge revenue sharing payments based on the acreage and the appraised value of refuge lands. The annual payments are calculated by formula determined by, and with funds appropriated by, Congress. Under all alternatives, we will continue those payments in accordance with the law, commensurate with changes in the appraised market value of refuge lands, or new appropriation levels dictated by Congress.

Additional NEPA Analysis

For all major actions, NEPA requires site-specific analysis and disclosure of their impacts, either in an EA or an environmental impact statement (EIS). Most of the major actions proposed in the three alternatives are fully analyzed and described in enough detail in this draft CCP/EA to comply with NEPA and would not require additional environmental analysis. Although this is not an all-inclusive list, the following projects fall into this category:

- Projects common to all alternatives
  - Biological inventories and monitoring
  - Minor modifications to our public use programs
  - Controlling invasive plants and animal pests
- Projects proposed under alternatives B and C only
  - A new refuge headquarters and visitor contact facility
  - Extending existing trails
  - Removal of Lower Peverly Pond Dam
  - Converting existing grasslands to shrub habitat to benefit the federally listed candidate New England cottontail.

Although we analyze in this draft CCP/EA the impacts of the management alternatives we have developed, additional NEPA analysis will be necessary for certain types of actions, even once we adopt a final CCP. Where decisions have not been made in this CCP, but must be made later, we analyze the impacts of the possible range of alternatives in this document, but may need to supplement this analysis later. An example of this is our proposal under alternatives B and C to expand the hunting program. We analyze the impacts of the expanded program at a general level herein, but this analysis will have to be supplemented before a final decision on whether to go forward with the proposed expanded hunt particular design is reached. Similarly, if we pursue the proposal under alternative C to remove all three dams along Peverly Brook, adoption of such recommendations would require additional analysis. In each case these are management actions whose precise details, and therefore consequences, cannot be known by the Service at this time.

Actions Common to Alternatives B and C

New Facilities, Staffing, and Maintenance

The existing refuge office does not have enough space to serve as both an administrative office and visitor contact station, given our anticipated needs over the next 15 years. Under alternatives B and C, we propose to expand visitor services and resource management, which would require additional space for both staff and visitors.

Appendix C includes construction and maintenance projects proposed in alternative B, buy not yet in the SAMMS and RONS databases. Once approved, if funding is not available, we would continue to seek alternative means of accomplishing our projects, for example through our volunteer program, challenge cost share grants, other partnership grants, or internships.

Under alternatives B and C, we would seek to fill our four approved, but vacant, staff positions which we believe are needed to accomplish our highest priority projects. The positions are:

(1) Assistant refuge manager
(2) Refuge wildlife biologist
(3) Visitor services specialist
(4) Maintenance worker

Peverly Pond Trail

Greg Thompson/USFWS

To accommodate increases in staff, we propose to construct a new administration/visitor contact facility. We would build the facility in an already disturbed area in the former Weapons Storage Area. The building would be approximately 7,000 square feet and follow Service's standard design for a small building and visitor contact facility (see appendix J). The new facility would have space for the four proposed position. The facility would also have space for two Wapack Refuge staff and a shared refuge law enforcement officer for Parker River, Great Bay, and Wapack Refuges. Finally, it would continue to provide office space for up to four regional office staff.

We also propose to build a separate new maintenance facility, given problems with the existing facility. The existing maintenance area is poorly sited and flooding has been a problem.

Strategies:

- Relocate the recreational vehicle (RV) pad, used by volunteers as housing, from the Caretakers Cottage to across from staff residence (at former kennel area), and increase number of power connections.
- Construct maintenance and storage building.
- Construct a new office/visitor facility adjacent to the existing office to house and support existing and proposed staff positions.

- Convert all Service roads beyond the residence and maintenance shop from pavement to gravel.
- Remove existing headquarters building.
- Convert existing shop to storage area

Land Protection Focus Areas

During the CCP process, several focus areas were identified by partners and the public for our planning team to consider for Service acquisition. Conservation of lands within these focus areas would support Great Bay Refuge's purposes, and the Refuge System and Service missions, with particular emphasis on protecting species of conservation concern, such as the Karner blue butterfly (federally endangered), the New England cottontail (Federal candidate species), and salt marsh sparrow (a State species of concern), and other Federal trust resources in the Great Bay/Coastal and Concord Pine Barrens ecosystems of New Hampshire. For alternatives B and C, we include several of those focus areas identified. We propose to evaluate these focus areas within the next 5 years to assess whether additional land protection is warranted to conserve Federal trust resources and, whether Service land acquisition from willing sellers is recommended.

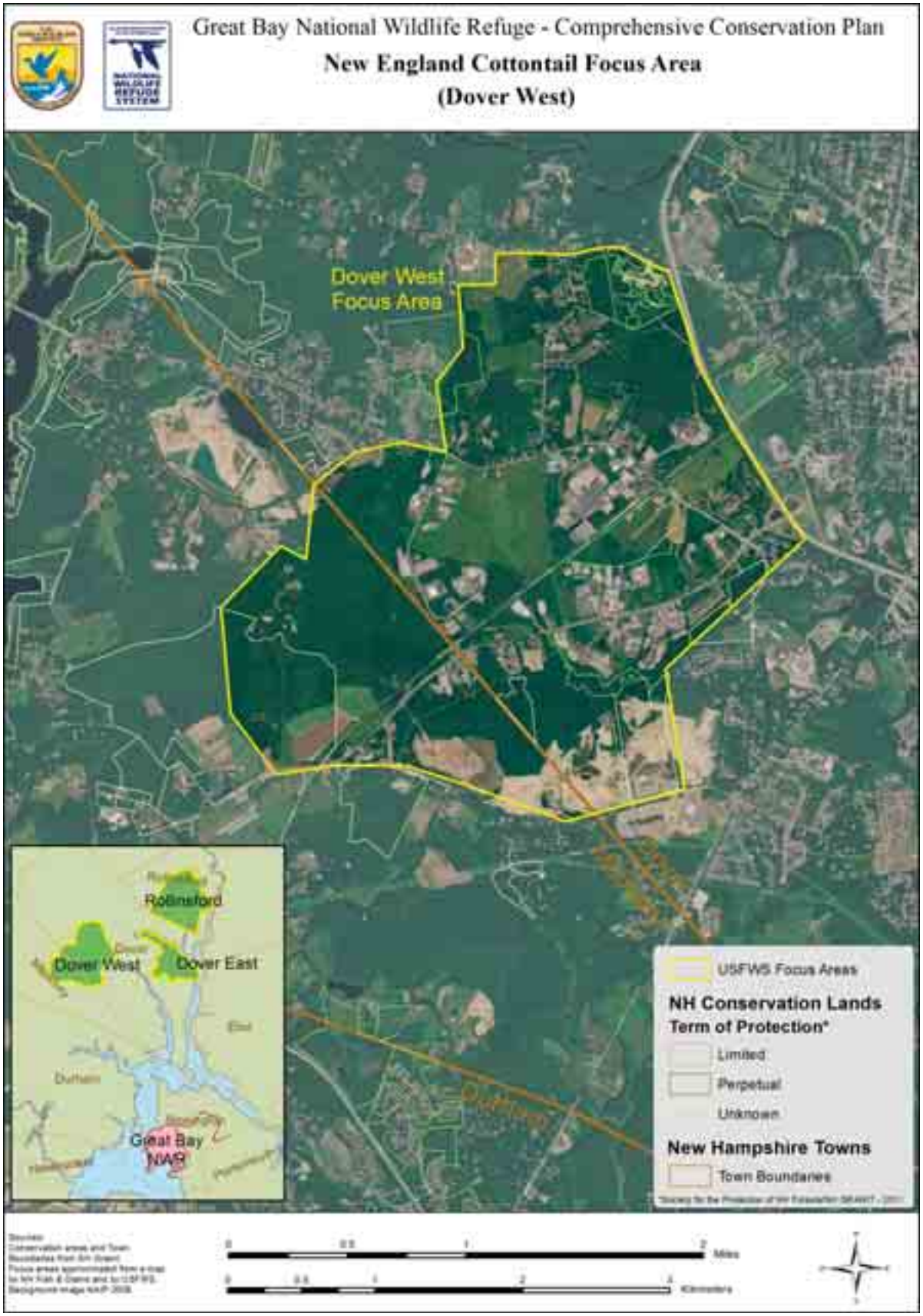
Within 5 years of CCP approval, we would conduct a biological analysis of these focus areas, to identify those specific areas that would improve resource protection for Federal trust species and aid in fulfilling the mission of the Refuge System and the purposes of the refuge. If the review determines that additional land protection by the Service should be pursued then we would initiate all necessary administrative procedures to expand the boundary of the refuge. If the Service's Director grants approval to continue the effort, we will prepare a separate EA and Land Protection Plan (LPP) to analyze all factors involved in a refuge expansion and propose an alternative for public consideration. We expect that any proposal which might emerge from this process will include significant public involvement in decisionmaking, involve partners in the protection effort, and will utilize the full range of protection methods, including management agreements, conservation easements, and fee acquisition.

We have organized the following discussion of proposed focus areas under two subheadings:

(1) Focus areas in coastal New Hampshire
(2) Focus area for Karner blue butterfly near the Concord pine barrens

Focus Areas in Coastal New Hampshire
We have identified several focus areas of high value habitats, including early successional habitat for New England cottontail and coastal and estuarine salt marsh. In consultation with our conservation partners in the region, we identified these high priority areas:

- *West Dover/ East Dover/Rollinsford Focus Areas* (map 3.1 and 3.2): NHFG identified a focus area from the existing Bellamy River Wildlife Management Area in Dover west and east of Route 16 and into Rollinsford, about 5 miles north of the existing Great Bay Refuge. The goals are to recover
  - the New England cottontail, a Federal candidate species, before it is listed,
  - a suite of declining early successional migratory birds, such as American woodcock, whip-poor-will, eastern towhee, brown thrasher, blue-winged warbler, and prairie warbler; and


Great Bay National Wildlife Refuge - Comprehensive Conservation Plan
New England Cottontail Focus Area
(Dover West)
Dover West
Focus Area
Rollinsford
Dover West
Dover East
Durham
Great Bay
NAR
USFWS Focus Areas
NH Conservation Lands
Term of Protection*
Limited
Perpetual
Unknown
New Hampshire Towns
Town Boundaries
Miles
Kilometers

Great Bay National Wildlife Refuge - Comprehensive Conservation Plan
New England Cottontail
Rollinsford and Dover East Focus Areas
Rollinsford Focus Area
Rollinsford
South Berwick, Maine
Dover
Dover East Focus Area
USFWS Focus Areas
NH Conservation Lands
Term of Protection*
Limited
Perpetual
Unknown
New Hampshire Towns
Town Boundaries
Miles
Kilometers

- species of greatest conservation need in the coastal plain of New England, such as Blanding's turtle, black racer, and hognose snake.

- *Great Bay Estuary* (map 3.3): The refuge seeks a greater role in the GBRPP, particularly in working with interested private landowners on the eastern side of the bay, extending from the current refuge boundaries south to Pierce Point in Greenland and east to the airport. In addition to protecting important habitats along the bay, these lands could offer potential boat access to the bay and opportunities for wildlife observation, hunting, and ice fishing.

- *Hampton-Seabrook-Salisbury Marsh* (map 3.4): The 5,000-acre Hampton-Seabrook Estuary is the largest contiguous area of salt marsh and tidal flats in New Hampshire. It forms the northern part of an extensive salt marsh system that extends south to Cape Ann, Massachusetts. Parker River Refuge is also part of this "Great Marsh." Although the Hampton-Seabrook Estuary is surrounded by development, and affected by ditching and tidal restrictions, it retains significant ecological value and supports a diversity of wildlife (McKinley and Hunt 2008). Several Federal trust species occur here, including a population of breeding salt marsh sparrows.

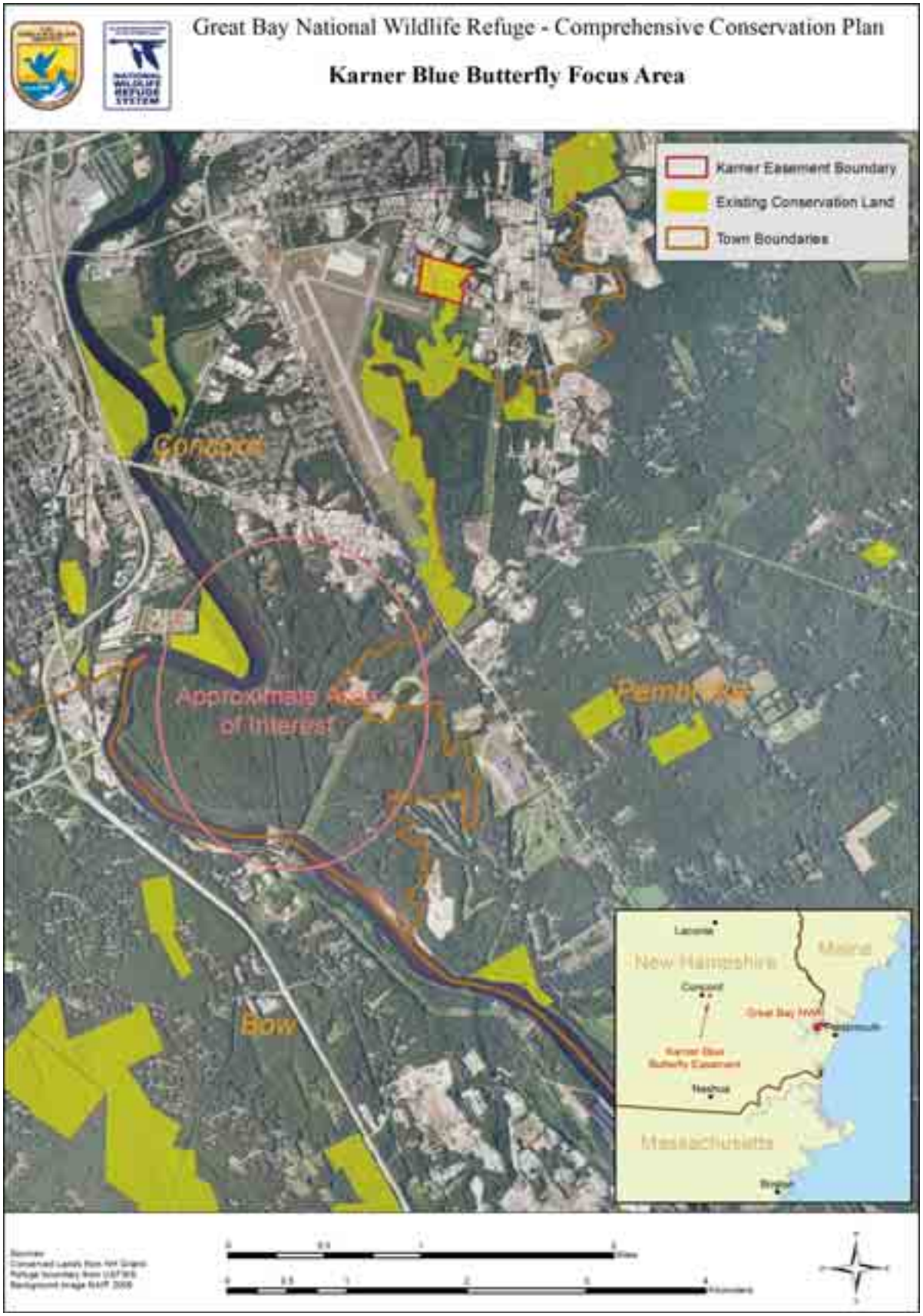
Focus Area for Karner Blue Butterfly in the Concord Pine Barrens
The Concord pine barrens support the only remnant population of the federally listed endangered Karner blue butterfly in New England. However, the existing 29-acre conservation easement managed by the refuge and lands under a 50-year management agreement with the city of Concord do not provide sufficient habitat to maintain a sustainable wild population (USFWS 2003, Fuller 2008). In consultation with NHFG, the Service has identified significant habitat for the Karner blue butterfly on adjacent lands that are not currently protected (map 3.5). The powerline corridor that runs through this focus area serves as a primary dispersal corridor for the butterfly. The Air National Guard also owns significant land that has suitable habitat for the butterflies. PSNH and the Air National Guard are two important partners in this focus area. Some of the lands under consideration in this focus area would also provide habitat for New England cottontail.

Historical Buildings
We have initiated consultation with SHPO to assess the National Historic Register eligibility of all structures in the former Weapons Storage Area and the Fabyan Point cabins. We expect this review to be completed within 1 year of CCP approval. If any structures are determined to be ineligible, we would plan to remove them, as funding and staffing allows. The only exception is under alternative B, if the bunkers are determined ineligible, we would plan to keep one or two them for possible use as bat hibernacula. If any of the structures are determined eligible, we would evaluate management options and/or mitigation measures with SHPO.

The Margeson Estate is on the National Register, but is in poor condition due to a lack of funding and resources available to maintain it. Our consultation with SHPO includes evaluating management options and/or mitigation measures for the estate. We have indicated to SHPO that our preferred alternative is recording the site and then demolishing the buildings. If we pursue demolition, with SHPO concurrence, additional NEPA analysis may be required.

Great Bay National Wildlife Refuge - Comprehensive Conservation Plan
East Great Bay Focus Area
Durham
Newington
Great Bay NWR
Pease International Tradeport
Approximate area of interest
Great Bay
Portsmouth
Pierce Point
Greenland
95
Existing Conservation Land
Town Boundaries

Great Bay National Wildlife Refuge - Comprehensive Conservation Plan
Hampton - Seabrook - Salisbury Marsh Focus Area
Hampton-Seabrook-Salisbury Marsh
Existing Conservation Land
Town Boundaries
Hampton Falls
Maine
Great Bay NWR
New Hampshire
Seabrook
Massachusetts
Parker River NWR
New Hampshire
Massachusetts
AMESBURY
SALISBURY
NEWBURYPORT
Miles
Kilometers


Great Bay National Wildlife Refuge - Comprehensive Conservation Plan
Karner Blue Butterfly Focus Area
Karner Easement Boundary
Existing Conservation Land
Town Boundaries
Concord
Approximate Area of Interest
Bow
New Hampshire
Maine
Massachusetts

Wild turkey on the refuge

Greg Thompson/USFWS

Alternatives or Actions Considered but Eliminated From Detailed Study

Based on public scoping and internal agency discussions, we considered several other alternatives, but eliminated from further study.

- **Developing Great Bay Refuge as a Major Interpretive Center for the Cold War Era** As a former Air Force Base, many military artifacts remained when the land was transferred to the Service. This included the many buildings and bunkers in the former Weapons Storage Area. We decided to begin removal of these facilities many years ago and, as funding allows, we continue to remove the structures. Maintaining the former Weapons Storage Area and other military structures is not consistent with the purposes for which the refuge was created. Therefore, the Service did not pursue this as an alternative. However, under alternative B, goal 4, objective 4.2, we do propose developing outreach information and self-guided interpretive materials to interpret the Cold War Era history of refuge lands.

- **Maximizing Public Use and Access, Including Providing Fish Opportunities** Great Bay Refuge is a relatively small refuge making it difficult to balance the protection of unique ecological features and wildlife habitats with providing public access that exposes visitors to the diversity of habitats. Greatly expanded public use, such as greater access to the refuge shoreline or more remote areas, would not be consistent with the purposes for which this refuge was established. Specifically, it would potentially degrade important wetland habitats on Great Bay Estuary and would disturb wildlife that has limited sanctuary in the area.

  In addition, past land uses, including the former Air Force Base, left behind contaminated sediments in the Peverly Brook system, which remain a human and wildlife health concern. Given these contamination issues, opening the refuge to fishing is not recommended.

  Therefore, we eliminated consideration of an alternative that greatly expands public use programs and increased access. However, visitor programs and public access would be more conservatively enhanced and expanded under alternatives B and C.

Alternatives Analyzed in Detail

Alternative A–Current Management

This alternative describes our current management of Great Bay Refuge, including activities currently underway, funded, or approved. Alternative A serves as a baseline for comparing the other two alternatives. In 2008, the 1,103-acre refuge was de-staffed. At that time, Parker River Refuge assumed administrative responsibilities for Great Bay Refuge, the Karner blue butterfly conservation easement, and Wapack Refuge in Hillsborough County, New Hampshire. Based on the limited staffing available, under this alternative we would continue to focus our biological program on the present priorities, including maintaining impoundments for migratory birds, managing grasslands for upland sandpipers and other grassland dependent species of concern, and inventorying and controlling invasive plant species. We would also continue to rely on a small, but active, group of volunteers to help with seasonal activities. The Parker River Refuge refuge manager would continue to serve on key partnership committees, such as the GBRPP and to work with the adjacent Pease Airport on wildlife and airstrike hazards.

With regards to visitor services on Great Bay Refuge, we would continue to host a 2-day fall deer hunt, with assistance from NHFG. The two existing pedestrian trails would remain open to offer wildlife observation and photography opportunities. The rest of the refuge would remain closed, including the refuge office, since there are no refuge staff onsite. We would continue to rely on our partners, including the town of Newington and other Service programs, to assist with law enforcement. We would continue to have limited ability to respond to requests for environmental education and interpretive programs.

On the Karner blue butterfly easement, we would continue to actively manage habitat for Karner blue butterflies in partnership with NHFG.

The existing habitat types are depicted on map 3.6. Map 3.7 shows the refuge's current infrastructure and facilities, including those that support the refuge's public use program.

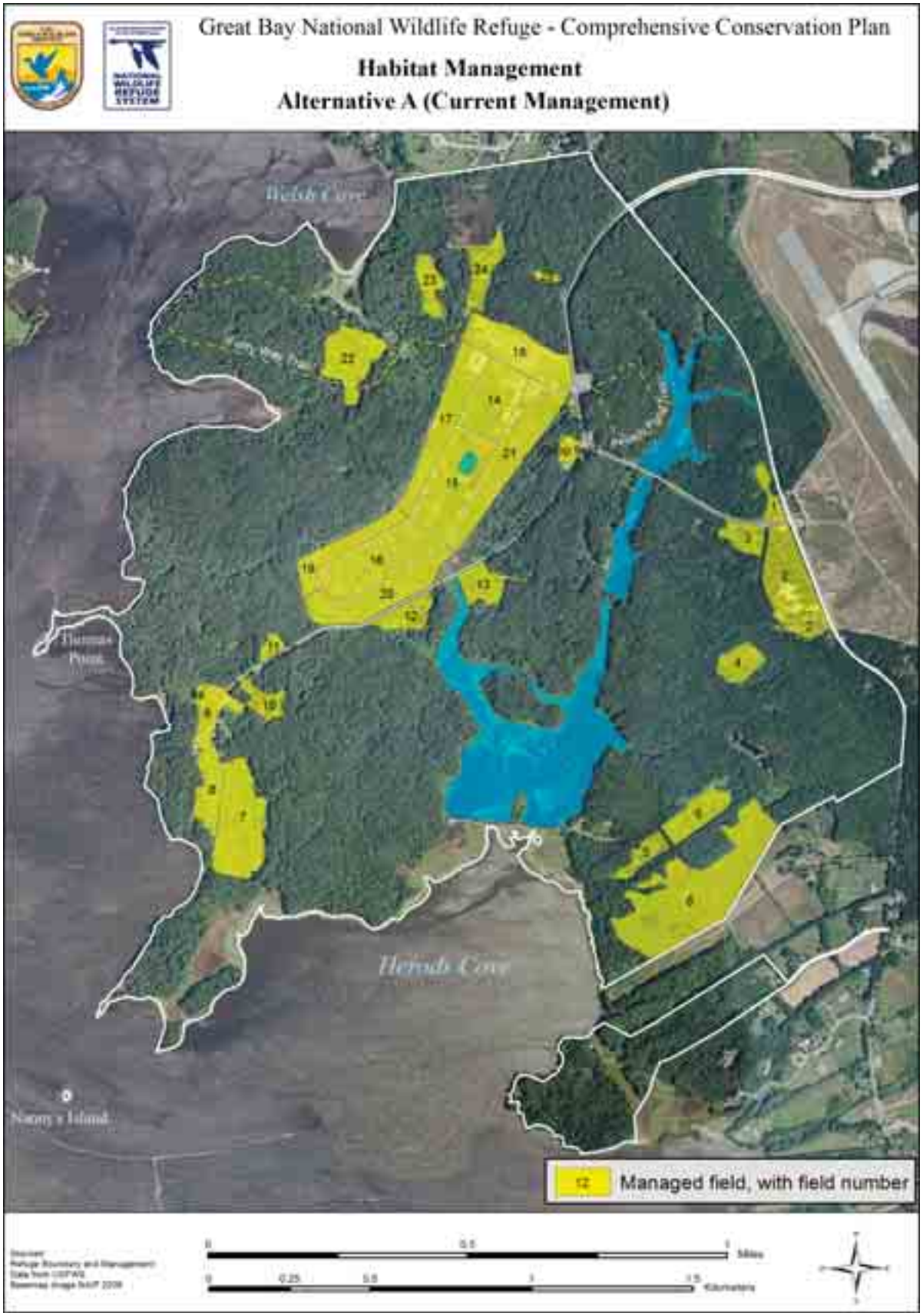
GOAL 1. **Perpetuate the biological integrity, diversity, and environmental health of estuarine and freshwater habitats on Great Bay Refuge to protect water quality and sustain native plant communities and wildlife, including species of conservation concern.**

Objective 1.1 (Salt Marsh) Annually maintain the existing quality and natural function of the refuge's 36 acres of salt marsh that supports a mix of native high and low marsh plant species including smooth cordgrass, salt meadow cordgrass, spikegrass), and black grass, with less than 1 percent overall cover of invasive plants, to provide habitat for salt marsh sparrows, wintering American black ducks, foraging wading birds, fish, and rare plants.

Rationale
See rationale under alternative B, goal 1, objective 1.1.

Strategies
Continue to:

- Maintain the existing quality and function of 36 acres of salt marsh, including a mix of high and low marsh vegetation, with less than 1 percent cover invasive plants
- Prohibit public access to salt marsh habitats.


Great Bay National Wildlife Refuge - Comprehensive Conservation Plan
Habitat Management
Alternative A (Current Management)
Herods Cove
Managed field, with field number

Great Bay National Wildlife Refuge - Comprehensive Conservation Plan
Public Use
Alternative A (Current Management)
Welsh Cove
Existing Observation Platform
Electric Gate
Gate
Existing Observation Platform
Parking Lot
Office
Kiosk
Shop
Thomas Point
Caretaker's House
Nutter Point
Herods Cove
Nanny's Island
Tolman Point
Structure
Right of Way
Admin only Road
Entrance Road
Non-FWS Road
Public Trail
Chain link Fence
Miles

- Control any existing and new invasive plant species in the salt marsh using the most effective technique, which could include cutting, handpulling, biological controls, and herbicide application (e.g., cut and drop or spot treatment).

Participate in CWIPP's ongoing identification, monitoring, and eradication efforts for invasive plants in seacoast marshes.

Objective 1.2 (Intertidal and Shallow Estuarine Waters)

This objective is not part of our current management.

Objective 1.3 (Freshwater Impoundments)

Manage the 62 acres of freshwater impoundments (44-acre Stubbs Pond, 11-acre Upper Peverly Pond, and 7-acre Lower Peverly Pond) in a mosaic of approximately 50 percent emergent marsh (cattails, softstem bulrush, and arrowhead) and 50 percent open water to benefit migrating waterfowl, nesting marsh birds such as marsh wren, and migratory fish, including alewife and blueback herring.

Rationale
See rationale under alternative B, goal 1, objective 1.3.

Strategies
Continue to:

- Maintain 62 acres of freshwater impoundments of Stubbs Pond (44 acres), Upper Peverly Pond (11 acres), and Lower Peverly Pond (7 acres).
- Address structural deficiencies in Stubbs Pond and Upper Peverly Pond Dams, as indicated in chapter 2, under "Freshwater Impoundments."
- Prioritize and control invasive plants using mechanical, chemical, prescribed fire, and ecological methods. This includes removal of purple loosestrife, *Phragmites*, and brittle waternymph through water level manipulation and biological controls. Chemical controls are used as a last option if the other techniques are not effective.
- Provide and manage alewife habitat in Stubbs Pond and ensure passage through the dike for migratory fish, including alewife, American eel, and blueback herring.
- Use adaptive management to maintain an optimal mix of approximately 50 percent open water and 50 percent aquatic vegetation to benefit breeding and staging waterfowl, marsh and wading birds, fish, and rare plants.
- Control mute swans, a nonnative species that negatively impacts local plants and waterfowl.

GOAL 2.

Perpetuate the biological integrity, diversity, and environmental health of upland and forested wetland habitats on Great Bay Refuge to sustain native plant communities and wildlife, including species of conservation concern.

Objective 2.1 (Appalachian Oak-Hickory Forests)

Manage 659 acres of Appalachian oak-hickory forests dominated by red, black, and white oaks, and shagbark hickory, with less than 10 percent of total vegetative cover of invasive plant species to provide, breeding habitat for birds of conservation concern including scarlet tanager, Baltimore oriole, wood thrush, and other mixed-forest dependent species, and to maintain the exemplary natural communities of Appalachian oak-hickory forest on the refuge.

Rationale
See rationale for alternative B, goal 2, objective 2.1.

Strategies
Continue to:
- Assess habitat potential for the federally listed endangered Indiana bat, State-listed eastern small-footed bat, and other bat species.
- Complete a vegetation map for Fabyan Point and the Thomas property and update the natural community map for the rest of the refuge.
- Complete the inventory and mapping of invasive plants on the refuge.

Objective 2.2 (Forested and Scrub-Shrub Wetlands, and Vernal Pools)

Maintain the 149 of forested wetlands, scrub-shrub wetlands, and vernal pools on the refuge to sustain high water quality and to benefit foraging woodcock, breeding willow flycatcher and other birds of conservation concern, native plant communities, and wetland obligate amphibians, such as wood frog.

Rationale
See rationale for alternative B, goal 2, objective 2.2.

Strategies
Continue to:
- Complete the inventory and mapping of invasive plant species. Prioritize invasive species to be controlled and implement control using biological, ecological or cultural, mechanical, prescribed fire, or chemical, as needed.
- Evaluate the existing amphibian and reptile monitoring data, including the malformed frog surveys, to determine future monitoring needs.

Objective 2.3 (Upland Shrubland)

Manage the existing 26 acres of dry upland shrub habitat that supports native shrubs and young trees (e.g., highbush blueberry, black huckleberry, dogwoods, arrowwood , bayberry (*Morella spp.*), meadowsweet, raspberry, sensitive fern, sumac, and elderberry) to provide nesting and foraging habitat for migratory birds of conservation concern including prairie warbler, blue-winged warbler, eastern towhee, American woodcock, and other thicket-dependent species.

Rationale
See rationale for alternative B, goal 2, objective 2.3.

Strategies
Continue to:
- Complete the inventory and mapping of invasive plant species. Prioritize invasive species to be controlled and implement control using biological, ecological, mechanical, or chemical methods, as needed.
- Maintain the existing shrub habitats using mechanical tools, such as a brush hog or mower.

Objective 2.4 (Grassland)

Manage 169 acres of existing grassland habitat to benefit grassland nesting birds, including bobolink and upland sandpiper, and roosting American woodcock.

Rationale
See rationale for alternative B, goal 2, objective 2.4.

Strategies
Continue to:

- Maintain three large grassland fields (over 25 acres total) in the Weapons Storage Area and Thomas Field through annual mowing or burning after grassland bird breeding season, sometime after July 15.

- Maintain several other patches of open field:
  - The fields along the Ferry Way Trail as wildlife viewing sites
  - The leach field for administrative purposes
  - The area around old apple trees and historic sites at Woodman Point

- Complete the inventory and mapping of invasive plant species; prioritize invasive species to be controlled, and implement control using biological, ecological, mechanical, or chemical methods, as needed.

GOAL 3. **Foster and maintain conservation, research, and management partnerships to promote protection and stewardship of the ecological resources of the Great Bay Estuary.**

Objective 3.1 (Great Bay Partnerships)

Continue to actively participate in key partnerships to promote land conservation, stewardship, research and management of resources of concern within the Great Bay watershed. These partnerships include the Great Bay Resource Protection Partnership, Piscataqua Region Estuaries Partnership, Coastal Watershed Invasive Plant Partnership, and Pease Development Authority Wildlife/Bird Strike Hazard Committee.

Rationale
See rationale for alternative B, goal 3, objective 3.1.

Strategies
Continue to:

- Be an active member of the GBRPP and serve on the Principal Partnership and Stewardship Committees.

- Participate on the Pease Development Authority Wildlife/Bird Airstrike Hazard Committee.

- Serve on the PREP Management Committee.

- Participate in oil spill response training and coordination, particularly as a precaution in the unlikely event that an accident occurs with the shipping traffic up the Piscataqua River.

- Partner with the town of Newington, NHFG, and regional Service personnel on law enforcement on and around the refuge.

- Attend CWIPP meetings and actively participate in coordinated invasive species control and outreach efforts.

Objective 3.2 (Landscape-scale Conservation Partnership)

This objective is not part of current management.

Objective 3.3 (Education and Outreach Partnerships)

Support programs that engage youth and young adults in activities that advance wildlife conservation and refuge goals.

Rationale
See rationale for alternative B, goal 3, objective 3.3.

Strategies
Continue to:
- Partner with Youth Conservation Corps (YCC) program to mentor students and achieve refuge goals and objectives.
- Use the Student Temporary Employment Program (STEP) and Student Career Experience Program (SCEP) to mentor students and achieve refuge goals and objectives.
- Collaborate with Phillips-Exeter Sustainable Program.

GOAL 4. **Promote enjoyment and awareness of Great Bay Refuge and the Great Bay Estuary by providing high-quality, compatible, wildlife-dependent public uses on refuge lands and on partner lands and waters around the refuge.**

Objective 4.1 (Wildlife Observation and Photography)

Continue to maintain the existing two self-guided Peverly Pond and Ferry Way Trails to provide quality wildlife observation and photography opportunities on the refuge.

Rationale
See rationale for alternative B, goal 4, objective 4.1.

Strategies
Continue to:
- Pursue funding to construct a boardwalk along the entire Peverly Pond Trail to meet accessibility standards.
- Maintain the view from the Ferry Way Trail observation deck by pruning shrubs and brush that grow in over time.
- Maintain the kiosk and the parking lot.

Objective 4.2 (Environmental Education and Interpretation)

Provide limited environmental education and interpretive programs using volunteers when available.

Rationale
Although environmental education and interpretation are priority public uses, the lack of staff at the refuge limits our ability to offer any structured programs with regularity. We currently rely on volunteers to lead walks or other interpretive programs, which depends solely on their interest and availability. We continue to receive more requests than we can currently fill.

Strategies
Continue to:
- Use volunteers, if available and interested, to conduct occasional guided walks along the Upper Peverly and/or Ferry Way Trails.

Objective 4.3 (Hunting)

Continue to provide a quality annual deer hunt to manage the white-tailed deer population, protect habitat, and provide a priority wildlife-dependent recreational opportunity.

Rationale
See rationale for alternative B, goal 4, objective 4.3.

Bill Thompson

White-tailed deer

Strategies
Continue to:
- Work with NHFG to handle the permit applications for the existing refuge deer hunt.
- Maintain closure on recreational trapping on the refuge.

Objective 4.4 (Fishing)

Continue refuge closure to fishing, including in the three impoundments and from the refuge shoreline.

Rationale
See rationale for alternative B, goal 4, objective 4.4.

Strategies
Continue to:
- Keep refuge closed to fishing.
- Prohibit boats from landing on refuge shoreline.
- Conduct outreach about, and enforcement of, fishing closure and prohibit boats from landing.

GOAL 5.

Contribute to the recovery of the federally listed endangered Karner blue butterfly and other rare Lepidoptera through the conservation, protection, and restoration of pine barrens habitat.

Objective 5.1 (Habitat Management)

Maintain and manage the 29-acre conservation easement, comprised of pine barrens habitat for the Karner blue butterfly and other rare Lepidoptera in collaboration with the NHFG and other partners.

Rationale
See rationale for alternative B, goal 5, objective 5.1.

Strategies
Continue to:

- Compile current cultural resource inventories and identify additional survey work needed to protect cultural resources in conjunction with site plan implementation.
- Support NHFG with habitat management actions when and where resources allow.
- Post and maintain easement boundary and protect habitat from adverse impacts.
- Identify funding sources or mechanisms to maintain sufficient funding for habitat management.

Objective 5.2 (Species Management)

In collaboration with New Hampshire Fish and Game, support captive rearing and release of Karner blue butterflies to restore a viable population to the Concord pine barrens.

Rationale
See rationale for alternative B, goal 5, objective 5.2.

Strategies
Continue to:

- Support NHFG in captive rearing and translocation of butterflies through outlined partnership.
- Implement recovery plan actions, when and where possible.

Objective 5.3 (Outreach and Education)

Maintain existing outreach and education programs that engage youth and volunteers in the conservation of the Karner blue butterfly and the pine barrens habitat.

Rationale
See rationale for alternative B, goal 5, objective 5.4.

Strategies
Continue to:

- Maintain the existing kiosk.
- Partner with the "Kids for Karners" program in the Concord schools, coordinated by NHFG and National Wildlife Federation.
- Support existing partnership with the New England Zoo and Aquarium Association to engage volunteers in conservation of local species through activities such as native plant propagation, transplanting, trail construction, and outreach.

Objective 5.4 (Land Protection)

This objective is not part of current management

Objective 5.5 (Partnerships)

This objective is not part of current management

Alternative B–Habitat Diversity and Focal Species Emphasis (Service-preferred Alternative)

Alternative B, the Service-preferred alternative, combines the actions we believe would best achieve the purposes, vision, and goals of Great Bay Refuge, and respond to public issues. It emphasizes the management of specific refuge habitats to support focal species whose habitat needs benefit other species of conservation concern that are found around Great Bay and in the larger landscape of coastal New Hampshire. In particular, we would emphasize habitat for priority birds identified in BCR 30 such as migratory waterfowl, waterbirds, forest-dependent songbirds, shrubland species, and estuarine species of concern including oysters and eelgrass that are indicators of ecosystem health.

Along the Peverly Brook stream, we propose to implement activities to enhance water quality, improve habitat for migratory fish and shellfish, and maintain habitat for waterfowl, marsh birds, and other aquatic species. Specifically, under alternative B we propose removing the Lower Peverly Pond Dam to create stream habitat, while maintaining the dams at Upper Peverly Pond and Stubbs Pond to benefit a range of fish and wildlife. We believe that this combination of maintaining the largest freshwater impoundments and restoring a stretch of stream habitat enhances our contribution to protecting resources of concern in the Great Bay Estuary. In addition, alternative B addresses ongoing concerns of contaminant levels in the sediments within Upper Peverly Pond caused by previous land uses. We would expand our conservation, research, and management partnerships to help restore and conserve the Great Bay estuarine ecosystem and to address emerging issues, including climate change and landscape-scale conservation.

Under alternative B, we propose the following habitat restoration projects in the former Weapons Storage Area. We would manage approximately half of the area as shrubland as a possible location for establishing a captive breeding program for New England cottontail, a Federal candidate species. We would manage the other half as grassland to provide nesting habitat for upland sandpipers and other grassland species of conservation concern. We would also evaluate the underground bunkers for their potential as bat hibernacula.

This alternative would enhance our visitor services programs, which has been limited under current management due to lack of staff. We propose to enhance the entrance to the refuge, create new interpretive materials, expand on an existing quality volunteer program, and offer visitors more opportunities to learn about the refuge and the surrounding environs. We would evaluate expansion of hunting opportunities to include wild turkey. These expanded programs would be possible through the proposed increased staffing and new refuge headquarters/visitor contact facility addressed earlier in chapter 3.

The habitat types that would result under alternative B are depicted on map 3.8. Maps 3.9 and 3.10 show refuge infrastructure and facilities, including those that would support the refuge's public use program, under alternative B.

GOAL 1. **Perpetuate the biological integrity, diversity, and environmental health of estuarine and freshwater habitats on Great Bay Refuge to protect water quality and sustain native plant communities and wildlife, including species of conservation concern.**

Objective 1.1 (Salt Marsh) Annually, maintain the quality and natural function of the 36 acres of salt marsh that supports a mix of native high and low marsh plant species including smooth cordgrass, salt meadow cordgrass, spikegrass, and black grass, with less than 1 percent overall cover of invasive plants, to provide habitat for breeding salt marsh sparrow, wintering American black ducks, foraging wading birds, fish, shellfish and rare plants.

Great Bay National Wildlife Refuge - Comprehensive Conservation Plan
Habitat Management
Alternative B (Service - preferred Alternative)
Welsh Cove
Herman Point
Middle Pond
Herods Cove
Navy's Island
Habitat Management Alternative B
Public Trails
Public Roads
Miles
Kilometers

Great Bay National Wildlife Refuge - Comprehensive Conservation Plan
Public Use - Existing and Proposed
Alternative B (Service - preferred Alternative)
Welsh Cove
Existing Observation Platform
New Observation Platform
Existing Observation Platform
Parking Lot
Kiosk
Office
Shop
Maintenance Road
Admission Drive
Thomas Point
Caretakers House
Sculpin Pond
Herods Cove
Fabyan Point
Nancy's Island
Refuge Boundary
Entrance Road
Proposed Entrance Road
Admin Road
Non-FWS Road
Right of Way
Existing Trail
Proposed Trail
Miles
Kilometers

Great Bay National Wildlife Refuge - Comprehensive Conservation Plan
Public Use Facilities and Refuge Infrastructure
Alternative B (Service-preferred Alternative)
McIntyre Road
New Observation Platform
New Admin/HQ and Visitor Contact Facility
Parking Lot
Kiosk
Observation Platform
Current Office (Remove)
Residence
New Observation Platform
New Maintenance Shop
New RV Pad
Current Maintenance Shop (Convert to Storage)
New office and maintenance shop building size and shape approximate
Entrance Road
Admin Road (no public access)
Non-FWS Road
New trails
Existing trails
Chain link Fence
Parking lot
0 250 500 1,000 1,500 2,000 Feet
0 250 500 Meters

Rationale

Several areas of salt marsh occur along the refuge shoreline, with the most extensive located near Woodman Point and Stubbs Pond. The low salt marsh is dominated by smooth cordgrass, while salt meadow cordgrass, spikegrass, and black grass are dominant in the high salt marsh. A healthy population of seaside mallow, a State-listed threatened plan, is found in the salt marsh near Woodman Point (NHB 2009). The salt marsh is relatively free of invasive plants, with the exception of patches of *Phragmites* adjacent to Stubbs Pond.

Up to 80 percent of the marshes that once occurred in New England have been lost to human development. The remaining salt marshes are being rapidly degraded by fragmentation and development (Bertness et al. 2002). Most of the salt marshes in New England, including those found around Great Bay were parallel ditched for mosquito control and to facilitate salt marsh haying. Salt marshes in the Great Bay Estuary occur as expansive meadow marshes and narrow fringing marshes. These marshes provide cover and forage habitats for fish, invertebrates, and birds, stabilize shorelines and protect against storm damage, and filter nutrients (Mills 2009). Protecting the remaining salt marshes is important to sustain habitat benefits, ecosystem services, and wetland functions.

In 1992, prior to refuge establishment, the town of Newington hired a contractor to spray the pesticide *Bacillus thuringiensis israelensis* (BTI) on marshes to control the extensive mosquito breeding occurring in areas of the marsh heavily impacted by humans. Beginning in 1996, in an effort to eliminate chemical application on the marshes and restore fish and wildlife habitat, the refuge initiated four Open Marsh Water Management (OMWM) projects. In total, 5.1 acres were implemented at Stubbs Pond, 11.25 acres at Herods Cove, 9.9 acres at Woodman Point, and 3.4 acres at Welch Cove. Project objectives included eliminating invasive plants (*Phragmites* and cattails) restoring native salt marsh vegetation such as widgeon grass, and creating suitable habitat for the mummichog minnow. The mummichog is a native predator of mosquito larvae; a healthy population eliminates or minimizes the need to spray BTI for mosquito control (University of Delaware, 2008).

Various open marsh and water management techniques were used. Ditch plugs were constructed to block man-made drainage ditches and create open water habitat. Pannes (beginning at a depth of 2 inches and gradually sloping to 24 inches) were excavated to increase open water habitat and to facilitate wading bird access. Sumps (2-foot-deep depressions) were excavated within pannes to ensure minnow survival during drought conditions. In some areas, shallow connector ditches were also excavated to allow minnow access between pannes.

As presented in chapter 1, the Service's policy on maintaining biological integrity, diversity and environmental health guides our conservation and protection of the broad spectrum of fish, wildlife, and habitat resources found on refuges (*http://www.fws.gov/policy/601fw3.html,* accessed May 2011*).* A major principle underlying this policy is to maintain and restore the diversity, structure, composition, and functioning of the refuge's fish, wildlife, and plant species, communities, and ecosystems, as well as biotic and abiotic processes that shape them. By developing an index of ecological integrity for the refuge's salt marshes, we will be able to gather baseline data and measure our success in sustaining and improving their biological integrity, diversity, and environmental health over time.

Coastal salt marshes provide breeding habitat for black ducks. Specifically, coastal marshes, estuaries, and sheltered coves are especially important foraging

habitat and shelter for black ducks in the winter (Dettmers 2006). On average, about 75 percent of New Hampshire's coastal wintering waterfowl gather on Great Bay, including nearly all of the State's Canada geese, greater scaup, and lesser scaup populations, as well as several thousand black ducks (Vogel 1995). The black duck is a globally vulnerable watch list species and is considered one of the highest priority species of concern according to the Atlantic Coast and Eastern Habitat Joint Ventures and among the state and provincial agencies where it occurs.

Virginia rail, red-winged blackbird, sora, salt marsh sparrow, and Nelson's sparrow nest and forage in salt marshes around Great Bay (Mills 2009). The salt marsh sparrow is a species of concern in New Hampshire and of highest conservation concern in BCR 30. The NHNHB Report (2009) documents an observation in 1997 of eight salt marsh sparrows; two were feeding young in the salt marsh at Woodman's Point. Flooding, particularly during new moon tides, is the primary cause of nest failure for the salt marsh sparrow, which is synchronized to nest immediately after a new moon tide. Vegetation structure and composition are less important in predicting nest success. Females wedge or suspend a nest in medium-high cordgrass just above the substrate or water near the mean high-tide line (Greenlaw and Rising 1994). Another potential threat to this species is elevated mercury levels, which were detected in salt marsh sparrows at other coastal National Wildlife Refuges (Lane 2008). Walsh et al. (in press) found the population at Chapman Landing, on the west side of Great Bay, was the most genetically differentiated from all populations sampled from Maine to Long Island.

According to the NHDES–Coastal Program (2005a), New Hampshire's salt marshes also provide habitat for other aquatic species, including a wide variety of fish and shellfish (e.g., American eel, mummichog, Atlantic silverside, nine-spine stickleback, shore shrimp, and sand shrimp). Several mammals also use salt marsh habitat including deer, muskrat, river otter, and red fox (NHDES 2005b).

Strategies

Continue to:

- Control any existing and new invasive plant species in the salt marsh using the most effective technique, which could include cutting, hand pulling, biological controls, and herbicide application (e.g., cut and drop or spot treatment).

- Participate in the CWIPP's ongoing identification, monitoring, and eradication efforts for invasive plants in seacoast marshes.

- Prohibit public access to salt marsh habitat on refuge.

Within 3 years of CCP approval:

- Develop an index of ecological integrity to
  (1) determine the current baseline integrity condition;

  (2) determine what areas of integrity are low and need attention; and

  (3) prioritize management actions to ensure that the index does not fall below the baseline level. The index's parameters may include vegetation richness and diversity, elevation, sediment accretion, salinity, extent of tidal fluctuation, and water quality measures.

- Evaluate all salt marshes that received OMWM to determine ecological integrity of the marshes, with special emphasis on hydrology, climate change impact,s and invasive plants.

- Collaborate with partners to assess the salt marsh sparrow population around the bay and determine the relative importance of the refuge population to the Great Bay ecosystem and to the larger regional population. Also, partner with UNH to determine how the refuge salt marsh sparrow population fits in the metapopulation structure in New England and throughout the species' range.

- Work with GBNERR to identify and address sources of mercury entering Great Bay, to the extent possible.

- Collaborate with GBNERR on their efforts to establish vertical benchmarks in various low-elevation habitat types within the Reserve. Promote placing one or more on the refuge. Regular surveying of these benchmarks, coupled with enhanced data from tide gauges, will enable accurate tracking of local sea level rise and anticipate its effects on habitats within the Great Bay ecosystem.

- Provide information to refuge visitors about the environmental sensitivity and importance of salt marsh to the health of the Great Bay Estuary.

- Implement an "early detection rapid response" program that would prevent new invasive species from becoming established within the freshwater tidal marsh by locating newly established invasive species and immediately addressing those populations through the appropriate control measure. This program would incorporate a combination of plant identification and inventories, maintaining updates of new invasive species present in the region, as well as having knowledge of the appropriate management techniques prior to conducting control efforts.

- Assess the distribution and health of rare plant populations.

- Work with partners to develop and implement a monitoring plan to identify breeding activities, abundance, and densities of salt marsh sparrows in Great Bay, inclusive of the refuge.

- Partner with BRI or other organizations to test if mercury levels are high in the refuge's salt marsh sparrow population, as one indicator of ecological health.

- With volunteers and partners, conduct fall waterfowl migration surveys, and mid-winter waterfowl surveys to the extent access is possible, of black ducks and other waterfowl to assess the importance of the refuge to regional migrating populations.

- Assess the effects of the OMWM treatments to determine if they were successful in meeting objectives.

Monitoring Components

- Annually monitor the salt marsh habitat for presence of invasive plant species.

- Establish and implement monitoring protocol to track changes in salt marsh biological integrity against its baseline index.

- Work with GBRPP, GBNERR and other partners to use SLAMM or other modeling results to develop a monitoring program that will evaluate conditions in the region's salt marshes over the next 15 years with respect to climate change and sea level rise.

- Establish and implement monitoring protocol with partners to evaluate breeding success of salt marsh sparrows.
- Work with NHFG to monitor migrating and wintering waterfowl.
- Establish and implement monitoring program to assess health and distribution of rare plant populations.

Objective 1.2 (Intertidal and Shallow Estuarine Waters)

Work with partners to protect and restore the health and function of the intertidal habitats in Great Bay Estuary, including enhancing water quality to benefit fish, shellfish, breeding and wintering bald eagles and waterfowl, and other estuarine life, such as oysters, softshell clams, and horseshoe crabs. Emphasize the restoration and maintenance of 2 acres of oyster beds around Nannie Island and Woodman Point, and the eelgrass beds.

Refuge-specific support of regional objectives would include:

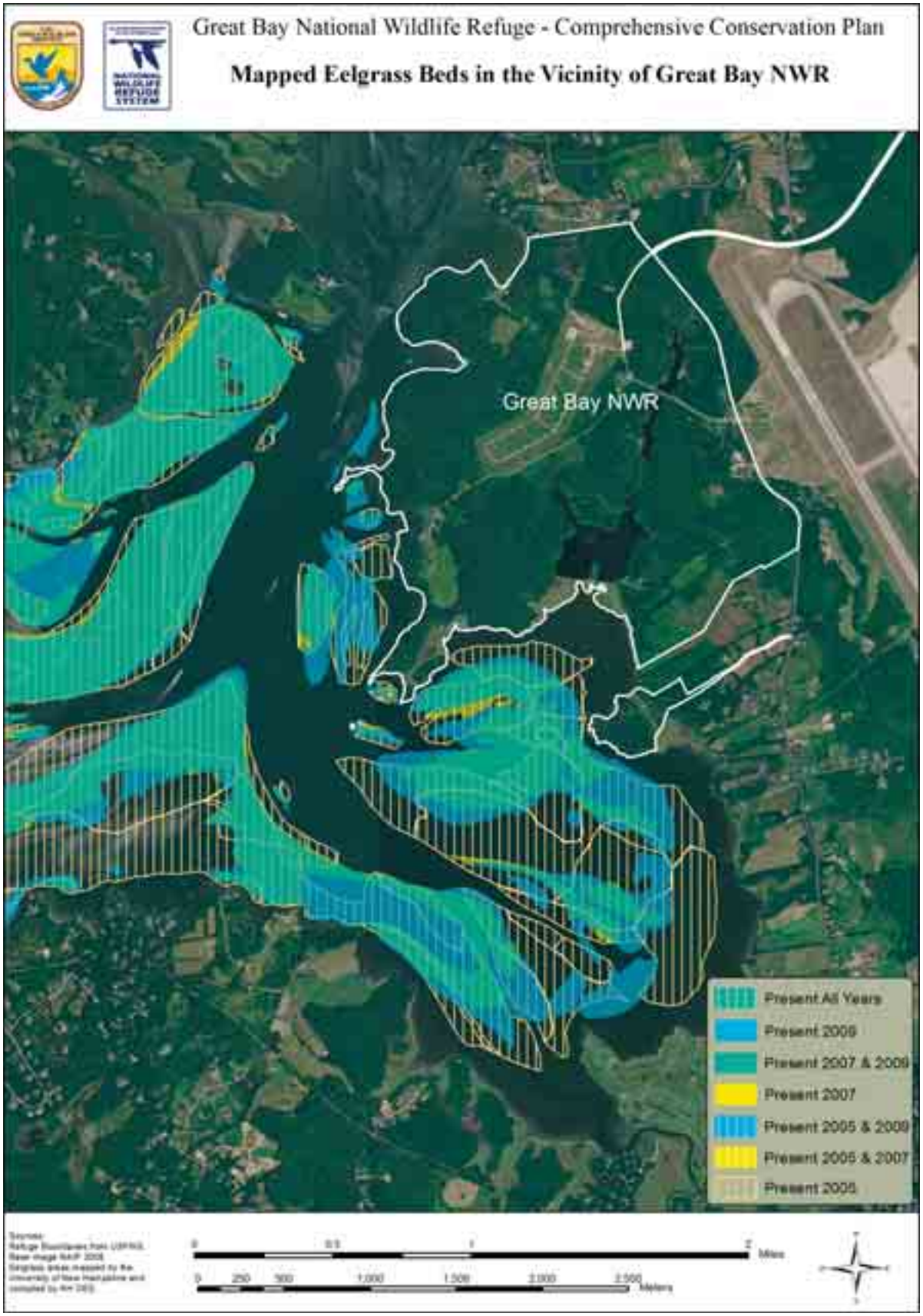
- Contribute to the PREP CCMP's goal of 50,000 bushel of adult oysters (greater than 3.2 inches) by 2020 by supporting 25,000 bushels of adult oysters in the Nannie Island area in the same time period.
- Contribute to the PREP CCMP's goal of restoring eelgrass cover to 2,900 acres and restoring connectivity of eelgrass beds throughout the Great Bay Estuary by 2020, by restoring the extent of eelgrass bed in Herod Cove and western shoreline of the refuge and increase eelgrass percent cover to a minimum of 60 percent for both beds.
- Contribute to protecting the water quality of the bay to provide migrating and watering habitat for waterfowl and breeding and wintering habitat for bald eagles. Support partner efforts to provide areas for waterfowl and bald eagles where they can nest, forage, and roost without human disturbance.

Rationale

Both eelgrass beds (map 3.11) and oyster beds (map 3.12) are regarded as keystone and indicator species for Great Bay Estuary. A keystone species is a species that plays a critical role in maintaining the structure and diversity of an ecological community and whose impact on the community is greater than would be expected based on its relative abundance or total biomass. Indicator species are plants and animals that, by their presence, abundance, lack of abundance, or chemical composition, demonstrate the quality of the environment.

Oysters, as long-lived filter feeders, are able to filter nutrients and pollutants to help maintain water quality and clarity in estuaries. Oysters accumulate in dense groups called beds or "reefs." These reef habitats provide homes or cover for other fish and crustaceans. Close to shore, oyster reefs serve as natural breakwaters, easing the impact of waves and boat wakes on shorelines.

Historical records document extensive oyster beds in most of Great Bay's tributaries and many channels within the bay. Hundreds of years of pollution, siltation, and harvest led to sharp declines in oysters throughout the bay (Mills 2009). More recent threats include two parasitic protozoans, *Haplosporidium nelson* (MSX) and *Perkinsus marinus* (Dermo). A major decline of oysters in Great Bay beginning in the early 1990s is thought to be caused by these protozoans. The population fell from 125,000 bushels in 1993 to 6,174 bushels in 2000; the population has since recovered to 10,044 bushels (PREP 2009).


Great Bay National Wildlife Refuge - Comprehensive Conservation Plan
Mapped Eelgrass Beds in the Vicinity of Great Bay NWR
Great Bay NWR
Present All Years
Present 2009
Present 2007 & 2009
Present 2007
Present 2005 & 2009
Present 2005 & 2007
Present 2005
Miles
Meters

Great Bay National Wildlife Refuge - Comprehensive Conservation Plan
Current Shellfish Beds in the Vicinity of Great Bay NWR
Great Bay NWR
Oyster beds - 2011
Softshell Clam beds - 2011
Miles
Meters

PREP established a management goal of 50,000 bushels of adult oysters or 10 million adult oysters by 2020 (PREP 2010). The largest oyster bed in Great Bay is located near Nannie Island, supporting almost 100,000 bushels of adult oysters in 1993 (map 3.12) (PREP 2009). This reef declined in area by 33 percent between 1997 and 2000, while a much smaller bed at Adams Point expanded by over 200 percent during the same period. In 2007, UNH constructed 12 mini-reefs (from recycled oyster shells), seeded with 1.2 million oyster spats, in a 1.75 acre area just north of Nannie Island. The Nannie Island restoration area experienced increased oyster densities from 2007 to 2009 due in large part to the exceptional 2006 natural recruitment observed throughout Great Bay (PREP 2009). Oysters filter about 20 gallons of water per day, which has major implications for the health of the Great Bay Estuary. In 1970, the oyster population could filter the estuary's water in 4 days. Today, with the reduced population, it takes 100 days or more (Mills 2009).

Eelgrass is an essential habitat in Great Bay Estuary and the basis of an estuarine food chain, providing food for migrating and wintering waterfowl and habitat for juvenile fish and invertebrates (map 3.11). In winter, eelgrass is dormant with much of its energy reserves tied up in the underground root or rhizome. This carbohydrate-rich food source is relished by wintering geese and ducks (Smith 2004). Eelgrass beds are particularly important to juvenile rainbow smelt, Atlantic silversides, nine-spined sticklebacks, alewife, and blueback herring. Larger fish and wading birds are attracted to the smaller fish that hide within the eelgrass beds. The long narrow leaves of eelgrass slow water flow and filtering suspended sediments from the water column (Short et al. 1992a).

A dramatic decline in eelgrass beds in 1989 to only 300 acres was linked to an outbreak of a slime mold (*Labryrinthula zosterae*), commonly called "wasting disease." Although the eelgrass beds recovered from the outbreak on up to 2,000 acres in 1996, the eelgrass beds are again in a slow and steady decline. Between 1990 and 2008, the eelgrass cover in Great Bay declined by 37 percent and eelgrass biomass by 64 percent. By 2008, eelgrass was gone from Little Bay, the Winnicut River, and almost entirely from the Piscataqua River (PREP 2010). Eelgrass beds remain offshore from the refuge, although greatly diminished from 1996. The loss of eelgrass beds has major implications for the health of the Great Bay Estuary, affecting water quality and habitat suitability for eelgrass-dependent species. Nutrient loading and increased turbidity from suspended sediments are considered two of the limiting factors to restoring eelgrass to the bay (PREP 2009).

Softshell clams are another important food source for wintering waterfowl, particularly diving ducks (map 3.12). A large clam flat is located in Herods Cove. Clam populations in Great Bay have fluctuated due to harvest pressures, invasive predators (such as the nonnative green crab) and diseases (such as "neoplasia"). Another interesting invertebrate found in Great Bay is the horseshoe crab, which is not a true crab. Horseshoe crabs spawn in late spring and early summer on the shores of Great Bay. In some places along the East Coast, horseshoe crab eggs are a valuable food source for nesting terns and wading birds and migrating shorebirds. Their distribution and ecological role in the Great Bay Estuary is unclear.

The bay is one of the primary bald eagle wintering areas in New Hampshire, contributing roughly 20 percent of the total eagles counted in the State during the mid-winter bald eagle survey (Martin 2011, personal comm). Eagles use large trees on the refuge, particularly dead or alive white and red pine as daytime perches, roost sites, and for nesting. As of 2010, there were 14 total nesting pairs of bald eagles in the State (NH Audubon 2010). In 2011, a pair of bald eagles nested on the refuge adjacent to the bay, and successfully fledged one chick. This

is the first time in decades that bald eagles have nested on the refuge. The bay also supports the largest concentration of wintering waterfowl in the State, with thousands of waterfowl using the bay at any one time. To provide undisturbed habitat for waterfowl and eagles, the refuge restricts public access to the shoreline.

Strategies

Continue to:

- Organize annual shoreline cleanup on the refuge with the help of volunteers.
- Restrict public access to the shoreline to provide buffer and undisturbed roosting, foraging, and breeding habitat for waterfowl and bald eagles.

Within 3 years of CCP approval:

- Begin working with NHFG and other Great Bay partners to restore oyster beds near Nannie Island and Woodman Point. This includes assessing the current status of the oyster reef and restoring the reef through existing or experimental methods such as augmenting the reef with spent clam shells or other material and seeding with oyster "spat" (young oysters).
- Begin working with NHFG, UNH, and other Great Bay partners to restore eelgrass bed west of Woodman Point and at Herods Cove. This includes assessing the current extent and percent cover of eelgrass beds and restoring beds by transplanting eelgrass.
- Begin working with NHFG, NHDEs, and Great Bay partners to reduce nutrient and sediment loading into Great Bay, which affects water quality and in turn affects oysters, eelgrass, and other aquatic life, with particular emphasis on oyster and eelgrass beds in Herods Cove.
- Work with NHFG to protect the clam flats in Herods Cove from overharvest through cooperative enforcement of State regulations on shellfish harvesting.
- Study the importance of the refuge shoreline as spawning and nursery habitat for horseshoe crabs; partner on assessing the health of horseshoe crab population in the estuary.
- Assess the need for additional protection for nesting bald eagles from human disturbance. If necessary, work with NHFG and other partners to provide additional buffer from recreational bay user.

Monitoring Components

- Work with partners to monitor the health and distribution of the oyster beds near Nannie Island and Woodman Point.
- Assess the Herod Cove clam flat to determine area of clam bed, density, and populations.
- Work with partners to monitor the health and distribution of eelgrass beds near the refuge.
- Work with partners to monitor the presence of nonnative invasive aquatic organisms, such as the green crab, to minimize impacts on native shellfish.
- Conduct annual horseshoe crab surveys at spawning sites on Great Bay, consistent with approved State or regional protocols. Shoreline protocols are currently being developed by the University of Rhode Island and the State of New Hampshire.

- Work with and GBNERR and PREP to monitor water quality within the Great Bay Estuary as indicator of ecological health.

Objective 1.3 (Freshwater Impoundments and Peverly Brook System)

Manage the 62-acre Peverly Brook system on the refuge to improve water quality, establish a more natural flow regime, improve migratory and resident fish habitat, and maintain habitat for waterfowl, marshbirds, and other aquatic life.

Objective 1.3a (Stubbs Pond)

Annually manage the existing 44-acre Stubbs Pond to maintain a diversity of native emergent marsh vegetation (e.g., cattails, arrowhead, wild rice, and softstem bulrush) with 30 to 50 percent open water and less than 5 percent invasive plant species (e.g., purple loosestrife and *Phragmites*) to benefit migrating waterfowl such as black duck, nesting marsh birds such as marsh wren and Virginia rail, raptors such as bald eagles and osprey, and migratory fish, including American eel, alewife, and blueback herring. Specific habitat targets include:

- Annually support migratory waterfowl through a mix of water depths, flooded vegetation (cattail, wild rice, and softstem bulrush) at peak fall migration (late October).

- Annually maintain a high water level in Stubbs Pond during the summer months to maintain 50 to 70 percent native emergent vegetation (cattail, wild rice, and softstem bulrush), and to provide breeding habitat for marsh and wading birds.

- Annually provide migratory fish (alewife and blueback herring) access to spawning habitat in Stubbs Pond by maintaining a minimum of 1.0 feet of running water through the fish ladder structure from late April to mid-July, or until water level is insufficient for fish passage.

Objective 1.3b (Upper Peverly Pond)

Annually maintain the existing 11-acre Upper Peverly Pond to provide wildlife observation opportunities, and to benefit migrating waterfowl, including wood duck, ring-necked duck, and green-winged teal, and to provide nursery habitat for American eel. Establish evaluation criteria, and regularly evaluate the environmental conditions of this pond to determine the desirability and feasibility of its future removal.

Objective 1.3c (Lower Peverly Pond)

Within 5 years of CCP approval, remove the failing dam and other associated infrastructure at Lower Peverly Pond, and restore the existing 7-acre pond to 1,100 feet of native riparian habitat, reconnecting a portion of a fragmented river system, reestablishing natural streamflow, and enhancing habitat for migratory native fish.

Rationale

The 1.52-mile Peverly Brook begins a few thousand feet north of the refuge boundary. The 907-acre watershed is the largest watershed in the town of Newington and was once a drinking water source for the city of Portsmouth. The city diked Peverly Brook around 1900 to serve as a water supply, creating Upper and Lower Peverly Ponds. The Air Force acquired the lands encompassing Peverly Brook in 1952 and managed the three freshwater impoundments for mosquito control and recreation. We describe the history of the impoundments under Air Force ownership in chapter 2 in the section on "Freshwater Impoundments."

According to the Service's New England Ecological Services Field office (NEFO), contaminants have not migrated any lower down the watershed and the contaminant levels in Lower Peverly and Stubbs Ponds meet clean-up goals (Drew Major, NEFO, personal communication). However, prior to any dam removals we would conduct additional sediment and water quality testing to ensure safe levels.

Since refuge establishment, the three impoundments in the Peverly Brook drainage have been managed primarily to benefit spring and fall migrating waterfowl and marsh nesting birds. Under alternative B, we would expand our management to include enhancing water quality, improving habitat for migratory and resident fish, and maintaining habitat for waterfowl, marsh birds, and other aquatic life. Specific strategies will be detailed in the HMP, such as water level management (e.g., timing, season, and desired water level) and invasive species treatments.

In chapter 2, in our discussion on freshwater impoundments, we provide a summary of the 2006 SEED report which identified concerns with the three impoundment infrastructures, but also included recommendations for improvement. Our summary in chapter 2 also includes what work we have been undertaking to date to address those concerns and implement recommendations.

Stubbs Pond: As part of this CCP process, we reviewed the benefits and consequences of maintaining Stubbs Pond as a freshwater impoundment versus breaching the dike and restoring it to a saltwater system. According to NHFG, Stubbs Pond is unique within the Great Bay Estuary system, given its large size (44 acres of freshwater wetland) and established population of wild rice. There are no other places in coastal New Hampshire that draw in the amount and diversity of waterfowl documented at Stubbs Pond, especially mallards and black ducks during spring and fall migration (Ed Robinson, Waterfowl Biologist, NHFG, personal communication). A recent study commissioned by the Service reported that Stubbs Pond is unlikely to be affected by sea level rise as a result of climate change (Clough and Larson 2009), although more detailed analysis is needed.

Water level manipulation is used in Stubbs Pond to manage the ratio of vegetation to open water and to control undesirable vegetation including invasive plants. The objective is to control the monoculture of cattail vegetation and increase vegetation diversity, opening up areas to increase the ratio of open water to emergent vegetation while controlling invasive purple loosestrife and common reed. Water level management has fluctuated from year to year, in part because of the difficulties in managing Stubbs Pond. A new water control structure was installed in 1996. Since then, refuge staff have used various techniques to control excessive cattail growth and to strive for a 50:50 balance of aquatic vegetation and open water. Techniques included mowing, manipulating water levels (drawdowns and flooding), use of herbicides on cattails, and release of *Galerucella* beetles to control purple loosestrife. The State-listed plant large bur-reed, is found in Stubbs Pond.

After several years of implementing these techniques, refuge staff concluded that spring drawdown of Stubbs Pond allows cattail and purple loosestrife to increase, while inhibiting other more desirable species, such as large bur-reed, soft stem bulrush, wild rice, wild celery, and arrowhead. Our experience indicates that Stubbs Pond should be kept relatively high during the spring and summer to discourage cattail growth. A drawdown in early fall benefits migratory birds. If weather permits, it may be possible to mow, spray, or burn cattail stands in the fall before refilling the pond in the winter to early spring.

A fish passage structure was installed in 1995 in Stubbs Pond but was not operated until the spring of 2003. The fish passage is now opened in late April to allow alewife and blueback herring migration into Stubbs Pond during May. Five years (1999 to 2003) of marsh bird surveys were conducted on the refuge. Virginia rail, least bittern, sora, common gallinule, pied-billed grebe, king rail, and marsh wren were recorded in Stubbs Pond. The amount of emergent wetland habitat has declined significantly throughout North America along with apparent declines of marsh-dependent birds. Changes in water levels, ratios of mud flats to open water areas, invertebrate communities, and amount of emergent plant cover in marsh habitats could affect habitat quality for marsh birds. Given the variability of rainfall, annual vegetation changes, and the varying needs of priority species, we would continue to use adaptive management and annually modify water levels as needed to create appropriate seasonal habitat conditions for the full suite of species, including waterfowl, marsh birds, and migratory fish.

In order to establish a baseline and improve our water level management in Stubbs Pond, we propose to map the bathymetry (the underwater elevations) of Stubbs Pond, relative to the dike, spillway, fish ladder, water control structure, brook, and salt marsh. This information would help us determine how to manipulate the pond's water levels to meet our objectives for migratory birds, fish passage, and other resource values. It would also help us establish a baseline from which to measure changes that might occur due to climate change, such as sea level rise or other processes that might result in subsidence or deposition in areas.

We also propose to work with partners to evaluate the effectiveness of the fish ladder and determine if there are practicable opportunities to enhance the movement of fish migrating through. Examples of improvements that have been recommended, but need further analysis, include the following:

- Creating an attraction jet to guide fish to the ladder.
- Installing a nature-like bypass to provide additional passage for American eel, alewife, and blueback herring.
- Install additional sections of the "steeppass" ladder.
- Determine if a new design or retrofit could allow fish to pass at a greater range of tides.

Great blue heron

USFWS

The existing fish ladder was designed to only pass fish at high tide because at lower tides fish cannot cross the tidal mudflats to reach the ladder. It would be very difficult and costly to provide fish passage at a wider range of tide levels (Brownell, personal communication, 2011).

Upper Peverly Pond: Upper Peverly Pond is used as a foraging and resting site during migration by a small number of waterfowl and marsh and wading birds (great blue heron, wood duck, bufflehead, ring-necked duck, and green-winged teal). It provides nursery habitat for American eel during its elver stage. American eel is a declining species that spends most of its life in fresh or brackish water, then travels downstream and far offshore to the Sargasso Sea where it spawns.

A new water control structure was installed on Upper Peverly Pond in 1999 to control water levels to benefit waterfowl. The pond was drawn down several times during spring for moist soil management with positive vegetative and waterfowl population response to this management. The vegetation in and around Upper Peverly Pond seems to be more stable than in Stubbs Pond. In 2004, the

invasive brittle water nymph was discovered in Upper Peverly Pond. Brittle water nymph is an annual invasive plant with no easy control methods. Upper Peverly Pond is a maintained primarily as open water habitat, with minimal water level management.

We propose to maintain the dam on Upper Peverly Pond for several reasons. There are still contaminated sediments remain in Upper Peverly Pond pond and trapped behind the dike. We are concerned that removal of the dam in the near future would release these sediments downstream with unknown environmental impacts and would likely diminish habitat for American eel as well as waterfowl. However, we propose to establish evaluation criteria, and regularly evaluate the environmental conditions of this pond to determine the feasibility of its future removal.

Lower Peverly Pond: The 7-acre Lower Peverly Pond has an antiquated spillway that is deteriorating and has no water control capabilities. Also, beaver activity in the area is significantly affecting the integrity of the dam and accelerating the likelihood of total failure. The current risk that the dam might fail is high. Under alternative B, we propose removing the dam at Lower Peverly Pond because of the expense to upgrade it to current safety standards, compared to the minimal value to Federal trust resources. The use of this pond by waterfowl, wading birds, and other species of concern is low. A limited number of waterfowl, including a few wood, black, and ring-necked ducks, and bufflehead, are seen during the spring and fall migration. We predict that we could recover and restore to near natural conditions approximately 1,100 feet of stream if the dam were removed.

Although removal of the Lower Peverly Dam might diminish some habitat for American eel, the presence of active beaver in the system will likely function similar to the existing dam, and might allow for improved eel passage (Douglas Smithwood, Fishery Biologist, USFWS, personal communication with Graham Taylor October 20, 2009). Furthermore, removal of the failing Lower Peverly Pond Dam is consistent with a proposal presented in a letter to the Service from the NHDES in 2007. That letter clearly stated that reconstruction of the dam would not be beneficial to aquatic life in Peverly Brook or Stubbs Pond. Rather, breaching the dam would remove the threat of dam failure and eliminate continued downstream erosion from the Lower Peverly spillway. The letter further noted that dam removal would improve the water quality in Peverly Brook and provide additional stream habitat for spawning blueback herring and other fish species. In addition, dam removal would be consistent with the Coastal Zone Management Act (Christian Williams, NH Coastal Program, personal communication, November 21, 2007).

Contaminant levels associated with the former Air Force Base have decreased enough that they are close to or meet clean-up targets. The Upper Pevely Pond Dam has acted as a sediment trap, preventing some contaminants from moving downstream. The removal of the Lower Peverly Pond Dam should not exacerbate any existing contaminant issues below Lower Peverly (Drew Major, Contaminants Specialist, NEFO, personal communication with Graham Taylor, Dec 12, 2009; see appendix I). We propose pre- and post-dam removal sampling to establish a baseline and measure any impacts to water and contaminants resulting from dam removal. Brittle waternymph was found in Lower Peverly Pond in 2004. We also propose to evaluate control methods prior to removal of the Lower Peverly Pond Dam.

We do not have a detailed plan for the dam removal at present. We would work with NHFG, NEFO, NHDES, and the Service's Central New England Fisheries Resource Office to coordinate the design. We will also consult with the SHPO

to determine if Lower Peverly Dam is eligible for the National Register and to minimize any potential impacts of its removal on cultural resources. We would expect the work would occur in late summer during low flow and drier conditions. Our concept would be to remove the concrete spillway using excavators and then use some of the earthen material to reconstruct and contour the uplands to begin restoration of a forested riparian area. Some recontouring of the stream channel would also likely be necessary to recreate the original stream channel and bed, or to approximate it the best we can. In our estimation, approximately 150 feet of stream reach would be included in the project area. We would hope to coordinate with the Coastal America program to implement the project.

Strategies

Continue to:

- Work with partners at the headwaters of the Peverly Brook system to improve water quality and ensure water quantity.

- Prioritize and control invasive plants (e.g., *Phragmites*, loosestrife, brittle waternymph) within the Peverly Brook system using mechanical (e.g., mowing), biological, chemical, prescribed fire, and ecological methods. Chemical controls are used as a last option if the other techniques are not effective.

- Use adaptive management in Stubbs Pond and Upper Peverly Pond to maintain an optimal mix of open water and aquatic vegetation (approximately 50 percent of each) to benefit breeding and staging waterfowl, marsh and wading birds, fish, and rare plants. Specific water level manipulations will be prescribed in the AHWP, based on existing conditions at the time.

- Annually maintain dikes, dams, spillways to ensure integrity of structure and address any items identified in the periodic SEED assessments (last done in 2006). Annually maintain and inspect water control structures and emergency valves (See "Freshwater Impoundments" section in chapter 2 for details on current and proposed maintenance of the dams).

- In partnership with NHFG, control mute swans, a nonnative species that negatively impacts local plants and waterfowl.

Within 3 years of CCP approval:

- Work with NHFG and the Service's Central New England Fisheries Program to evaluate effectiveness of the ladder and determine if there are practicable opportunities to enhance the movement of fish migrating through the ladder from late April to mid-July given the constraints of tidal flow and with consideration for maintaining quality, open water habitat for migratory birds.

- Work with Service's NEFO to monitor contamination and identify remediation options for Upper Peverly Pond. Develop evaluation criteria and regularly evaluate the environmental conditions of this pond to determine the feasibility of its future removal.

- Seek technical and financial assistance from partners with project design and implementation to remove the Lower Peverly dike and restore that section of the Peverly drainage. Consult with the SHPO to determine if Lower Peverly Dam is eligible for the National Register and to minimize any potential impacts of its removal on cultural resources. Work with NHFG, NHDES, NEFO, and the Service's Central New England Fisheries Program to plan/design removal of impoundment structure and restoration of brook, including stream channel and adjacent riparian area. Begin all requirements to obtain permits for the work.

- Prevent infestation of invasive species during and after the dam removal at Lower Peverly. Use early detection rapid response techniques.

- Complete bathymetry study of Stubbs and Upper Peverly Ponds to help refine impoundment management on those ponds.

- Re-locate, or construct an additional, osprey platform at Stubbs Pond in order to encourage nesting away from the dike and to minimize the disturbance to nesting birds caused by management activities.

Within 5 years of CCP approval:

- Assuming funding is secured, remove Lower Peverly Pond Dam and restore the existing 7-acre pond to stream and adjacent riparian habitat. Prior to dam removal:

  - Evaluate the extent of brittle waternymph in the impoundments and determine control methods.

  - Assess Lower Peverly Pond for water and sediment contamination. If levels do not pose a concern for refuge resources, begin required permitting process for dam removal.

  - Arrange assistance with Coastal America program to help during construction and restoration phase.

Monitoring Components

- Monitor water levels in Stubbs Pond and Upper Peverly Pond, 1 to 2 times per week, year-round as feasible (i.e., if open water).

- Check fish ladder several times a week from late April to mid-July and weekly from September to November for structural condition and fish use.

- Conduct a Water Resource Inventory and Assessment following the National Service standards to determine current water conditions (quality and quantity) and needed future monitoring.

- Weekly monitor osprey and bald eagle nest during nesting season.

- Conduct sediment and water quality monitoring in the Peverly Brook system from Lower Peverly to Stubbs Ponds to establish pre-dam removal baseline. One year after the removal of the Lower Peverly Dam, conduct post-dam removal monitoring impacts in Stubbs Pond.

- Annually monitor the migratory fish populations and movement in the Peverly Brook system.

- Monitor sediments and water quality in the Peverly Brook system for contaminants every 3 to 5 years.

- Develop a monitoring protocol to assess current habitat condition of Lower Peverly Pond and adjacent habitats, and monitor vegetation community change after dam removal.

- Develop a protocol for ongoing evaluation of Upper Peverly Brook to determine if pond should be dredged, maintained as is, or breached. Establish thresholds or triggers that would lead to a shift in management based on regional landscape context, contribution to Federal trust resource conservation, potential management implications and commitments, changes in visitor services, long-term solutions to contaminant issues.

- Map and monitor invasive plants in the Peverly Brook system, and update every 5 years.
- Work with the New England Wildflower Society and other partners to establish and implement a protocol for routine monitoring of rare plant populations documented by NHB in Stubbs Pond including large bur-reed and stout bulrush.
- Work with the Pease Airport Authority to establish regular monitoring of potential runoff from the airport into the Peverly Brook watershed, particularly potential runoff from the new de-icing pads.
- Collect baseline information on freshwater mussels in the impoundments and potential impacts from water level drawdowns and restoration.

GOAL 2.

Perpetuate the biological integrity, diversity, and environmental health of upland and forested wetland habitats on Great Bay Refuge to sustain native plant communities and wildlife, including species of conservation concern.

Objective 2.1 (Appalachian Oak-Hickory Forests)

Maintain the biological integrity, diversity, and environmental health of the refuge's 700 acres of mature Appalachian oak-hickory forests to provide habitat for breeding and migrating birds of conservation concern including scarlet tanager, Baltimore oriole, wood thrush, and breeding and migrating forest bats. Ensure less than 10 percent of total vegetation cover is invasive plant species (e.g., common buckthorn, common barberry, glossy buckthorn, and winged euoynomous).

Rationale

In appendix B (part 1.3), we detail the process we used to determine what elements comprise the biological integrity, diversity, and environmental health for each of the refuge's plant communities. We reviewed historical conditions, site capability, the current regional landscape conditions, and the biological diversity on the refuge. We also considered natural processes and limiting factors which could potentially affect each plant community.

Many of the forests on Great Bay Refuge have a recent agricultural history and are dominated by successional white pine or hardwoods. Although pine, hardwoods, and mixed stands are clearly evident, the current overstory dominant tree species are not necessarily the best indicator of what natural community types occurred on the refuge. White pine stands are common and are generally a stronger indication of past land use history than they are of the long-term potential of a site. The NHB used the total composition of plant species, in combination with soil attributes, to indicate community type (Sperduto 2000).

Dry Appalachian oak forests are characterized by southern (or "Appalachian") species that reach the northern extent of their ranges in southeastern New Hampshire and southern Maine. The typical dominant trees in this forest type include a mix of oaks, such as red, black, and white oaks, and the somewhat less abundant shagbark hickory. The shrub layer is dominated by flowering dogwood, mountain laurel, and American hazelnut. Pennsylvania sedge may form extensive "lawns," contributing to a park-like setting. This community supports a high diversity of herbaceous plants, including numerous State rare species, such as sweet goldenrod, birdfoot violet, hairy bedstraw, reflexed sedge, slender knotweed, fern-leaved false-foxglove, Maryland tick-trefoil, and prostrate tick-trefoil.

The mesic Appalachian oak-hickory forest on the refuge is documented as an exemplary natural community, according to NHB. This community type includes a mix of Appalachian hardwoods, as described above, and "transitional" hardwoods, such as beech, birches, and maples. Hemlock and white pine occur in variable amounts in both forest types. The mesic oak-hickory forests tend to have a more diverse forest canopy compared to the dry oak forest. The mesic forest occurs in two variants, both of which occur on the refuge. The dry-mesic variant occurs on well-drained find sandy loam soils where beech, paper birch, and some dry-site herbs are more frequent. The mesic variant is more common on silt loam soils with more moisture, where white ash and black cherry might be more prevalent (Sperduto and Nichols 2004).

Oak forests were not dominant in the Northeast pre-human settlement. Burning by Native Americans may have increased oak dominance in certain forests. European settlement further increased oak dominance through logging, land clearing and the introduction of chestnut blight (Abrams 1992). Oak and hickory are early to mid-successional species that depend on fire or disturbance for regeneration. Abrams (1992) suggested a fire frequency of 50 to 100 years in pre-settlement oak forests to sustain oak species. Some of these forests may succeed to other overstory species in time due to lack of adequate red oak regeneration, and from increases in beech on drier sites and sugar maple and beech on more mesic sites. Repeated fire would tend to knock back fire-sensitive species like beech and sugar maple. As such, any natural, semi-natural, and/or controlled fire regimes may be necessary for the long-term maintenance of oak and hickory on some sites (Sperduto and Nichols 2004). However, projected changes to natural processes under climate change predictions (northward shift of ecosystems and increased likelihood of natural fires) may maintain this habitat.

Appalachian oak forests are important to many wildlife species given the abundance of nut-bearing oaks and hickories. These rich foods are eaten by wild turkey, white-tailed deer, ruffed grouse, squirrels and other small mammals, blue jays, rose-breasted grosbeak, and wood duck among other birds. The mature deciduous trees in these forests offer nesting sites for scarlet tanager, Baltimore oriole, and wood thrush, which are three species of conservation concern in this region. All three prefer deciduous or mixed mature forests. The oriole occurs in more open or semi-open wooded areas, while the wood thrush is found more commonly in mature forests with a denser understory of shrubs and sub-canopy trees. The scarlet tanager occurs across a broader range of mature forest understory conditions.

Bat surveys on the refuge from 2009 to 2011 detected several species of bats using the refuge both during migration and breeding period. Migrating species including northern myotis, eastern small-footed bat, little brown bat, big brown bat, and eastern red bat. Confirmed breeding species include northern myotis (most abundant), red bat, eastern small-footed bat, and big brown bat. Bats use forested areas for roosting and wetland areas for feeding. The loose bark of hickory species and other tree species in stages of decay provide breeding and migratory habitat for bats. The northern myotis and the big brown bat roost under tree bark and the red bat roosts in dead leaves in trees. Small-footed bats are found in rocky outcrops. Very little is known about the range, habitat, reproduction, and population size of bats in New England. In addition, recent dramatic declines in bats due to the white-nose syndrome raise the importance of Great Bay Refuge as potential habitat for breeding and migrating bats (see Shrub section for bat hibernacula and refugia at Great Bay). The Service is currently conducting a 90-day review for the listing of the northern myotis and eastern small-footed bat. To date, none of the bats caught at Great Bay has shown any signs of white-nose syndrome or wing damage. Much of New Hampshire's

Appalachian oak forest is lost to development and large intact stands are rare. The remaining oak-hickory forests have fewer large trees, less diverse understory vegetation, and little coarse woody material on the forest floor.

In the summer and fall of 2006, the Forest Service, Forest Health Protection Group, Durham Office, conducted a forest health assessment on the refuge. Their full report is included as appendix H. In general, the forest stands on the refuge are healthy. However, many stands inventoried were overstocked, large diameter stands. This forest condition is common in stands that have had no active management. In their assessment, the distribution of size classes is not balanced on the refuge and mature size classes are overrepresented. They report that there is a potential for overstocked stands to be less vigorous, more susceptible to pests, lacking adequate regeneration in the understory, and which may lead to the loss of moderate to intolerant shade species in future stands. Their report includes management recommendations. As indicated below under our strategies, we would continue to work with the Forest Service and other forest ecologists to develop specific treatments for managing the refuge's forests.

The 41-acre increase in the Appalachian oak-hickory forest habitat (as compared to alternative A) is based on our proposal to allow small (less than 3 acres) isolated patches of grassland and shrubland habitat, that are otherwise surrounded by trees and not providing quality grassland or shrubland habitat, to naturally revert to mature forest. This is expected to take at least 50 years. Over the next 15 years, however, we anticipate that those grassland patches would only succeed to a shrubland-type and existing shrubland would only succeed to a sapling-pole stand. Allowing these isolated patches to revert to forest over the long term would reduce edge effect from forest fragmentation, increase habitat for forest interior dwelling species of conservation concern, and reduce the amount of management-intensive habitat on the refuge.

Strategies

Continue to:

- Assess use of refuge's habitats by Indiana bats, eastern small-footed bats, northern myotis, red bats, and other tree bat species using acoustic monitoring and mist nets, and monitor refuge's population for white-nosed syndrome; focus assessment on large diameter trees which may be important summer roosting habitat.

- Complete a vegetation map for Fabyan Point and Thomas property and update the natural community map for the rest of the refuge.

Within 5 years of CCP approval:

- Allow an additional 41 acres of grassland and shrubland habitat to naturally succeed to forest (705 total acres) by discontinuing mowing for woodcock singing grounds.

- Work with forest ecologists to determine appropriate management techniques to sustain species diversity, forest structure, and ecological integrity of the oak-hickory forest community, and develop best management practices (e.g., prescribed fire, silvicultural practices, or passive management) to sustain a healthy oak-pine forest.

- Evaluate and develop management strategies for red pine, which occurs in 44 patches on 25 acres on the refuge. These pines are approximately 170 years old. According to Sperduto (personal communication, 2010) red pine start to die out between 170 to 200 years old and may need fire to regenerate, although no evidence of fire is apparent on these sites and they appear to be regenerating naturally.

- Survey for and locate potential roosting sites for bats species known to breed on the refuge (northern myotis, red bat, big brown bat, and eastern small-footed bat) using acoustic monitoring and radio tracking.

- Manage 25 acres of plantations (white pine, red pine, white fir, and white spruce) to ensure succession to oak-hickory forests and control any disease outbreaks.

- Complete inventory and mapping of invasive plants for the refuge.

Monitoring Components

- Re-visit the exemplary Appalachian oak-hickory forests identified by NHB in 1990 to assess their condition. Consult with NHB on this reevaluation. Evaluate the rest of the oak-hickory forest with these sites as reference.

- Monitor the red pine plantation by Woodman Point for successful regeneration, and manage (using prescribed fire) if necessary.

- Develop a long-term monitoring program to track the vegetative and wildlife response to climate change. Project topics may include phenology of plants and birds, species composition, hydroperiods of forested wetlands, and fire regimes.

- Survey forests and adjacent habitats for Indiana bats and other bats species. Use mist-netting and acoustic surveys during breeding, roosting, and migration periods to determine the presence and abundance of bat species. Also, search large diameter trees for bat activity, particularly in summer.

- Continue to partner with the Forest Service Research Station in Durham, New Hampshire to conduct forest health surveys annually.

- Annually, monitor the long-term effectiveness of invasive plant treatments.

Objective 2.2 (Forested and Scrub-Shrub Wetlands)

Maintain the biological integrity, diversity, and environmental health of 158 acres of forested and scrub-shrub wetlands within the larger matrix of oak-hickory forests and Peverly Brook drainage, to sustain high water quality and native vegetation such as speckled alder, spicebush, silky dogwood, and winterberry, to benefit foraging woodcock, breeding willow flycatcher, other birds of conservation concern, and native plant communities. Ensure less than 10 percent of total vegetative cover of invasive plant species. Wet forests and shrublands that contain functioning vernal pools will also be managed to benefit vernal pool obligate species of conservation concern, such as wood frog.

Rationale

We detail how we determined what elements comprise the biological integrity, diversity, and environmental health for each of the refuge's plant communities in appendix B (part 1.3). In summary, we reviewed historical conditions, site capability, the current regional landscape conditions, and the biological diversity on the refuge. We also considered natural processes and limiting factors which could potentially affect each plant community.

Approximately 13.5 percent of the Great Bay Refuge is forested or scrub-shrub wetland. As noted in chapter 2, approximately 81 percent of those wetlands are forested and 19 percent is scrub-shrublands. Vernal pools are an important habitat feature that is imbedded in these wetlands types.

In 2000, the NHB mapped the natural plant communities on the refuge. They identified four forested wetland community types:

(1) Black gum–red maple–basin swamp
(2) Seasonally saturated red maple swamp
(3) Red maple–elm–ladyfern silt forest
(4) Red maple–sensitive fern–tussock sedge basin/seepage

These forested wetlands are imbedded within the forest matrix and occur in a range of sizes from 0.27 acres to a 65-acre red maple swamp that is hydrologically connected to Stubbs Pond.

NHB mapped a mosaic of scrub-shrub habitats, including approximately 12 acres of "speckled alder basin/seepage shrub thicket." The moist, silty soils associated with this wet shrub community are particularly suited to alder thickets and hence potential foraging habitat for American woodcock. Moist shrublands are also habitat for several species of concern including willow flycatcher and blue-winged warbler, as well as many other migrating songbirds. Maintaining shrubland habitats in native shrub condition and controlling invasive shrubs requires active management.

Vernal pools are a critical component of these wetlands habitats as they support a wide diversity of species. Wood frogs, both spotted and blue-spotted salamanders, and fairy shrimp all depend on vernal pools. Several rare species including Blanding's and spotted turtles also use vernal pools as "stepping stones" as they move from one wetland to another. Black gum basin swamps and other seepages often function as vernal pools, which are essential breeding habitats for some species of amphibians and invertebrates.

A former refuge manager created a 1-acre wetland in 1995 by installing a wooden water control structure to impound several drainage ditches in the former Weapons Storage Area. This wetland holds water during the spring and early summer and goes dry during late summer. Cattails dominate this wetland and a few marshbirds were noted here such as sora and Virginia rails, and some frogs. Under alternative B, we propose to remove the water control structure and plug the ditches to create a wet shrub-meadow to benefit New England cottontail and several bird species of concern, as mentioned above. There is another 1-acre impounded wetland east of Stubbs Pond and adjacent to the large red maple swamp complex. This open water impoundment was likely created with the collapse of a culvert under the access road to Stubbs Pond.

Under this alternative, the amount of forested and scrub-shrub wetlands would increase approximately 9 acres from current levels due to the removal of the Lower Peverly Dam and restoration of a portion of Peverly Brook.

Strategies

Continue to:

- Complete the inventory and mapping of invasive plant species. Prioritize invasive species to be controlled and implement control using biological, ecological or cultural, mechanical, prescribed fire, or chemical, as needed.

- Evaluate the existing amphibian and reptile monitoring data, including the malformed frog surveys, to determine future monitoring needs.

Within 5 years of CCP approval:

- Maintain water control structure off Ferry Way Trail to prevent flooding by beaver.

- Inventory and map and assess the quality of forested and scrub-shrub wetlands, including vernal pool habitat and rare plants.

- Remove the water control structure from the 1-acre impoundment in the former Weapons Storage Area and plug the ditches to create wet shrub meadow habitat. Maintain the water control structure on the Ferry Way Trail as it prevents the trail from flooding by beaver.

- If the access road to Stubbs Pond is rehabilitated, install a culvert where the current impoundment is to restore hydrological flow on both sides of the road.

Monitoring Components

- Initiate a cover board project to inventory and monitor use of various habitats by salamanders and snakes. This project will measure presence, abundance, and use of habitat by these species.

- Evaluate the existing amphibian and reptile monitoring data, including the deformed frog surveys, to determine other future monitoring needs.

- Continue participation in the U.S. Geological Survey's Amphibian Research and Monitoring Initiative (ARMI) to monitor long-term population trends of vernal pool associated amphibians, including monitoring for water quality.

- Establish a monitoring program to measure vegetation and hydrology before and after removal of the water control structure in former Weapons Storage Area and near Stubbs Pond.

- Complete the inventory and mapping of invasive plant species. Prioritize invasive species to be controlled and implement control using biological, ecological or cultural, mechanical, or chemical as needed. Annually, monitor the long-term effectiveness of any treatments.

Objective 2.3 (Upland Shrubland)

Annually manage at least 54 acres of upland shrub habitat in three areas (former Weapons Storage Area, along McIntyre Road, and in the old orchard) to support native shrubs and young trees (e.g., highbush blueberry, black huckleberry, dogwoods, arrowwood, bayberry, meadowsweet, raspberry, sensitive fern, sumac, elderberry) and less than 25 percent cover of invasive plants, to provide nesting and foraging habitat for migratory birds of conservation concern including prairie warbler, blue-winged warbler, eastern towhee, American woodcock, New England cottontail and other thicket-dependent species.

Within 5 years of CCP approval, evaluate the feasibility of establishing a captive breeding and/or "hardening" pre-release site for New England cottontail on at least 37 acres of shrubland in the Weapons Storage Area. If determined feasible, manage these shrublands to provide preferred cottontail habitat which consists of dense native shrubs and vine tangles with a density of 20,000 woody stems per acre that are at least 20 inches tall and less than 3 inches in diameter. Work with partners to release captively bred young to suitable sites to reestablish or augment populations.

Within 5 years of CCP approval, experiment with modifying two to four bunkers, which lie within shrubland habitat, to provide bat hibernacula and refugia. Work with the Service's New England Field Office and partners to explore those opportunities.

Rationale

The refuge currently has approximately 26 acres of early successional shrub habitat that is reverting from previous management practices. Under alternative B, we propose to manage an additional 28 acres of shrubland habitat to benefit migratory birds and other shrubland-dependent species of conservation concern. This additional acreage is primarily is a result of active shrub management that would occur in the former Weapons Storage Area, which is currently grassland. Invasive species often quickly invade areas that are disturbed on the refuge, particularly grassland and shrubland areas. Autumn olive is particularly difficult to control as it quickly invades open land habitat. The shrub habitat provides nesting and foraging habitat for birds of conservation concern including prairie warbler, blue-winged warbler, eastern towhee, and American woodcock, and habitat for other thicket-dependent species. However, invasive plants also provide dense cover from predators needed by many of these species, particularly New England cottontail. When managing shrublands for birds and New England cottontail, we will balance managing for a native composition of shrubs while providing sufficient cover and food resources. This is particularly true for New England cottontail habitat in the former Weapons Storage Area, where some areas will initially be allowed to be re-vegetated by invasives while we restore a more native, higher nutritional shrub cover in other areas.

Shrublands and brushy old fields are critical wildlife habitats that are essential for the survival of many wildlife species. Of 40 bird species associated with shrubland habitats, 22 are undergoing significant population declines in eastern North America. Forest interior birds also use shrub habitats extensively during the migratory and post breeding period (Rodewald and Brittingham 2004, Vitz and Rodewald 2006, and Chandler 2007). Important habitat characteristics for both shrub nesting birds and bird use during migration are high dense cover, which provides protection from ground and aerial predators, and native fruit-bearing plants, which provide diverse high quality prey base (Vitz and Rodewlad 2004). Additionally, 139 species of reptiles, amphibians, birds, and mammals either prefer (17 species) or use (122 species) shrub and old-field habitats. Shrubland habitats in the Northeast also contain higher proportions of State-listed butterflies and moths than other natural community types. Of 3,500 species of butterflies and moths in the Northeast, 58 are dependent upon shrublands, which provide sunny open areas in combination with desired host plants such as scrub oak and blueberry. Fifty-six of these are considered rare (Tefft 2006).

Great Bay Refuge supports breeding habitat for several species of shrubland birds, including eastern towhee, prairie warbler, blue-winged warbler, and willow flycatcher. Shrub habitats on the refuge range from alder thickets (described under objective 2.2) to dry, old field conditions. In addition to its value to breeding birds, shrubland habitat is important because many other birds rely on it at various other times of the year. Many shrub species bear fruit in the fall, which helps boost the fat reserves for migrating and overwintering birds. Chandler et al. (2007) found that forest nesting birds preferred shrub habitat during the post-fledgling period, presumably due to its higher insect and fruit abundance. The loss and degradation of naturally maintained shrublands has been extensive throughout the region (Dettmers 2003). In Eastern North America over the last 60 years, open habitats (e.g., grasslands, savannah, barrens, and shrublands) have declined by 98 percent, with shrubland communities comprising 24 percent of this decline (Tefft 2006). Residential development, conversion to other land uses, and natural succession has contributed to the decline of shrub habitats. In southeastern New Hampshire, many shrub communities are now dominated by invasive plants.

The New England cottontail is a candidate species for listing under the Federal Endangered Species Act, and has declined significantly throughout its range. Litvaitis and Tash (2006) estimated the species only occupied 14 percent of its historical range as of 2004, with the population in New Hampshire and Maine persisting in highly developed, fragmented areas. Kovach and Fenderson (2010) found four major genetically distinct sub-populations:

- Maine/New Hampshire
- Cape Cod
- Connecticut/Rhode Island
- Connecticut/New York

All sub-populations face reduced fitness due to fragmentation, with the Maine/New Hampshire and Cape Cod population at the greatest risk of extinction. A fine scale genetic study in southern Maine found a drastic reduction in patch occupancy and range contraction from 1997 to 2007, and a 50 percent reduction in effective population size of some remnant populations in the same time period (Kovach and Fenderson 2010).

Strong partnerships are developing in the cottontail rabbit's remaining ranges to manage and restore shrub habitat. However, major barriers to dispersal and rapid loss of genetic diversity and extirpation of local patches indicate that reintroduction and augmentation within each genetically distinct population is a necessary tool for the survival of this species. There is an ongoing effort at the Roger William Zoo in Rhode Island to captive breed and rear New England cottontail. To date, seven rabbits have been taken into captivity from Connecticut. Due to the necessity to maintain separation among the four distinct populations, the zoo does not have the capacity to supply rabbits throughout its range.

We have been in discussion with partners regarding the potential for managing a captive rearing facility in the bunker area of the former Weapons Storage Area. This would increase the amount of shrub habitat that currently occurs on the refuge by approximately 30 acres. The former Weapons Storage Area is currently fenced, which would facilitate cottontail management. Another benefit of shrub management is to conceal the existing bunkers. These bunkers are an eyesore in an otherwise natural landscape and cannot be reasonably removed without extensive disturbance and expense. A captive rearing program on the refuge would be similar to that implemented for the riparian brush rabbit in the San Joaquin Valley of California, where founder rabbits are rotated through the facility at 6 to 12 month intervals, and then placed in the wild. We would also consider using the area for "hardening," a process in which captively breed rabbits are slowly acclimated to natural conditions prior to being released into the wild.

The refuge does not currently have sufficient shrub habitat to support a viable population of New England cottontail, even over the short term. However, we are exploring the option of working with partners to coordinate the protection of a significant population off-refuge in the Dover, New Hampshire area.

The majority of bat species are facing unprecedented threats to their population due to white-nose syndrome. The disease was first detected in a cave in New York in 2007. Since then, it has spread to 13 U.S. states and 2 Canadian provinces, from ranging from Newfoundland, West Virginia to Indiana. In 2011, it was also detected in three additional states (Oklahoma, Delaware, and Missouri), however no deaths associated with white-nosed syndrome has been detected in those states to date.

Researchers suspect that a cold-loving fungus (*Geomyces destructans)* is cause of the disease. The fungus appears to disrupt normal patterns of hibernation, causing bats to arouse too frequently from torpor and starve to death. Staggering mortality rates (greater 90 percent in some caves) have pushed even some of the most common species to risk of extinction. Frick et al. (2010) predicted that little brown bats could be extinct in 20 to 60 years. The Service is currently reviewing the northern myotis and eastern small-footed bat for Federal listing (75 FR 38095).

In response to this threat, the refuge is collaborating with numerous partners, including the Service's New England Field Office, NHFG, and other states and refuges, to conduct a pilot study to adaptively modify two to four bunkers on the refuge to provide suitable hibernacula for bats. The pilot study involves monitoring temperature and relative humidity in the bunkers while we increase insulation and humidity in the bunkers using a wide range of techniques. Bats use military bunkers at other sites in New England, including those at Odione State Park in Rye, New Hampshire. By modifying additional abandoned military bunkers to suitable hiberacula, we can

- provide alternative refugia/hibernacula to surviving bats or non-affected bats;
- minimize spread of disease by disinfecting hibernacula after bats leave;
- use bunkers as experimental chambers to eradicate white-nose syndrome or lessen its impact on infected bats.

Bat species that might use these bunkers include big brown bats, little brown bats, northern myotis, and eastern small-footed bat. All species of these are known to occur on Great Bay Refuge during the breeding and migratory season. Northern myotis are the most common species on the refuge.

There are two other shrubland units on the refuge. The first is the 14-acre unit by MacIntyre Road that has sandy soils and supports primarily shrub species. This site could potentially support the State-listed endangered northern blazing star and the State-listed threatened hairy hudsonia. Both plants occur on abutting airport lands. Although these species do not currently occur on the refuge, this is a potential site for reintroduction. The blazing star occurs in sandplain grasslands and other dry, open habitats and may require prescribed fire. The hairy hudsonia also requires sandy areas. The other shrub unit is an old 3-acre orchard directly west of the MacIntyre Road unit. It would continue to be managed as an open orchard for wildlife observation.

Under alternative B, as noted above, the overall shrubland habitat acreage on the refuge would increase by at least 28 acres due to active management in the former Weapons Storage Area on areas which are currently in grassland. However, it is also important to note that a few smaller shrubland habitat patches would succeed to forest. These patches, all less than 3 acres, are either embedded in, or immediately adjacent to, large forest patches. Because they fragment the existing forest, and/or create additional edge habitat when contiguous forest habitat is a priority on the refuge; they do not provide valuable wildlife viewing opportunities; and, they are not efficient to manage from an administrative perspective, we propose to allow them to succeed to forest. Management activities would be minimal in those shrublands, and likely only need to occur to manage invasive plants or pests.

We may allow additional acres of 37 acres of grasslands in the former Weapons Storage Area to revert to shrubland if

- upland sandpipers do not breed in this field within 3 to 5 years, and;
- no other grassland species of conservation concern would benefit from those grasslands.

We would also likely continue to manage some of the former Weapons Storage Area as grassland for wildlife-observation opportunities and administrative purposes (see objective 2.4).

The proposed shrub management areas are depicted on map 3.8.

Strategies

In addition to alternative A and within 5 years of CCP approval:

- Use adaptive management to modify two to four bunkers to achieve ideal hibernation conditions for cave-dwelling bats (constant temperature above freezing and relative humidity of 80 to 100 percent from late August to May). Potential strategies include the following:
  - Closing and insulating the door of the bunkers
  - Scraping soil on top of bunkers and adding rigid insulation
  - Plugging up drainage ditches and adding water (small pools or water pumps) to increase moisture in bunkers
  - Installing bricks and cinder block walls for added thermal regulation and hibernating surfaces
- Determine what ecological integrity components should be monitored as part of the managed shrub community and develop a management plan that would sustain the 54 acres on an approximately 15-year rotation.
- Complete the inventory and mapping of invasive plant species. Prioritize invasive species to be controlled, and implement control using biological, ecological or cultural, mechanical, prescribed fire, or chemical methods as needed.
- Establish partnership with scientists at Boston University to identify and conduct various research projects involving bats and bat ecology.
- Develop a restoration and monitoring plan for the bunker areas at the south end of the former Weapons Storage Area and the areas abutting this site outside the fenced former Weapons Storage Area as a shrub community totaling approximately 37 acres or more, using the brontosaurus or other mechanical tools, and native plantings as needed. Incorporate monitoring protocols and adaptive management techniques gained from the Regional Shrub Adaptive Management Project led by Parker River Refuge biologist.
- Collaborate with NHFG and UNH to determine feasibility of New England cottontail captive propagation for reintroduction to other areas in the region.
  - If found feasible, maintain the existing Weapons Storage Area fence around the proposed native shrub management area to provide safe habitat (free of mammalian predators) for New England cottontails. Shift rest of fence to create exclosure at north end of shrub management area.

- If right conditions achieved for hibernating bats, work with partners to develop a plan to attract bats and manage and/or experiment with different ways to address white-nose syndrome.

- Develop a shrub restoration partnership to propagate native species and work with local contractors to select and transfer dominant shrubs from development sites.

- Determine the distribution and management needs of northern blazing star and hairy hudsonia, and evaluate potential habitat for reintroduction of northern blazing star. If potential habitat is located and reintroductions are possible, develop survey and monitoring protocol for reintroduced populations.

- If upland sandpipers do not nest in the grassland portion of the former Weapons Storage Area within 3 years of creating suitable habitat, let majority of grassland (30 to 35 acres) revert to shrub habitat.

Monitoring Components

- Identify and treat invasive plant populations using early detection rapid response methods and monitor the long-term effects of treatments.

- Monitor the density and plant composition in the shrub habitat blocks every 5 years to assess management needs.

- Monitor breeding and migratory bird use of shrub habitat after successful establishment and every 5 years as part of breeding bird point surveys. Data collected will include presence/absence and abundance.

- Monitor for other shrub-dependent species, such as black racer and smooth green snake, using the cover board technique or other established protocols.

- Monitor modified bunkers to obtain suitable conditions for hibernating bats (temperature and relative humidity on an hourly to daily basis). If ideal conditions are established, work with partners to continue to monitor conditions and develop an additional strategy for monitoring strategy bat use in the bunkers. Within 2 years of achieving ideal conditions, work with partners to establish a plan for ongoing research on hibernating bats in bunkers.

Objective 2.4 (Grassland)

Annually manage the Thomas Field (39 acres) to maintain a mix of grass and herbaceous vegetation at mixed heights ranging from 8 to 24 inches during the summer, with minimal thatch build-up, less than 15 percent of total vegetation of woody species and greater than 5 percent bare ground, to provide nesting habitat for upland sandpiper and other grassland species of conservation concern.

Annually manage the former Weapons Storage Area (38 acres) similar to the Thomas field. If upland sandpipers do not breed in this field within 3 to 5 years, and no other grassland species of conservation concern would benefit from those grasslands, determine whether to allow the Weapons Storage Area field to revert to shrubland. Include in that determination whether to maintain a small portion of grassland in the northwest corner for wildlife observation and cultural interpretation.

Manage the Woodman Point Field (15 acres) to maintain a mix of grassland herbaceous species as nesting habitat for bobolinks, singing habitat for woodcock, and migration habitat for Lepidoptera and other species of conservation concern. Manage the Ferry Way Trail grassland unit (6 acres) primarily to provide habitat diversity for wildlife viewing along the trail and also to support singing

habitat for woodcock and migration habitat for Lepidoptera and other species of conservation concern

Rationale

In 2005, refuge staff were managing 21 treatment areas as grasslands for nesting birds and other wildlife, primarily in the former Weapons Storage Area, at Woodman Point, along the refuge road, along Ferry Way Trail, and adjacent to the Thomas Farm. Many of these grassland areas have a component of little bluestem, as well as nonnative grasses. The largest grassland, approximately 70 acres, is in the former Weapons Storage Area. This grassland complex is managed using prescribed fire and mowing to control autumn olive and other woody plants. The 30-acre Thomas field and 24-acre Woodman Point Field complex are mowed and hydro-axed. The remaining grassy areas range from 2 to 4 acres in size and are mowed every 1 to 2 years to benefit woodcock. Since 2008, seven of these treatment areas have been allowed to revert to shrub or forest habitats.

Northeastern grasslands have provided habitat for grassland birds and other wildlife for hundreds of years. Historically, most of northern New England was forested with grasslands generally restricted to scattered small openings along river floodplains, wetlands, and beaver meadows. However in southern New England early settlers described more extensive openings including coastal sandplain grasslands, heathlands, and openings maintained by Native Americans. By the 1800s, grasslands were widespread throughout the region and grassland birds such as grasshopper, savannah, and vesper sparrows, upland sandpipers, eastern meadowlarks, and bobolinks were thought to be prevalent. By the late 1800s grasslands were declining as farms were abandoned, existing farms changed their use of the land, and fire was used less. More recent human development has consumed many remaining open fields. Remnant patches of grasses remain throughout the Northeast along railroad grades, rivers, roadsides, cemeteries, pastures, old fields, and reverting farmlands (Capel 2006).

Grassland bird species recorded during surveys on the refuge from 2001 to 2003 included eastern meadowlark, bobolink, upland sandpiper, field sparrow, red-winged blackbird, American kestrel, and vesper sparrow. Brown thrasher and eastern towhee, two shrubland species, were also recorded. In 2003 and 2004, at least one pair of upland sandpipers was observed using the former Weapons Storage Area and the Thomas field during the nesting season. The Thomas Field pair was observed nesting for the second year in a row.

In the NHWAP (NHFG 2005), “extensive grasslands” are defined as areas greater than 25 acres(10 hectares) dominated by grasses, forbs, and sedges with little shrub or tree cover. Large grasslands are particularly important, since many grassland birds require large areas for nesting. The State-listed endangered upland sandpiper, for example, typically requires over 150 acres of grassland that supports a mix of short (greater than 8 inches) and tall (up to 24 inches) grasses for foraging and nesting, respectively. They also need taller structures—fence posts, signs, tall mullein—as singing perches. Many of the remaining large grasslands in New Hampshire are restricted to hayfields, cropland, airports, capped landfills, and military installations, places that do not have wildlife habitat as a primary objective and in some cases may be in conflict with wildlife management (NHFG 2005). The airfield at the Tradeport, adjacent to the refuge, has supported a population of 8 to12 nesting pairs of upland sandpipers on its 500 to 600 acres of grasslands since 1989. As this is the State’s only extent breeding population, the Tradeport and NHFG seek help in managing a second population of upland sandpipers on refuge land. The species has been sighted at several other locations in New Hampshire including Dover,

Manchester, and southern Coos County (P. Hunt and D. De Luca, NH Audubon, personal communication with refuge manager).

Given the regional decline of grassland habitats, the refuge can play an important role in maintaining several large blocks of this habitat. Here, the Service has the capacity to annually manage these habitats to benefit species of conservation concern. The refuge has two sites that lend themselves to managing large blocks of grassland habitat: the north end of the former Weapons Storage Area and the Thomas Field at the south end of the refuge. Although both sites are smaller than the 150-acre minimal patch size, upland sandpipers have nested in both fields in the past, and are known to prefer grassland adjacent to airports (USGS 2006).

Two additional sites would also continue to be managed as grassland under alternative B. The Ferry Way Trail grassland unit is 6 acres and would be managed to provide a popular and high-quality wildlife viewing opportunity for the public. The 15-acre Woodman Field includes a diverse mix of grasses and flowering herbaceous species.

Another potential area to consider for future grassland management is a 15 to 20 acre field on the northern boundary of the refuge, north of the Ferry Way Trail. A small little blue stem field has persisted there since prior to 2000 (mapped by NHB) without any management. Additionally, the soils adjacent to this small grassland, including the 15-acre pine plantation, are very sandy and suitable for grassland management. Although these grasslands would not be suitable for upland sandpipers, other wildlife species of conservation concern would benefit including bobolink, northern leopard frog, smooth green snake, as well as a host of butterflies, moths, spiders, bees, and other insects (NHFG 2005).

As presented in table 3.1, under alternative B, grassland acres would be reduced from 169 acres to 98 acres. Of that 71 acre reduction, 28 acres of grassland would be actively managed as shrubland in the former Weapons Storage Area, thus continuing to provide early successional habitat. The remaining 43-acre difference would be allowed to revert to forest for reasons similar to those we presented for shrublands. In summary, we would propose to allow fields to revert to forest if

- they fragment the existing forest;
- create additional edge habitat when contiguous forest habitat is a priority on the refuge;
- they do not provide valuable wildlife viewing opportunities; and/or
- they are not efficient to manage from an administrative perspective.

Management activities would be minimal in the area allowed to revert to forest, and likely only need to occur to manage invasive plants or pests.

The proposed grassland management areas are depicted on map 3.8.

Strategies

Within 2 years of CCP approval:

- Complete the inventory and mapping of invasive plant species. Prioritize invasive species to be controlled and implement control using biological, ecological, mechanical, or chemical methods, as needed.

- In conjunction with revising the HMP, develop best management prescriptions (e.g., mowing, burning, frequency, seeding, haying, disking, etc.) for maintaining grass-dominated fields of variable sizes as indicated below.

- Enhance the habitat quality of the two larger grassland habitats (39-acre Thomas field and 38-acre former Weapons Storage Area field) for upland sandpipers through annual mowing, burning, and/or other management tools after grassland bird breeding season (August 1). Consider management options that would also benefit pollinators.

- Similarly, manage the Woodman Field (15 acres) as nesting habitat for bobolink, singing grounds for American woodcock, and as migration habitat for Lepidoptera.

- Evaluate site capacity (including soil and hydrology) of all non-administrative grassland units to determine ideal plant species composition and structure, use of management tools such as fire and mowing; and restore to shrub or forest if site is not suitable for grassland management. Evaluate site capacity of shrub unit by MacIntyre Road and the pine plantation by the refuge's northern boundary to be managed as grassland habitat for pollinators, bobolinks, and singing ground for American woodcock.

- Mow the (6 acres) fields along the Ferry Way Trail for early successional species such as pollinators, raptors, and landbirds as well as a wildlife viewing site for visitors.

- Allow eight patches of shrub and grassland openings in the forest to revert to forest to reduce forest fragmentation.

- Except as discussed elsewhere under historic resources, remove any remaining structures. Within the former Weapons Storage Area this would include all above ground structures and possibly the bunkers.

- Partner with New Hampshire Audubon and NHFG to develop methods for enhancing habitat for upland sandpipers on the refuge.

Within 5 years of CCP approval:

- Remove remaining Weapons Storage Area fencing and remaining military structures in the grassland management area. Remove hedgerows and small woodlots at the Thomas Field to enlarge the grassland area.

- Complete the inventory and mapping of invasive plant species; prioritize invasive species to be controlled and implement control using biological, ecological or cultural, mechanical, or chemical as needed.

Monitoring Components

- Continue to monitor breeding birds in the refuge's grassland habitats, according to regional protocol, to determine population trends, density, and use by grassland obligate species (e.g., upland sandpiper).

- Develop monitoring protocol and establish parameters to determine success for restoration of grassland habitat (for upland sandpipers) and for restoration of grasslands to shrub or forested habitat.

GOAL 3. **Foster and maintain conservation, research, and management partnerships to promote protection and stewardship of the ecological resources of the Great Bay Estuary.**

Objective 3.1 (Great Bay Resource Conservation, Research, and Management Partnerships)

Maintain and expand current key partnerships to promote land conservation, stewardship, research and management of resources of concern within the Great Bay Estuary. These partnerships include the Great Bay Resource Protection Partnership, Piscataqua Region Estuaries Program, Coastal Watershed Invasive Plant Partnership, Pease Development Authority Wildlife/Bird Strike Hazard Committee, and the New England Cottontail Working Group, among others.

Rationale

GBRPP is a coalition of public and private conservation groups that formed in 1994 to help protect the remaining important habitats within and around Great Bay. GBRPP takes a comprehensive, landscape-scale approach to conservation and habitat protection by developing and implementing conservation strategies through a combination of scientific field studies and ongoing communication with local, regional, State, and national conservation representatives. Parker River Refuge's refuge manager attends the quarterly meetings of the GBRPP. Since 1996, the partnership has protected over 5,000 acres of habitat around Great Bay.

In 1992, a MOA was signed between the Service, Federal Aviation Administration, U.S. Department of Agriculture–Animal and Plant Health Inspection Service), and Pease Development Authority. The MOA calls for coordination and quarterly meetings among the parties to review and discuss past and future wildlife management practices by the Service on the refuge and Pease Development Authority at the airport; the effects of such management practices on airport operations and on Service trust resources; and airport facility aircraft operations and their potential effects on the refuge (MOA 1992). This group is referred to as the Wildlife/Bird Air Strike Hazard Committee. Current issues include managing upland sandpipers that nest on the airport, impacts of large birds, such as wild turkeys, on the runway, and addressing potential impacts to the refuge from new de-icing pads and other sources of runoff.

As previously mentioned, Great Bay Refuge is a "sustaining partner" of CWIPP, a partnership among 11 agencies and organizations concerned with the effects of invasive plants within New Hampshire's coastal watershed. The goal through this cooperative effort is to achieve better management of invasive plants while improving working relationships between the signatories and the public.

We would also expand our partnerships to include the New England Cottontail Working Group, as well as partnerships with local land trusts and other private land management cooperatives in the region who have a goal to conserve lands of high resource value to Federal trust species.

Strategies

Continue to:

- Be an active member of GBRPP and serve on the Principal Partnership and Stewardship committees.
- Participate on the Pease Development Authority Wildlife/Bird Airstrike Hazard Committee.
- Serve on the PREP Management Committee.
- Participate in oil spill response training and coordination. One important reason to stay current on these skills is as a precaution in the unlikely event that an accident occurs with the shipping traffic up the Piscataqua River.

- Partner with the town of Newington, NHFG, and regional Service personnel on law enforcement on and around the refuge.

- Attend CWIPP meetings and actively participate in coordinated invasive control and outreach efforts.

Within 2 years of CCP approval:

- Facilitate research on the refuge, with focus on research that supports management goals and objectives, such as groundwater studies, hydrology, land use change impacts, habitat management, and habitat restoration.

- Work with the New England Cottontail Working Group to implement habitat improvements and opportunities for cottontail recovery. Evaluate the feasibility to propagate and restore New England cottontails to the refuge, specifically within the former Weapons Storage Area.

- Support research by partners in the Great Bay Estuary on conservation and management of eelgrass and oyster restoration, Great Bay water quality, and other topics that are linked to the refuge's goals and objectives.

- Identify refuge research needs and establish links with partners who can assist the refuge in researching these management questions; specifically, partner with the GBNERR and the National Estuarine Research Reserve's Science Collaborative.

- Work with Service's Ecological Services Private Lands Program to identify and evaluate projects that would support or enhance refuge goals and objectives and provide other resource assistance when possible.

Within 5 years of CCP approval:

- Enhance and strengthen collaboration with UNH's Jackson Lab in research and restoration of the Great Bay Ecosystem, particularly with restoration of eelgrass and oyster beds, salt marsh research, and monitoring water quality in the bay.

- Work with partners around Great Bay to create habitat management demonstration areas on the refuge and partner lands, including demonstration of invasive species control, grassland and shrubland management, dam removals, and oyster bed restoration.

- Facilitate technical workshops pertaining to the demonstration areas.

- Become a signatory to the CWIPP agreement.

Within 10 years of CCP approval:

- Establish partnership with Pease and Great Bay Country Clubs to develop management plans for their lands that contributes to the goals and objectives of the refuge and local conservation partnerships.

Monitoring Component

- The Air Force will continue its long-term groundwater well monitoring on the refuge to monitor water quality impacts from previous military uses. Obtain and interpret the results of this monitoring relative to refuge management. Adapt management practices accordingly.

- Develop a long-term monitoring plan to help identify and remediate (as feasible and necessary) potential offsite source of pollution that could negatively impact the refuge.

Objective 3.2 (Landscape-scale Conservation Partnerships)

Over the next 15 years, expand partnerships to address the refuge's role in landscape-scale conservation issues including climate change, regional population trends, research priorities, land use changes, and water quality.

Rationale

GBNERR is also a member of the GBRPP and the boundary of the reserve encompasses Great Bay Refuge. The Research Reserve System recently established a science collaborative, to fund collaborative, science-based projects that address coastal management issues. The priority research areas include impacts of land use change, habitat change and restoration, estuarine contamination, and stormwater and nonpoint source pollution management. The GBNERR is specifically interested in water quality, land use change, biological communities, and climate change. The Service is interested in collaborating with the reserve and other researchers on many of these issues.

In 1999, the Service launched the nationwide Land Management Research and Demonstration (LMRD) Areas "…to facilitate development, testing, teaching, publishing, and demonstration of state-of-the-art management techniques that support the critical habitat management information needs for fish, wildlife, and plant conservation within the System and other lands" (USFWS 1999). Two LMRD areas were established in our region: the Northern Forest LMRD and the Coastal Salt Marsh LMRD. Partnerships are a key element of demonstration areas. The Great Bay Refuge will partner with other participating national wildlife refuges, State and Federal agencies, universities, and others to further research on and off the refuge to advance our understanding of wildlife habitat concerns in the northern forest and coastal salt marshes.

The greatest effects of climate change will be on regional air and water temperatures, precipitation patterns, storm intensity, and sea levels. These effects are predicted to influence natural disturbances by resulting in an increase of freeze-free periods, decreased snow cover, increased storm intensities and frequencies, increased likelihood and frequency of droughts, damaging ozone, and an increase in the spread of invasive species and disease (NHFG 2005). The resulting effects on wildlife and habitats are expected to be variable and species-specific, with a predicted general trend of ranges shifting northward. The uncertainty about the future effects of climate change requires managers to use adaptive management to maintain healthy ecosystems in light of that unpredictability (Inkley et al. 2004). Tidal marshes are among the most susceptible ecosystems to climate change, especially rapid sea level rise. The refuge expects to partner at all levels—around Great Bay, within New Hampshire, regionally and nationally—to address this immense conservation challenge.

Strategies

Within 5 years of CCP approval:

- Conduct a research needs assessment for the refuge. Emphasize research projects that evaluate our assumptions, objectives, strategies, and techniques on species, habitat, and ecosystem management.

- Develop information exchange for research. Seek research partnerships to foster collaborations across the region.

- Collect information that contributes to regional information needs such as winter banding of waterfowl to help define populations.

- Identify the role of the refuge in contributing to the Service's 5-Year Action Plan on climate change and support similar initiatives in the NHWAP and NHCP.

- Participate in and support the priorities of the North Atlantic LCC.

- Collaborate with GBNERR on monitoring sea level rise as part of national effort. Assess feasibility of having reserve install a sediment elevation table (SET) in the refuge salt marsh.

- Work with PREP to support the EPA climate ready estuary project; Work with GBNERR and Great Bay Stewards to develop and outreach impacts of human land use and climate change on the bay's resources, and facilitate implementation of mitigation measures by the bay's residents and visitors.

- Establish a partnership with UNH and the Jackson Lab to work with the refuge in addressing research needs.

Monitoring Components

- Continue to participate in regional ecological studies, such as malformed frog surveys, land bird monitoring, frog call surveys, analyses of mercury in fish, and invasive plant distribution surveys and control methods.

- Collaborate with the Service's Regional Inventory and Monitoring Program and our Great Bay partners to monitor long-term trends associated with climate change and effectiveness of mitigation measures.

Objective 3.3 (Education and Outreach Partnerships)

Within 5 years of CCP approval, support and coordinate with area environmental education facilities such as the Great Bay Discovery Center and the Seacoast Science Center, as well as area schools, to advance wildlife conservation and refuge goals.

Rationale

Similar to many refuge programs, partnerships are key to successful environmental education and outreach. Specifically, refuge staff have partnered with the YCC, STEP, and SCEP programs and the Phillips-Exeter Sustainable Program to complete projects on the refuge. The students gain valuable experience and the refuge completes much needed management activities.

By collaborating with and supporting area environmental centers, including local schools, the refuge can affect a wide range of environmental education opportunities. The Great Bay Discovery Center, on the shores of Great Bay in Greenland, serves as the conservation-education headquarters for GBNERR. Their facility offers interpretive displays, meeting space for workshops, outdoor interpretive trails, and reaches people of all ages with stewardship messages. Likewise, the Seacoast Science Center has many similar features. By working together on stewardship messages, and sharing resources where feasible, we can multiply our individual efforts into a more effective collective effort to promote environmental stewardship in coastal New Hampshire.

Strategies

Continue to:

- Partner with YCC program.

- Use the STEP and SCEP to mentor students and achieve refuge goals and objectives.

- Help CWIPP develop fact sheets on priority invasive species.
- Collaborate with Phillips-Exeter Academy students to complete refuge projects.

Within 2 years of CCP approval:

- Add Web site link to GBNERR and other relevant links (such as Save Great Bay on Coastal Program Web site) on the Great Bay Refuge Web site.
- Work with the GBRPP to create regional recreational access information and maps that highlight locations around the bay where recreational activities can occur, especially those not available on the refuge such as kayak/canoe launch points.
- Collaborate with the Great Bay Discovery Center and GBRPP on educational and interpretive programs, materials, and maps; share outreach messages.
- With partners develop stewardship outreach material and program to reduce pollution and fertilizer runoff from residential and commercial facilities.
- Collaborate with local schools, GBNERR, and Gulf of Maine Institute (GOMI), to establish a coastal environmental stewardship and advocacy team with high school students in New Hampshire (see Newburyport, Massachusetts high school team as example and other GOMI-sponsored team).
- Seek a volunteer willing to coordinate the volunteer program to improve organization, recruit new volunteers, and help prioritize and implement work.
- Create an orientation program for all volunteers and expand volunteer corps.
- Work with the Pease Development Authority and Great Bay Stewards to establish a Friends of Great Bay Refuge group.
- Partner with the New Hampshire Office of Tourism, New Hampshire Department of Transportation, Pease Development Authority, and others to provide information on the refuge, including signs, maps, and directions to the refuge.

GOAL 4.

Promote enjoyment and awareness of the Great Bay Refuge and Great Bay Estuary by providing high-quality, compatible, wildlife-dependent public uses on refuge lands and on partner lands and waters around the refuge.

Objective 4.1 (Wildlife Observation and Photography)

Provide enhanced high quality wildlife observation and photography opportunities by improving the refuge's two existing trails and pursuing new self-guided opportunities on Fabyan Point.

Rationale

The Refuge Improvement Act of 1997 identified wildlife observation and photography as two priority public uses for national wildlife refuges, along with environmental education, interpretation, hunting, and fishing. In 2006, the Service's regional visitor services team identified wildlife observation and photography as areas of emphasis for Great Bay Refuge.

As an unstaffed refuge, we have had limited ability to conduct a vibrant visitor services program. Despite these limitations, the refuge is popular, especially for birders and walkers. The refuge is open from dawn to dusk, with vehicle access controlled by a timed gate along Arboretum Drive. The trails are for foot traffic only. The Peverly Pond Trail is wheelchair accessible. Bicycles and motor vehicles are limited to the entrance road and parking lot. Pets are only allowed in the

Great egret

Tim Williams

vehicle-accessible areas and only on leash. All other areas beyond the parking lot and the two trails are closed to the public.

The existing trails lead to several different habitat types including freshwater wetlands, fields, oak-hickory forests, and the shores of the Great Bay Estuary. They are accessed from the visitor parking lot at the end of Arboretum Drive, adjacent to the refuge office building (map 3.6). The 2-mile Ferry Way Trail begins across from the parking lot and starts out as an asphalt path next to a chain link fence (the former Weapons Storage Area). A leisurely walk on this trail takes about 2 hours. The 0.5-mile Peverly Pond Trail begins to the east of the parking lot.

Three Service staff conducted a visitor services review of the refuge in fall 2009. The review is part of the CCP planning process and provides recommendations to improve the quality of the visitor services at the refuge. Given the lack of staff and closure of the refuge office in recent years, many people are unaware of the visitor services opportunities available on the refuge. The recommendations included modest improvements to the existing trails and interpretive materials and structures to enhance the existing wildlife viewing and photography experience at the refuge, as well as attract more visitors. This in turn offers an opportunity to reach more people with key stewardship messages.

Strategies

Continue to:

- Pursue funding to construct a boardwalk along the entire Peverly Pond Trail to meet accessibility standards.
- Maintain the view from the Ferry Way Trail observation deck by pruning shrubs and brush that grow in over time.

Within 3 years of CCP approval:

- Re-route the Peverly Pond Trail and modify Ferry Way Trail to improve wildlife viewing opportunities.
- Add benches and an interpretive sign to the wildlife observation blind.
- Highlight wildlife observation and photography opportunities on the Great Bay Refuge Web site.
- Improve trail sign location, including installing “No Dogs” and “No Bicycles” signs at trailheads.

- Construct an elevated observation platform overlooking the former Weapons Storage Area with interpretive panel, once the former Weapons Storage Area fencing and structures are removed.
- Remove roads around buildings in the former Weapons Storage Area once buildings are demolished
- Develop a bird or watchable wildlife checklist for the refuge.
- Create a hotspot for the refuge on eBird and encourage visitors to post their sightings. Include a link to eBird on the refuge's Web site.
- Conduct a refuge photo contest during June through August. Check with local businesses for potential prize donations.
- Work with area biking enthusiasts to develop a bike access onto McIntyre Road at juncture with the refuge entrance road underpass.
- Develop a more effective method for gathering visitor services data (e.g., number of daily visitors, visitor uses, and experiences at refuge).

Within 10 years of CCP approval:

- At Fabyan Point, pursue acquisition of public access right-of-way and upgrade road conditions to allow safe passage of public vehicles. If the right-of-way is acquired, we would use a staged approach to upgrading and constructing facilities. Within 15 years, if feasible and no safety concerns arise, we would
  - first, make minor improvements to the road, create several parking places, and build an interpretive kiosk;
  - second, construct a trail and viewing platform; and
  - finally, construct car top-only boat launch.

Objective 4.2 (Environmental Education and Interpretation)

Within 5 years of CCP approval, 90 percent of refuge visitors contacted will be able to identify the refuge's purpose, name at least one habitat and associated wildlife species of conservation concern, or know the regional importance of the refuge through their experiences at the refuge or with one of our partners around Great Bay.

Rationale

Great Bay Refuge is close to a highly populated area. Yet, due to the lack of staff, closed office, and history as a former military base, the perception of the local community is that the refuge projects a message of "hands-off" and "stay out." Yet the refuge has many unique natural resources and a diverse cultural history to share with visitors. The absence of dedicated visitor services staff for the refuge has resulted in few public interpretive programs or environmental education on or off the refuge. The refuge currently relies on volunteers to lead walks or other interpretive programs, which depends solely on their interest and availability. We continue to receive more requests than we can currently fill. Right now, our major interpretive materials consist of a general station brochure and one kiosk that provides information on the refuge, wildlife, and refuge management.

The refuge Web site also lacks information or links for teachers or students. Census estimates for 2008 indicate that 139,546 persons under 18 years old live in the three counties closest to the refuge: Rockingham and Strafford Counties in New Hampshire and York County in Maine. There is a tremendous opportunity for the refuge to help with environmental education in the area and to increase the appreciation and stewardship of the refuge through greater interpretation.

Strategies

Continue to:

- Provide limited environmental education and interpretation programs upon request
- Use volunteers, if available and interested, to conduct occasional guided walks along existing trails.

Within 2 years of CCP approval:

- Update exhibits and information panels and refuge Web site; improve visitor orientation.
- Set up a wildlife observation log book and a visitor register at the main kiosk.
- Re-route the Peverly Pond Trail and modify Ferry Way Trail to improve wildlife viewing opportunities. Once the former Weapons Storage Area fence is removed, shift the Ferry Way Trail as appropriate.
- Initiate guided interpretive walks that can be led by partners and volunteers.
- Investigate opportunities to engage more youth programs on the refuge and on partner lands.
- Investigate opportunities to expand relationship with faculty and student programs at Phillips-Exeter to expand research projects.

Within 5 years of CCP approval:

- Develop three to five key environmental education messages and activities associated with each message about the refuge flora, fauna, habitats, and ecosystems that can be used in environmental education programs with local school teachers, college faculty, and youth group leaders.
- Develop key interpretive themes and the major messages to convey about the refuge, its role in regional conservation, and how citizens can become better stewards of the environment. Use these themes and messages to update the interpretive panels at main kiosk at parking lot.
- Collaborate with GBNERR on creating shared stewardship messages and interpretive materials.
- Develop curriculum-based, multi-sensory, interdisciplinary, and learner-based environmental education activities that can be lead by volunteers; partner with others such as UNH Cooperative Extension Coverts Project, UNH Marine Docents, Seacoast Science Center, Great Bay Discovery Center, and others.
- Develop interpretive materials to highlight the prehistoric and historic land use history of the Great Bay area and the rich cultural history of refuge lands, including the history of Pease Air Force Base and its relationship to the Cold War.
- Replace the current paved parking lot with a permeable surface; consult with the UNH Stormwater Management Center to determine appropriate design and materials, and develop interpretive materials related to design.

Objective 4.3 (Hunting)

Continue to provide a quality annual deer hunt to manage the white-tailed deer population, protect habitat, and provide a priority, wildlife-dependent recreational opportunity. Within 3 years of CCP approval, evaluate the opportunity to expand hunting to include a wild turkey hunt and a fall bow season for deer.

Rationale

Prior to Service ownership, deer and waterfowl hunting were permitted by the Air Force, but it was limited to military personnel, retirees, and their dependents, and was only allowed in certain areas. From 1967 to 1989, the Air Force used hunting as a management tool, due to the need to minimize aircraft strikes on the runway. It was estimated that 8 to 10 deer were taken annually from throughout the former Pease Air Force Base. The Air Force also permitted waterfowl hunting only on Stubbs Pond and only for Air Force personnel, dependents, and retirees. The former base was closed to hunting from 1989 to 1993 in advance of the land transfer to the Service (USFWS 1995).

When the refuge was first proposed, the Service received public comments that deer hunting should continue, while others suggested that it be used only as a biological management tool. In response to these comments, a Hunt Plan was completed for the refuge in 1993 (USFWS 1993). In 1995, the Service completed an EA to evaluate establishing and conducting an annual public white-tailed deer hunting program and waterfowl hunting program on the refuge. The decision from this EA was to open the refuge to controlled hunting of white-tailed deer in accordance with all Federal, State, and local regulations (USFWS 1995).

The first white-tailed deer hunt on the refuge occurred in the fall of 1996 and has been held every year since then. The hunt is a 2-day, Saturday and Sunday hunt, by permit only. A maximum of 20 permits per day are drawn from a pool of applicants each year. From 1996 to 2007 the number of hunters has ranged from 13 to 22. The number of deer harvested during a given hunt has ranged from 8 to 22 deer, with a mix of does and bucks taken. The refuge is closed to all other public uses during the 2-day deer hunt.

The refuge shoreline is open to waterfowl hunting, with access by boat only. Land access for waterfowl hunting is not allowed on the refuge.

Both Pease Airport Authority and NHFG support offering a wild turkey hunt on the refuge. First, offering a wild turkey hunt will provide a priority, wildlife-dependent recreational opportunity to refuge visitors. According to NHFG, there is an adequate population of wild turkeys at the refuge to support a hunt (Bridges, pers. comm., 2011). Second, Pease Airport Authority believes a hunt would help reduce the airport's turkey population. Currently, turkeys are the greatest hazard to airport operations (i.e. bird-air strike hazard). Although we do not have a specific proposal, we will evaluate whether to offer either a spring or fall turkey hunt, or both. During the State's spring turkey season, hunters are only allowed to harvest males (gobblers). However, hunters are allowed to harvest females during the fall season, which would likely better control the turkey population. We would also consider developing a youth turkey hunting program, in cooperation with NHFG and other partners, to extent practicable and there is interest.

Strategies

Continue to:

- Work with NHFG to handle the permit applications for the existing refuge deer hunt.
- Maintain closure on recreational trapping on the refuge.

Within 3 years of CCP approval:

- Evaluate the opportunity to expand the hunt program to include a fall bow season for deer and a turkey season. Develop a youth turkey hunting program, in cooperation with NHFG and other partners, to the extent practicable and there is interest.

- Work with NHFG to evaluate closing the shoreline of the refuge, including Herods Cove, to waterfowl hunting to protect estuarine habitats and associated species.

Objective 4.4 (Fishing)

Provide maps and other information on off-refuge fishing opportunities to refuge visitors and continue to assess the potential to open the refuge to fishing in the future by annually monitoring the level of contaminants in refuge sediments and fish and assessing the potential health risks from consuming refuge fish.

Rationale

Upper Peverly, Lower Peverly, and Stubbs Ponds were historically stocked and fished by the Air Force as we detailed in chapter 2 under "Freshwater Impoundments." The two Peverly Ponds were stocked with largemouth bass, rainbow trout, and brook trout. Upper Peverly Pond was also stocked with crayfish. Stubbs Pond was stocked with largemouth bass, crayfish, and alewife.

Despite this fishing history, recreational fishing is not currently allowed on the refuge due to concerns with contaminant levels in the sediments and fish and potential risks to human health. Mercury is present in the fish in Upper Peverly Pond. Before any public fishing is allowed, additional fish studies should be done. We would continue to promote other off-refuge fishing opportunities around the Great Bay Estuary.

Strategies

Continue to:

- Keep refuge closed to fishing.
- Prohibit boats from landing on refuge shoreline.
- Conduct outreach and enforcement to ensure that fishing and boat landings do not occur.

Within 1 year of CCP approval:

- Promote fishing opportunities available at established fishing sites around Great Bay.
- Develop a fact sheet on why fishing is not allowed on the refuge and offering off-refuge sites where they can pursue fishing.
- Train volunteers to answer questions about fishing.

Within 5 years of CCP approval:

- In conjunction with water quality studies in the Peverly Brook system, establish a schedule to conduct periodic sampling of fish to determine whether they continue to pose a risk to human health if consumed. Establish conditions under which, over time, the refuge might consider opening up to recreational fishing.

GOAL 5.

Contribute to the recovery of the federally listed endangered Karner blue butterfly and other rare Lepidoptera through the conservation, protection, and restoration of the pine barrens habitat.

Objective 5.1 (Habitat Management)

Working with NHFG and other partners, protect, manage, and restore historic pine barren communities in the Concord area, including the refuge's 29-acre easement, to benefit the federally listed endangered Karner blue butterfly, other rare Leidoptera, and shrubland bird species.

Rationale

Great Bay Refuge also includes a 29-acre conservation easement in the pine barrens of Concord, New Hampshire, in Merrimack County (map 3.13). The property is managed primarily for the federally listed endangered Karner blue butterfly. The easement is approximately 45 miles west of Great Bay Refuge. The parcel abuts the Concord Airport and is within a fragmented, but important complex of remnant pine barrens habitat that supports rare moths and butterflies. The easement land is a mix of open pitch pine-scrub oak, pine-hardwood, and other scrubland (map 1.2).

Karner blue butterflies inhabit pine barrens, an early successional community composed of 4 distinct vegetative strata: herbaceous, heath, scrub, and canopy. Within the scrub and canopy strata, shade-providing pitch pine and scrub oak dominate. The lower strata include grasses, vascular plants, and heath. Throughout these layers little bluestem and big bluestem are the principle grass species. New Jersey tea, spreading dogbane, lowbush blueberry, and huckleberry, as well as State threatened wild lupine, blunt-leaved milkweed, and golden heather comprise the majority of the herbaceous and heath layer and provide a critical source of nectar (USFWS 2003).

Currently, Karner blue butterflies are restricted to fragmented pine barren remnants, highway and powerline rights-of-way, airports, military camps, and gaps in forest stands that support their obligate host plant, wild lupine (USFWS 2003). Karner blue butterflies, as well as other members of the family Lycaenidae, are highly susceptible to environmental changes and population declines. The limiting factors for Karner blue butterflies have been compounded by a severe loss of habitat. Nearly 90 percent of historic pine barren communities along the Merrimack River have been lost (Helmbolt and Amaral 1994). This makes the 29-acre Karner blue butterfly conservation easement especially important to the survival of this species in the Concord pine barrens.

Habitat restoration and management on the Karner blue butterfly conservation easement began in 1996 and has included removal of overstory vegetation using a hydroaxe, brontosaurus, pruning, and prescribed fire to create openings and grassy patches to allow wild lupine, the host plant of larval Karner blue butterflies, to thrive. The U.S. Department of Agriculture–Wildlife Services assisted with woodchuck removal and fencing to prevent browsing of lupine. Over time, most of the 29 acres has been managed.

In 2004, a spearhead was found on the easement, which changed the pace and process for active management. We have been cooperating with the SHPO to conduct surveys in areas they request. The SHPO has also reviewed the 5-year Lupine Restoration Plan and indicted several areas where they recommend testing occur. The Guard funds currently cover the cost of hiring a consultant to conduct these surveys. An old farm site dating to 1800s is also on the easement. NHFG is developing methods for planting native lupine seed that would avoid conflict with cultural resources.

Concord school kids have helped grow and plant lupine. “Kids for Karners” is a program started by National Wildlife Federation and NHFG around 2000. In the past 9 years, over 1,700 lupine plants have been grown by local school children and planted on the Service’s easement. The project includes a teachers training in the winter, classroom plantings in the spring and a field trip to the easement at the end of the school year to plant lupine and tour the Concord pine barrens.

As part of a mitigation agreement, the Guard has provided $80,000 a year to NHFG for habitat management of the pine barrens around the airport, including

Great Bay National Wildlife Refuge - Comprehensive Conservation Plan
Karner Blue Butterfly Easement
Existing and Proposed Trails
Regional Drive
Concord Municipal Airport
Trail
Gate
Kiosk
Proposed Trail
Gate
Chenell Drive

on the Karner blue easement. NHFG has also used funds from the State moose plate program, Section 6, and State Wildlife Grants to implement habitat management. In addition to habitat management on the 29-acre easement, NHFG also manages 320 acres within conservation management zone of 450 acres on city of Concord lands.

Strategies

Continue to:

- Compile current cultural resource inventories and, in cooperation with SHPO, identify additional survey work needed to protect cultural resources in conjunction with site plan implementation.
- Support NHFG with habitat management actions, including prescribed burning, when and where resources allow.
- Post and maintain easement boundary and protect habitat from adverse impacts.
- Identify funding sources or mechanisms to maintain sufficient funding for habitat management

Within 3 year of CCP approval:

- Work with Service's Ecological Services Concord, New Hampshire office to conduct programmatic Section 7 consultation to cover incidental take of Karner blue butterflies associated with habitat management on the easement and adjacent airport.
- Update HMP to include habitat management for the Karner Blue Butterfly easement. Include information such as which vegetation manipulations should occur, when they should occur, and/or under what conditions. Potential treatment methods including prescribed fire, hydroaxing or brushhogging, herbicides, manual pulling, planting or seeding of native lupine.
- Facilitate NHFG's efforts to seed native lupines and avoid conflict with cultural resources; schedule archaeological surveys as soon as practicable in high priority lupine seeding sites.
- Support NHFG and the Service's Ecological Services office efforts to protect and manage additional acreages to meet revised population and goals identified in latest population viability model.

Monitoring Components

- Prioritize monitoring needs in conjunction with site plan implementation.

Objective 5.2 (Species Management)

In collaboration with New Hampshire Fish and Game and the Karner Blue Butterfly Recovery Team, restore and sustain a viable Karner blue butterfly population for the entire Concord pine barrens recovery unit through captive rearing and release. The population goal for the refuge easement is a viable sub-population that produces at least 750 wild-born individuals in any one brood on the Service's conservation easement lands, sustained for at least 4 out of 5 consecutive years.

Rationale

In 1992, the Karner blue butterfly was listed as federally endangered. The population at the Concord pine barrens is the only population in New England. The distribution of Karner blue butterflies is largely dependent on the availability of wild lupine, the larval food source, and preferred native nectar

sources (Schultz and Dlugosch 1999). These plants occur in pine barrens communities, which occur primarily on glacially deposited sand, shale, and serpentine soil types in parts of eastern North America (NHFG 2006). In New Hampshire, this community type once spanned the Merrimack River valley from Canterbury to Nashua, occupying Windsor sandy loams and Hinckley cobbly sandy loams (VanLuven 1994). Today, only the Concord pine barrens supports a population of Karner blue butterflies. The Concord population represents the easternmost extent of this species' distribution and is separated from the nearest population in New York by over 140 miles (225 kilometers) (Helmbolt and Amaral 1994). This butterfly formerly occurred in a band extending across 12 states from Minnesota to Maine and in the province of Ontario, Canada.

Without enough suitable habitats to support a viable population, the Karner blue butterfly became extirpated in New England in 2000 (Amaral 2000), and was subsequently reintroduced. The PSNH lands off Pembroke Road, north of the refuge easement, was the site of the last remaining wild population. In 2000, TNC found only 6 eggs, none of which hatched. NHFG began a captive rearing program in 2000 to restore a viable population. The Karner blue butterfly captive rearing and reintroduction program is funded by the State and paid for with State Moose Plate Grants and Section 6 grants. The first adults from a population in New York were released in 2001. The first eggs and larvae were released in 2003. The program has focused primarily on the rearing and release of adult butterflies. Mark-recapture has been actively implemented since 2004 to track survival and breeding in the wild. The first mark-recapture surveys during the 2004 summer flight resulted in the observation of 22 "wild-born" unmarked Karner blue butterflies on the easement (out of 31 total including surrounding conservation lands on the airport). From 2001 to 2008, butterflies were only released on the refuge easement. The first release of butterflies on non-easement land occurred in 2009 due to a significant increase in captive reared adult numbers. In 2010, two releases of adult butterflies occurred (over 2,500 individuals in the Concord pine barrens).

Karner blue butterflies live only 4 days as adults. Each year, the population can produce two broods, with each brood being a separate generation. The highest population numbers from either brood in a particular year is used for recovery goal population estimates. The Karner Blue Butterfly Recovery Plan has a goal of one viable population in the Concord pine barrens recovery unit, consisting of 3,000 wild-born individuals. A viable population is further defined as a minimum 3,000 individuals (in either brood) that is sustained for at least 4 out of 5 consecutive years. Any year that does not meet 3,000 individuals, has to have a minimal population of at least 1,500 individuals, and the final year has to reach at least 3,000 individuals. Recent population viability analysis indicate that 3,000 individuals is not sufficient to sustain a viable population (Fuller 2008), and the recovery goal may be updated in the future.

In 2008, the easement produced 56 wild individuals. In 2010, the entire Concord pine barrens produced 313 wild individuals and a total of 3,749 captive-reared individuals were released (1,300 individuals in the first brood; 2,449 individuals in the second brood).

Strategies

Continue to:

- Support the Karner blue butterfly captive rearing and translocation program conducted by NHFG, through the partnership outlined in objective 5.5.

- Implement recovery plan actions when and where possible.

- Within in 2 years of CCP approval:

- Evaluate effectiveness of captive-rearing program and develop milestones for reaching recovery goals.
- Support NHFG and the Service's Ecological Service's efforts to update recovery population goals based on latest population viability model.
- Determine if easement lands are being managed sufficiently and effectively to contribute to Karner blue butterfly management and recovery.

Monitoring Components
Support NHFG monitoring program for the Karner blue butterfly on the refuge easement to document recovery as per the Federal Recovery Plan.

Objective 5.3 (Outreach and Education)

Within 3 years of CCP approval, install new and expanded interpretive signs and trail on the Karner blue butterfly conservation easement, establish a program of guided walks, create additional Web-based information, and work with partners to improve enforcement on easement lands.

Rationale
The Karner blue butterfly conservation easement is within walking distance of many businesses and residential homes. An unpaved right-of-way runs through the center of the easement, which is gated at each end. A kiosk at the west entrance explains about the ecology of the Karner blue butterfly, but needs updating.

As we described in chapter 2, the easement has a 0.4-mile hiking trail for visitors; however, there is no interpretive signage along the trail to make the public more aware of the pine barrens ecosystem and associated management issues, and to protect the sensitive areas within the easement. Under alternative B, we propose to develop a 0.1-mile addition to the trail and provide quality self-guided interpretive panels along the entire length.

In addition, more information on the Karner blue, pine barrens, and the easement is needed on the Service's Web site, with links to NHFG and other partners. Law enforcement is a concern given the sensitivity of the resource, proximity to a human population, and lack of any regular onsite staff.

Strategies
In addition to alternative A, and within 3 years of CCP approval:

- Add approximately 0.1-mile to the existing 0.4 mile trail and establish self-guided interpretive panels along its length. Panels will explain butterfly ecology and management, to enhance the visitor's understanding and experience. The trail will be clearly designated as the approved footpath to reduce impact on sensitive resources off-trail.
- Upgrade existing kiosk with interpretive information about butterfly recovery efforts, pine barrens ecology, and warnings about Lyme disease. Construct an additional kiosk on east end of property with similar information.
- Provide volunteer-led group tours and interpretive talks onsite.
- Work with NHFG to develop interpretive materials and information.
- Improve Web site information and link to refuge and NHFG Web sites.
- Develop brochure that describes pine barrens ecology, other dependent species and aspects of biological diversity, in addition to butterfly ecology.

- Have Service law enforcement officers contact NHFG Conservation Officers and Service Special Agents to coordinate on visiting the site and enforcing against unauthorized uses.

Monitoring Components

- Monitor and evaluate the number of violations and take appropriate action to discourage future infractions.

Objective 5.4 (Land Protection)

In collaboration with New Hampshire Fish and Game and interested landowners, protect and manage approximately 850 additional acres of pine barrens habitat south of the city of Concord airport to augment the Service's Karner blue butterfly conservation easement.

Rationale

Historically, natural disturbances and Native American settlement patterns maintained open habitat for Karner blue butterflies in the Northeast. The Karner blue and its obligate host plant, wild lupine, have persisted in some developed areas, such as airports, utility rights-of-way, and road edges because moderate human disturbances mimic beneficial natural disturbances. However, urbanization and fragmentation by roads and development in parts of the butterfly's range may have already degraded populations beyond what is needed to maintain viable populations (USFWS 2003, Fuller 2008). The butterfly can disperse across roads but may be hampered by traffic and wind. Also, small, isolated habitat patches do not seem to retain these butterflies (Fuller 2008). Preventing further fragmentation of existing habitats and connecting corridors is an important management priority.

Although intense development and habitat fragmentation continues in the region around the Concord pine barrens, the remaining undeveloped lands from the airport south to the Merrimack River are still mostly pine barrens habitat. Historically, the Concord area has always been an important patch of habitat for the Karner blue butterfly population along the Merrimack River corridor. Major development in the corridor has degraded or eliminated habitat; the exclusion of fire has also degraded pine barrens, which is fire-dependent.

The NHFG has identified potentially restorable areas between the powerline, which extends through the refuge's Karner blue easement, and the Merrimack River. This was identified as the best location to focus effort on Karner blue butterfly recovery. Karner blue butterflies have been observed traveling up to 1 mile along the powerline corridor. The Army National Guard is in the process of acquiring the remaining potentially good undeveloped Karner blue habitat south of the current management area. They plan to construct a classroom-training facility in the front section of the property, with a lighter footprint in the back of the property. The NHFG intends to work with the Guard on maintaining as much Karner blue butterfly habitat as possible.

Strategies

Within 2 years of CCP approval:

- In partnership with NHFG, the Service's Ecological Services, city of Concord, landowners, and other partners, evaluate role of the refuge in acquiring additional lands—in fee simple or conservation easement—from interested landowners within the focus area, to expand protection and management for the federally endangered Karner blue butterfly.

- If determined that refuge has a role, then proceed with necessary administrative process. The Service will only acquire lands from willing sellers, either in fee simple or as conservation easements.

Objective 5.5 (Partnerships) Establish a formal partnership with New Hampshire Fish and Game to continue and enhance the existing collaboration on Karner blue butterfly species and habitat management and develop new partnerships with local businesses, land trusts, and other entities to enhance and expand Karner blue butterfly population and pine barrens habitat restoration.

Rationale

The Karner blue butterfly conservation easement was established in July 1992 through a cooperative agreement between the Service, the city of Concord, the CCDC, the U.S. Postal Service, and TNC. From 1992 to 1999, TNC carried out most of the management on the easement, which included removal of unwanted vegetation by mechanical methods and with prescribed burns and planting of wild lupine. Since 2000, NHFG has conducted the onsite management which has continued with vegetation removal, plantings, moth and butterfly surveys, and a captive rearing program.

Greg Thompson/USFWS

Great Bay Refuge welcome sign

The refuge has administrative responsibility for the easement. Given that Great Bay Refuge is unstaffed, these responsibilities lie with the refuge manager at Parker River Refuge. The Service has maintained an informal partnership with NHFG, as they implement onsite management and captive rearing of the Karner blue butterflies. A more formal agreement is needed to ensure that continued funding and support for habitat management, captive rearing, and law enforcement. The Service also seeks to expand other partnerships including with TNC and the New Hampshire Prescribed Fire Council in relation to the use of prescribed fire. Local land trusts and area businesses may be able to help the Service advance its goals of restoring healthy populations of Karner blue butterflies to the Concord pine barrens.

Strategies

Within 5 years of CCP approval:

- Participate in New Hampshire Prescribed Fire Council to enhance safety and share resources while implementing prescribed burning on the easement.
- Develop a memorandum of understanding (MOU) with NHFG regarding cooperation and funding for species and habitat management, monitoring and law enforcement of easement lands.
- Develop stronger partnerships with local land conservation groups to assist with recovery of Karner blue butterflies and pine barrens habitat in the area.
- Engage at least 20 percent of the corporate business employees in adjacent industrial park in developing and implementing a volunteer/community service program within the next 5 years.

Alternative C–Emphasis on Natural Processes

Alternative C relies primarily on ecosystem processes—such as natural disturbances—to maintain or restore the biological integrity, diversity, and ecological health of the refuge. Under this alternative, we envision the refuge as a place that retains its capacity to regenerate, reproduce, sustain, adapt, and evolve with minimal human influence (Karr 2004). Most active management under this alternative would be implemented to restore self-sustaining natural communities and ecological processes. Some active management or restoration would be needed to address human-induced threats such as invasive species control and removal of water control structures and other infrastructure. We would evaluate the role of natural processes such as fire in restoring and maintaining oak-hickory forests. Grasslands and shrublands would be allowed to naturally succeed to forested conditions.

All three impoundments in the Peverly Brook drainage would be removed and the brook restored to stream habitat. Prior to removal of each dam we would remove invasive plants and contaminated sediments. Our objective is to improve water quality and habitat for migratory fish and other aquatic organisms. We would work with partners to restore oysters and eelgrass to the Great Bay Estuary to improve the bay's environmental health.

We would remove all remaining structures in the former Weapons Storage Area and any other remaining structures. Under alternative C, we would create more public access into the refuge, since we anticipate a reduction in sensitive grassland, shrubland, and waterfowl breeding areas. These areas would succeed to forest, or be restored to estuarine habitat, accordingly. A proposed new trail out to Woodman Point would use a portion of an existing management road. Most of the other existing management roads would be retired and restored to natural habitat. Similar to alternative B, structures at Fabyan Point would be removed and a new trail constructed that provides a view of the bay.

Our proposal for managing the Karner blue butterfly easement would be similar to alternative B.

Map 3.14 shows the habitat management proposed under alternative C, while map 3.15 depicts the proposed public use facilities.

GOAL 1. **Perpetuate the biological integrity, diversity, and environmental health of estuarine and freshwater habitats on Great Bay Refuge to protect water quality and sustain native plant communities and wildlife, including species of conservation concern.**

Objective 1.1 (Salt Marsh) Maintain the quality and natural function of the existing 36 acres of salt marsh and restore up to an additional 44 acres of salt marsh and other estuarine habitats through the removal of Stubbs Pond dike to support a mix of native high and low marsh plant species including smooth cordgrass, salt meadow cordgrass, spikegrass, and black grass for breeding salt marsh sparrow, wintering American black ducks, foraging wading birds, fish, and rare plants.

Develop an index of ecological integrity for the refuge's salt marsh habitat and establish a baseline for future monitoring of its biological integrity in order to sustain quality habitat for breeding salt marsh sparrow, wintering American black ducks and other waterfowl, foraging wading birds, fish, shellfish, and rare plants. Implement strategies, as warranted by monitoring results, to ensure no degradation of integrity occurs and that the salt marsh continues to support a mix of native high and low marsh plant species with less than 1 percent overall cover of invasive plants.

Great Bay National Wildlife Refuge - Comprehensive Conservation Plan
Habitat Management
Alternative C (Emphasis on Natural Processes)
Welsh Cove
Thomas Point
Stubbs Dam Removed
Hemds Cove
Nacco's Island
Habitat Management Alternative C
Miles
Kilometers

Great Bay National Wildlife Refuge - Comprehensive Conservation Plan
Public Use
Alternative C
Welsh Cove
Existing Observation Platform
Electric Gate
Parking Lot
Kiosk
Office
Residence
Shop
Stubbs Dam Removed
Herods Cove
Woodman Point
Fabyan Point
Structure
Entrance Road
Proposed Road
Admin Road
Public Trail
Proposed Trail
Miles
Kilometers

Rationale
In addition to alternative B, the removal of the Stubbs Pond Dam would provide the opportunity to restore up to 44 acres of additional salt marsh and associated estuarine habitat; potentially up to 80 acres of contiguous salt marsh habitat. An analysis of a 1916 topographic map shows Peverly Brook draining into a large salt marsh complex connected to Herods Cove (TNC, Ray Konisky, personal communication). According to TNC, this was the largest contiguous expanse of salt marsh on Great Bay proper and as such would offer the greatest potential for restoration with removal of the Stubbs Pond Dam. While we propose that up to 44 acres might be restored to salt marsh, further evaluation would be necessary before we could provide an accurate estimate of restoration potential. It is possible that the developments that have occurred in the Peverly Brook might have affected the hydrology of the system, and the elevation of the pond bottom, e.g., deposition might have occurred, to the point that it would difficult to reestablish salt marsh without a lot of earth moving. We are also concerned about creating a disturbance that would improve conditions for *Phragmites* to dominate. Similar to alternative B, we would want to conduct a bathymetry study to establish what the elevations are in the pond relative to the existing salt marsh and the brook. This information would help us determine the potential for salt marsh migration, whether naturally occurring or actively manipulated.

See alternative B, objective 1.1 for more details on the importance of salt marsh habitats and the development of an index of ecological integrity.

Strategies
In addition to alternative B:
- Work with partners to develop a restoration plan for this site and initiate removal of the Stubbs Pond Dam and associated infrastructure. See also objective 1.3.

Objective 1.2 (Intertidal and Shallow Estuarine Waters)

Work with partners to protect and restore the health and function of Great Bay Estuary's intertidal habitats, and sustain up to 2 acres of oyster beds around Nannie Island and Woodman Point and restore and maintain eelgrass beds within Herods Cove, contributing to the restoration of these populations within the Great Bay Estuary and maintaining healthy habitats for horseshoe crabs, softshell clams, and other estuarine life.

Rationale

See rationale for alternative B, goal 1, objective 1.2.

Strategies
Same as alternative B

Objective 1.3 (Peverly Brook System)

Restore the 1.52 miles of Peverly Brook on the refuge to stream habitat by removing the three impoundment infrastructures and restoring native freshwater wetland, salt marsh, and riparian vegetation, to improve water quality, enhance natural flow regimes, improve migratory and resident fish habitat, and estuarine habitats for salt marsh sparrows, horseshoe crabs, and other species of concern.

Rationale
The refuge maintains three freshwater impoundments on Peverly Brook: Lower Peverly, Upper Peverly, and Stubbs Ponds. All three impoundments are interconnected and fed by springs and small tributaries. Restoring these impoundments to more natural stream habitat coincides with efforts throughout the State to remove dams and restore rivers and streams to benefit fish,

freshwater mussels, and other aquatic organisms. The Peverly Brook system, if restored, could benefit migratory fish that are currently barred by the dams and dikes from moving up- and downstream. Although the initial investment in time and resources to restore these habitats would be high, in the long term, removal of the dams will eliminate the time-intensive water level manipulations currently used to manage the impoundments. Natural processes, including an active beaver population, will create a diversity of microhabitats along the Peverly Brook drainage that will benefit migratory fish, waterfowl, and waterbirds, although we anticipate that the numbers of waterfowl and waterbirds using these habitats will be less than the numbers currently documented for the existing impoundments.

According to the NHDES, sediments from Upper Peverly Pond exceeded acceptable limits for nickel and cadmium in the past. Currently the contaminant levels are near acceptable levels, but are still not safe for fish consumption. Prior to the removal of each of the impoundments, we would develop and implement methods to control existing invasive aquatic plant populations (including brittle waternymph) and remediate any remaining contaminated sediments to ensure that downstream habitats are not adversely affected by the dam removals. In addition, we would develop restoration plans for each impounded area prior to initiating removal of impoundment infrastructures.

Strategies

Within 1 year of CCP approval:

- Prior to dam removal evaluate the presence of the invasive brittle waternymph in Lower Peverly Pond and Stubbs Pond to assess potential for infesting Herods Cove. Eradicate prior to dam removal, if needed.

- Conduct sediment and water quality (for metals) monitoring in Lower Peverly and Stubbs Ponds to establish pre-dam removal baseline. One year after the removal of the Lower Peverly Dam, conduct post-dam removal monitoring of Stubbs Pond.

- Begin required permitting process to remove the earthen dam and associated structures on Lower Peverly Pond, following sediment and water quality monitoring. Grade, contour, and restore the natural streambed, bank, and riparian area. Seek technical and financial assistance from potential partners including Department of Defense, Ducks Unlimited and/or others. Consult with the SHPO to determine if Lower Peverly Dam is eligible for the National Register and to minimize any potential impacts of its removal on cultural resources.

- Begin required permitting process for removal of the Stubbs Pond dike.

- Evaluate the presence of environmental contaminants in the sediments of Upper Peverly Pond and evaluate the impact of dam removal on downstream water quality. If determined to be high, then remediate/remove sediment, then begin permitting process for the removal of the Upper Peverly Pond dam.

- Discontinue use of roads to impoundments that are no longer needed for management access and restore to natural vegetation.

- Establish and implement protocol to monitor fish response to dam removals.

- Monitor water quality for contaminants in conjunction with airport operations in particular de-icing.

- Every 3 years, map invasive plants in the Peverly Brook system for 15 years after restoration.

Within 3 years of CCP approval:
- Develop monitoring plan to access whether restoration objectives are met, and their effects on biological integrity, diversity, and environmental health.

Within 5 years of CCP approval:
- Establish and implement a protocol for routine monitoring of seaside mallow in restored salt marsh areas.

GOAL 2. **Perpetuate the biological integrity, diversity, and environmental health of upland and forested wetland habitats on Great Bay Refuge to sustain native plant communities and wildlife, including species of conservation concern.**

Objective 2.1 (Appalachian Oak-Hickory Forests)

Restore and maintain 852 acres of Appalachian oak-hickory forests to sustain the suite of characteristic species including red, black, and white oak, and shagbark hickory and less than 5 percent cover of invasive plant species, to provide breeding habitat for birds of conservation concern including scarlet tanager, Baltimore oriole, and wood thrush among other mixed-forest dependent species, and to maintain the exemplary natural communities of Appalachian oak-hickory forest on the refuge.

Rationale

The rationale for alternative B, goal 2, objective 2.1 explains the significance of this habitat type for many Federal trust species and other species of conservation concern. Under alternative C, we propose to further expand this habitat by allowing grasslands and shrublands to succeed to forest, and by restoring riparian habitat along Peverly Brook in conjunction with the proposed dam removal. Alternative C would rely primarily on ecosystem processes—such as natural disturbances—to maintain or restore the biological integrity, diversity, and ecological health of the refuge.

Strategies

In addition to alternative B strategies:
- Remove all roads east of the Peverly Brook drainage and rehabilitate former road sites.
- Allow grasslands and shrublands to succeed naturally, resulting in a total of 852 acres of forest.
- Evaluate the historic role of fire in maintaining upland forests in this area. Implement prescribed fire (natural or prescribed) as determined to be suitable and feasible.

Objective 2.2 (Forested and Scrub-Shrub Wetlands, and Vernal Pools)

Maintain 169 acres of forested wetlands, scrub-shrub wetlands, and vernal pools within the larger matrix of oak-hickory forests and Peverly Brook drainage, to sustain high water quality and native shrub vegetation such as speckled alder, spicebush, silky dogwood, and winterberry and less than 10 percent invasive plant species. This mosaic of wet forests and shrublands, including some that function as vernal pools, will benefit obligate amphibians such as the wood frog, foraging woodcock, breeding willow flycatcher and other birds of conservation concern, and native plant communities.

Rationale

See rationale for alternative B, goal 2, objective 2.2.

Strategies
In addition to alternative B:

- Remove the small water control structure on the road to Stubbs Pond and restore wetland community.
- Maintain the small water control structure on the Ferry Trail that prevents flooding from beaver activity.
- Monitor the reptile, amphibian, and bird communities and monitor water quality and quantity to ensure environmental health of these wetland communities
- Monitor the hydro-period of the vernal pools and evaluate their ability to provide breeding habitat for amphibians and reptiles under climate change.

Objective 2.3 (Upland Shrubland)

Allow natural succession of upland shrub communities to forest habitat, while continuing to control invasive plant species to ensure less than 25 percent cover among native plants. Over the next 15 years, no shrub habitat would be managed.

Rationale
Our emphasis under this alternative is to reduce the human management footprint and allow natural ecosystem processes to create and modify native plant communities. Many native shrubs occur on the refuge—highbush blueberry, black huckleberry, dogwoods, arrowwood, bayberry, meadowsweet, raspberry, sensitive fern, sumac, elderberry. Many of these species would continue to occur in the forest understory for the life of this plan and natural disturbance (e.g., wind and ice storms, disease, etc.) would continue to create small patches of shrublands (5 acres or less). However, we anticipate losing large shrub blocks (greater than 20 acres). Additional shrub habitat, such as alder thickets, would be maintained in wetland areas. We recognize that some animal species of concern require larger blocks of shrub habitat and would likely become less common on the refuge.

If we pursue additional land acquisition in Dover/Concord area, we anticipate using active management under this alternative to manage for New England cottontail and Karner blue butterfly as that is the primary purpose of those land protection efforts.

Strategies
Within 2 years of CCP approval:

- Complete the inventory and mapping of invasive plant species. Prioritize invasive species to be controlled and implement control using biological, ecological, mechanical, or chemical as needed.
- Stop active management (e.g., “brontosaurus”, hydro-ax, prescribed fire) of shrub habitat, except as needed to control invasive plant species.

Objective 2.4 (Grassland)

Allow 169 acres of existing grasslands to transition through natural succession to oak-hickory forest or other natural community types, based on site capability. Allow natural disturbances to occur, while continuing to control invasive plant species to ensure less than 15 percent cover among native plants. Over the next 15 years, no grassland habitat would be managed.

Rationale
Although grassland-dependent wildlife species are in decline in the Northeast, the historical record is unclear on which species were successfully breeding here prior to extensive land clearing by settlers. Under this alternative we

are managing for site capability, with reliance on natural processes primarily. Grasslands require intensive management to maintain and therefore are not consistent with this alternative. Likely some natural disturbances—such as small lightning fires, wind storms, hurricanes, beaver activity—will continue to occur and create patches of grassy habitat. We are also uncertain if the refuge lands can provide a large enough grassland habitat complex (e.g., greater than 120 acres) to entice upland sandpipers to breed here. Furthermore, the upland sandpiper has probably always been rare in New Hampshire, and perhaps did not arrive until after 1800. Other wildlife species that utilize disturbed sites, such as fields, would continue to find patches of habitat across the landscape resulting from natural disturbances.

Strategies
Within 5 years of CCP approval:

- Complete the inventory and mapping of invasive plant species. Prioritize control of woody invasive species using biological, ecological, mechanical, or chemical methods, as needed.
- Except as discussed elsewhere under historic resources, remove any remaining structures, including those within the former Weapons Storage Area.
- Stop active management (e.g., "brontosaurus," hydro-ax, prescribed fire) of grassland habitat, except as needed to control invasive plant species.
- Discontinue use of refuge management roads to grassland areas that are no longer needed and restore roads to natural vegetation.

GOAL 3. **Foster and maintain conservation, research, and management partnerships to promote protection and stewardship of the ecological resources of the Great Bay Estuary.**

Objective 3.1 (Great Bay Resource Conservation, Research, and Management Partnerships)

Expand key partnerships to promote land conservation, stewardship, research and management of resources of concern within the Great Bay Estuary. These include the Great Bay Resource Protection Partnership, Piscataqua Region Estuaries Partnership, Coastal Watershed Invasive Plant Partnership, Pease Development Authority Wildlife/Bird Strike Hazard Committee, and the New England Cottontail Working Group, among others.

Rationale
See rationale for alternative B, goal 3, objective 3.1.

Strategies
Same as alternative B, except that:

- The research and management topics will be more focused on restoring and maintaining natural communities, understanding ecosystem processes, and controlling invasive plant populations.

Objective 3.2 (Landscape-Scale Conservation Partnerships)

Over the next 15 years, expand partnerships to address the refuge's role in landscape-scale conservation issues including climate change, regional population trends, research priorities, land use changes, and water quality.

Rationale
See rationale for alternative B, goal 3, objective 3.2.

Strategies
Same as alternative B, except that:
- The research and management topics will be more focused on restoring and maintaining natural communities and understanding ecosystem processes.

Objective 3.3 (Education and Outreach Partnerships)

Within 5 years of CCP approval, support and coordinate with area environmental education facilities such as the Great Bay Discovery Center and the Seacoast Science Center, as well as area schools, to advance wildlife conservation and refuge goals.

Rationale
See rationale for alternative B, goal 3, objective 3.3.

Strategies
Same as alternative B.

GOAL 4.

Promote enjoyment and awareness of the Great Bay Refuge and Great Bay Estuary by providing high-quality, compatible, wildlife-dependent public uses on refuge lands and on partner lands and waters around the refuge.

Objective 4.1 (Wildlife Observation and Photography)

Provide enhanced high quality wildlife observation and photography opportunities, including new, quality, self-guiding opportunities by enhancing the refuge's two existing trails, and creating two new trails through forested habitats.

Rationale
See rationale for alternative B, goal 4, objective 4.1.

Strategies
In addition to alternative A, and within 3 years of CCP approval:
- Develop new interpretive materials that describe the Service's goal of restoring natural communities on the Great Bay Refuge.
- Create a new trail out to Woodman Point using the existing management access road.
- Highlight wildlife observation and photography opportunities on the refuge Web site.
- Improve trail sign location, including installing "No Dogs" and "No Bicycles" signs at trailheads.
- Develop a bird or watchable wildlife checklist for the refuge.
- Create a hotspot for the refuge on eBird and encourage visitors to post their sightings. Include a link to eBird on the refuge's Web site.
- Conduct a refuge photo contest during June through August. Check with local businesses for potential prize donations.
- Establish a hiking trail and observation deck at Fabyan Point.

Objective 4.2 (Environmental Education and Interpretation)

Within 5 years of CCP approval, 90 percent of refuge visitors contacted will be able to identify the refuge's purpose, name at least one habitat and associated wildlife species of conservation concern, or know the regional importance of the refuge to the health of the Great Bay Estuary through their experiences at the refuge or with one of our partners around Great Bay.

Rationale
See rationale for alternative B, goal 4, objective 4.2.

Strategies
Same as alternative B.

Objective 4.3 (Hunting)

Continue to provide a quality annual deer hunt to manage the white-tailed deer population, protect habitat, and provide a priority, wildlife-dependent recreational opportunity. Within 3 years of CCP approval, evaluate the opportunity to expand hunting to include a wild turkey hunt and a fall bow season for deer.

Rationale
See rationale for alternative B, goal 4, objective 4.3.

Strategies
Same as alternative B, with the addition of the following, within 3 years of CCP approval:

- Evaluate need to vary deer hunt locations, given greater public access proposed under this alternative.
- Explore expansion of hunting opportunities to include wild turkey hunting and fall bow season for white-tailed deer.
- Evaluate the program through staff observation and hunter contacts.
- Partner with other organizations, such as the National Wild Turkey Federation, to conduct hunter education classes.

Objective 4.4 (Fishing)

Provide maps and other information about off-refuge fishing opportunities to refuge visitors.

Rationale
Under alternative C, we would remove all dikes on the refuge. Because of this the refuge would no longer support open water habitat. Therefore, we do not anticipate that there would be any fishing opportunities on the refuge. There are many other opportunities for fishing near the refuge and we would continue to promote and provide information these off-refuge opportunities to refuge visitors.

Strategies
Same as alternative B.

GOAL 5.

Contribute to the recovery of the federally listed endangered Karner blue butterfly and other rare Lepidoptera through the conservation, protection, and restoration of the pine barrens habitat.

Objective 5.1 (Habitat Management)

Maintain and manage the Service's 29-acre Karner blue butterfly conservation easement, comprised of pine barrens habitat, for the Karner blue butterfly and other rare Lepidoptera in collaboration with the New Hampshire Fish and Game and other partners.

Rationale
See rationale for alternative B, goal 5, objective 5.1.

Strategies
Same as alternative B.

Objective 5.2 (Species Management)

In collaboration with New Hampshire Fish and Game and the Karner Blue Butterfly Recovery Team, restore and sustain a viable Karner blue butterfly population for the entire Concord pine barrens recovery unit through captive rearing and release. The population goal for the refuge easement is a viable sub-population that produces at least 750 wild-born individuals in any one brood on the Service's conservation easement lands, sustained for at least 4 out of 5 consecutive years.

Rationale
See rationale for alternative B, goal 5, objective 5.2.

Strategies
Same as alternative B.

Objective 5.3 (Outreach and Education)

Within 3 years of CCP approval, install new and expanded interpretive signs and trail on the Karner blue butterfly conservation easement, establish a program of guided walks, create additional Web-based information, and work with partners to improve enforcement on easement lands.

Rationale
See rationale for alternative B, goal 5, objective 5.3.

Strategies
Same as alternative B.

Objective 5.4 (Land Protection)

In collaboration with New Hampshire Fish and Game and interested landowners, protect and manage approximately 850 additional acres of pine barrens habitat south of the city of Concord airport to augment the Service's Karner blue butterfly conservation easement.

Rationale
See rationale for alternative B, goal 5, objective 5.4.

Strategies
Same as alternative B.

Objective 5.5 (Partnerships)

Establish a formal partnership with New Hampshire Fish and Game to continue and enhance the existing collaboration on Karner blue butterfly species and habitat management and develop new partnerships with local businesses, land trusts, and other entities to enhance and expand Karner blue butterfly population and pine barrens habitat restoration.

Rationale
See rationale for alternative B, goal 5, objective 5.5.

Strategies
Same as alternative B.

Comparison of Objectives and Strategies for Great Bay Alternatives

Table 3.2 highlights the actions that distinguish each of the alternatives we present in detail above for Great Bay Refuge and the Karner blue butterfly easement. The table is organized to show how the objectives and strategies proposed under each alternative relate to refuge goals, resources, programs, and key issues to allow easy comparison of the alternatives. We have not included management actions that would not differ among the alternatives in this table. For more information on these activities, please refer to the "Actions Common to All of the Alternatives" discussion earlier in this chapter.

	Alternative A–Current Management	Alternative B–Service-preferred Emphasis on Habitats and Focal Species	Alternative C–Emphasis on Natural Processes
Goal 1 Perpetuate the biological integrity, diversity, and environmental health of estuarine and freshwater habitats on Great Bay Refuge to protect water quality and sustain native plant communities and wildlife, including species of conservation concern.			
Issues Addressed: How will we balance the management of aquatic habitats for wetland-dependent birds, fisheries, and biological integrity? How will manage the impoundments? Should we pursue restoration of wetland habitats through dam removal? How will we ensure the integrity of water quality to protect freshwater and saltwater-dependent species? How will we address environmental contaminants on the refuge? What role should the refuge have in helping to restore oysters and eelgrass beds to the Great Bay Estuary? How will the refuge manage exemplary natural communities and protect rare plant populations?			
Objective 1.1 Salt Marsh	*Continue to:* • Maintain the existing quality and function of 36 acres of salt marsh, including a mix of high and low marsh vegetation, with less than 1 percent cover of invasive plants • Prohibit public access in salt marsh habitats • Control any existing and new invasive plant species • Participate in CWIPP's ongoing identification, monitoring, and eradication efforts for invasive plants in seacoast marshes	*In addition to alternative A, and within 3 years of CCP approval:* • Develop an index of ecological integrity to: ◆ Determine current baseline conditions ◆ Prioritize management actions ◆ Ensure no degradation of integrity • Collaborate with partners to assess the Great Bay salt marsh sparrow population and the relationship of the bay's population to regional populations • Work with GBRPP to identify and address sources of mercury into Great Bay, to extent possible • Collaborate with GBNERR to track local sea level rise and anticipate effects on the Great Bay ecosystem • Provide refuge visitors with information on the importance of salt marsh to the health of the Great Bay Estuary • Implement an "early detection rapid response" program to prevent new invasive species from becoming established by immediately addressing newly detected populations • Conduct waterfowl surveys with volunteers and partners	*In addition to alternative B:* • Work with partners to develop a restoration plan for this site and initiate removal of the Stubbs Pond Dam and associated infrastructure (see also objective 1.3)
Objective 1.2 Intertidal and Shallow Estuarine Waters	*This objective is not part of our current management*	*Within 3 years of CCP approval:* • Work with NHFG and other Great Bay partners to restore oyster beds near Nannie Island and Woodman Point, and eelgrass beds in Herods Cove • Work with NHFG and other Great Bay partners to reduce nutrient and sediment loading into Great Bay, which affects water quality, oysters, eelgrass, and other aquatic life • Work with NHFG to protect the clam flats in Herods Cove from overharvest, through State regulation of shellfish harvesting • Work with partners to study the importance of Great Bay Refuge shoreline as spawning/nursery habitat for horseshoe crabs; partner on assessing the health of horseshoe crab population in the Estuary • Assess the need for additional protection of nesting bald eagles from human disturbance	*Same as alternative B*

	Alternative A–Current Management	Alternative B–Service-preferred Emphasis on Habitats and Focal Species	Alternative C–Emphasis on Natural Processes
Goal 1 Perpetuate the biological integrity, diversity, and environmental health of estuarine and freshwater habitats on Great Bay Refuge to protect water quality and sustain native plant communities and wildlife, including species of conservation concern. (cont.)			
Objective 1.3 Freshwater Impoundments and Peverly Brook System	*Continue to:* • Maintain and manage 62 acres of freshwater impoundments for migratory waterfowl fish and nesting birds; continue to address structural deficiencies in the dams • Prioritize and control invasive plants impacting the impoundments • Provide and manage alewife habitat in Stubbs Pond and ensure passage through the dike's fish ladder for migratory fish, including alewife, American eel, and river herring • Use adaptive management to maintain optimal mix of approximately 50 percent open water and 50 percent aquatic vegetation to benefit breeding waterfowl, marsh and wading birds, fish, and rare plants • Control nonnative mute swans	*In addition to alternative A (with exception of Lower Peverly Dam removal project noted below), and within 3 years of CCP approval:* • Annually maintain and inspect impoundment structures • Facilitate movement of migratory fish through Stubbs Pond fish ladder from late April to mid July; work with NHFG and the Service's Fisheries Program to evaluate effectiveness of the ladder • Work with Service's New England Field Office to monitor contamination and identify remediation options for Upper Peverly Pond • Work with NHFG, NHDES, and NEFO to plan/design removal of Lower Peverly Dam impoundment structure and restoration of brook. Begin all requirements to obtain permits for the work • Complete bathymetry study of Stubbs and Upper Peverly Ponds to help refine impoundment management • Re-locate or construct additional osprey platform in new location at Stubbs Pond; move away from dike *Within 5 years of CCP approval:* • Remove Lower Peverly Pond Dam and restore the existing 7-acre pond to stream habitat. Prior to dam removal: ◆ Evaluate the extent of brittle waternymph in the impoundments and determine control methods ◆ Assess Lower Peverly Pond for water and sediment contamination. If levels do not pose a concern for refuge resources, begin permitting process for dam removal ◆ Seek technical and financial assistance for partners	*Within 1 year of CCP approval:* • Conduct sediment and water quality (for metals) monitoring in Lower Peverly and Stubbs Ponds to establish pre-dam removal baseline; 1 year after the removal of the Lower Peverly Dam, conduct post-dam removal monitoring of Stubbs Pond • Begin required permitting process to remove the earthen dam and associated structures on Lower Peverly Pond, following sediment and water quality monitoring; grade, contour, and restore the natural stream bed, bank, and riparian area; seek technical and financial assistance from potential partners including Department of Defense, Ducks Unlimited and/or others. • Consult with the SHPO to determine if Lower Peverly Dam is eligible for the National Register and to minimize any potential impacts of its removal on cultural resources • Prior to dam removal evaluate the presence of the invasive brittle waternymph in Lower Peverly Pond and Stubbs Pond to assess potential for infesting Herods Cove; eradicate prior to dam removal if needed. • Begin required permitting process for removal of the Stubbs Pond dike.

	Alternative A–Current Management	Alternative B–Service-preferred Emphasis on Habitats and Focal Species	Alternative C–Emphasis on Natural Processes
Goal 1 Perpetuate the biological integrity, diversity, and environmental health of estuarine and freshwater habitats on Great Bay Refuge to protect water quality and sustain native plant communities and wildlife, including species of conservation concern. (cont.)			
Objective 1.3 Freshwater Impoundments and Peverly Brook System (cont.)			• Evaluate the presence of environmental contaminants in the sediments of Upper Peverly Pond and evaluate the impact of dam removal on downstream water quality; if determined to be high, then remediate/remove sediment, then begin permitting process for the removal of the Upper Peverly Pond Dam • Discontinue use of roads to impoundments that are no longer needed for management access and restore to natural vegetation • Establish and implement protocol to monitor fish response to dam removals • Monitor water quality for contaminants in conjunction with airport operations in particular de-icing • Every three years, map invasive plants in the Peverly Brook system for 15 years post restoration *Within 3 years of CCP approval:* • Develop monitoring plan to access whether restoration objectives are met, and their effects on biological integrity, diversity, and environmental health. *Within 5 years of CCP approval:* • Establish and implement a protocol for routine monitoring of seaside mallow in restored salt marsh areas.

	Alternative A–Current Management	Alternative B–Service-preferred Emphasis on Habitats and Focal Species	Alternative C–Emphasis on Natural Processes
Goal 2 Perpetuate the biological integrity, diversity, and environmental health of upland and forested wetland habitats on Great Bay Refuge to sustain native plant communities and wildlife, including species of conservation concern.			
Issues Addressed: What is the appropriate contribution of the refuge to regional landscape goals of upland habitats including grassland and shrubland habitats? Which upland forest habitats and forest-dependent species should be management priorities? How should we manage the Weapons Storage Area? How will we manage nonnative invasive plants on the refuge? What role, if any, should the refuge play in restoring New England cottontail? How can the refuge manage exemplary natural communities?			
Objective 2.1 Appalachian Oak and Pine Forests	*Continue to:* • Manage 659 acres of Appalachian oak-hickory forest to maintain native plants, with less than 10 percent cover invasive plants, habitat for breeding birds of concern and exemplary natural communities • Assess habitat potential for bat species including federally listed endangered Indiana bats, State-listed bat species • Complete a vegetation map for Fabyan Point and Thomas property and update the natural community map for the rest of the refuge • Complete inventory and mapping of invasive plants	*In addition to alternative A and within 5 years of CCP approval:* • Allow an additional 41 acres of refuge habitat to naturally succeed to forest (for a total of 700 acres) • Monitor natural succession of the four conifer plantations to oak-hickory forest • Develop a comprehensive management program to prioritize and control invasive species • Work with forest ecologists to determine appropriate management techniques to sustain species diversity, forest structure, and ecological integrity of oak-hickory forest community • Develop management strategies for scattered patches of red pine (approximately 25 acres) on the refuge • Survey for and locate potential roosting sites for bats species known to breed on the refuge (northern myotis, red bats, big brown, and eastern small-footed bat) using acoustic monitoring and radio tracking	*In addition to alternative B:* • Allow grasslands and shrublands to succeed naturally, resulting in a total of 852 acres of forest • Remove all roads east of the Peverly Brook drainage and rehabilitate former road sites • Evaluate the historic role of fire in maintaining upland forests in this area; implement prescribed fire (natural or human ignited) as determined to be suitable and feasible

	Alternative A–Current Management	Alternative B–Service-preferred Emphasis on Habitats and Focal Species	Alternative C–Emphasis on Natural Processes
Goal 2 Perpetuate the biological integrity, diversity, and environmental health of upland and forested wetland habitats on Great Bay Refuge to sustain native plant communities and wildlife, including species of conservation concern. (cont.)			
Objective 2.2 Forested and Scrub-Shrub Wetlands, Vernal Pools	*Continue to:* • Maintain 149 acres of forested and scrub-shrub wetlands and vernal pool habitats to maintain high water quality and benefit obligate amphibians, foraging woodcock, breeding birds of conservation concern, and native plant communities • Complete inventory of invasive species and prioritize control efforts • Evaluate the existing amphibian and reptile monitoring data to determine future monitoring needs	*In addition to alternative A and within 5 years of CCP approval:* • Maintain 158 acres of forested wetlands scrub-shrub wetlands, and vernal pools (the increase in forested wetlands over alternative A is due to the removal of Lower Peverly Pond and subsequent habitat restoration) • Maintain water control structure off Ferry Way Trail to prevent flooding by beaver • Inventory, map, and assess the quality of forested and scrub-shrub wetlands as vernal pool habitat and for rare plants • Remove the water control structure from the 1-acre impoundment in the former Weapons Storage Area and plug the ditches to create wet shrub meadow habitat. • If rehabbing access road to Stubbs Pond, install culvert to restore hydrological flow	*In addition to alternative B:* • Maintain 169 acres of forested wetlands; this is an increase in forested wetlands due to restoration of Upper and Lower Peverly Pond impoundments • Remove the small water control structure on the road to Stubbs Pond and restore to wetland community • Maintain the small water control structure on the Ferry Trail that prevents flooding from beaver activity • Monitor the reptile, amphibian, and bird communities and monitor water quality and quantity to ensure environmental health of these wetland communities • Monitor the hydro-period of the ephemeral vernal pools and evaluate their ability to provide breeding habitat for amphibians and reptiles under climate change

	Alternative A–Current Management	Alternative B–Service-preferred Emphasis on Habitats and Focal Species	Alternative C–Emphasis on Natural Processes
Goal 2 Perpetuate the biological integrity, diversity, and environmental health of upland and forested wetland habitats on Great Bay Refuge to sustain native plant communities and wildlife, including species of conservation concern. (cont.)			
Objective 2.3 Dry Shrubland	*Continue to:* • Manage 26 acres of shrub habitat using mechanical tools to provide nesting, foraging, and migrating habitat for birds of conservation concern • Complete inventory of invasive species and prioritize control efforts	*In addition to alternative A and within 5 years of CCP approval:* • Maintain and manage at least 54 acres of shrub habitat (at least 28 additional acres over alternative A) • Determine desired vegetation composition and ecological integrity components of the managed shrub community • Develop a management plan that will sustain shrubland on a 15-year rotation • Develop a restoration and monitoring plan for 25 acres of shrubland in the bunker areas at the south end of the Weapons Storage Area and the areas abutting this site outside the fenced WSA. • Collaborate with NHFG and UNH to determine feasibility of a New England cottontail captive propagation program on the refuge for re-introduction to other areas in the region; if feasible, maintain the existing WSA fence around the proposed native shrub management area to provide safe habitat (free of mammalian predators) for New England cottontails. Shift rest of fence to create exclosure at north end of shrub management area • Develop a shrub restoration partnership propagating native species and also working with local contractors to select and transfer dominant shrubs from development sites • Modify one to two former bunkers to create conditions suitable for use as bat hibernacula. Evaluate conditions every 2 to 3 years and modify design as necessary. If successful, consider creating 2to 3 additional bat bunkers • Determine the distribution and management needs of northern blazing star and hairy hudsonia, and evaluate potential habitat for reintroduction of northern blazing star. If potential habitat is located and reintroductions are possible, develop survey and monitoring protocol for reintroduced populations • If upland sandpipers do not nest in the grassland portion of the former Weapons Storage Area within 3 years of creating suitable habitat, let majority of grassland (30 to35 acres) revert to shrub habitat • Complete inventory of invasive species and prioritize control efforts	*Within 2 years of CCP approval:* • Allow all shrubland on refuge to naturally succeed to forest • Complete inventory of invasive species and prioritize control efforts

	Alternative A–Current Management	Alternative B–Service-preferred Emphasis on Habitats and Focal Species	Alternative C–Emphasis on Natural Processes
Goal 2 Perpetuate the biological integrity, diversity, and environmental health of upland and forested wetland habitats on Great Bay Refuge to sustain native plant communities and wildlife, including species of conservation concern. (cont.)			
Objective 2.4 Grassland	*Continue to:* ● Manage 169 acres of grassland habitat to benefit nesting grassland birds of conservation concern ● Manage large grassland fields (greater than 25 acres) through mowing or burning after July 15 ● Maintain several other patches of open field: ◆ The fields along the Ferry Way Trail as wildlife viewing sites ◆ The area around old apple trees and historic sites at Woodman Point ◆ The leach field (for administrative purposes) ● Complete inventory of invasive species and prioritize control efforts	*Within 2 years of CCP approval:* ● Reduce grassland management to 98 acres ● In conjunction with completing the HMP, develop best management prescriptions for maintaining grasslands with consideration of : ◆ Maintain the two larger grassland habitats (39 acre Thomas Field and 38 acre former Weapons Storage Area Field) through annual mowing or burning after grassland bird breeding season (July 15) or later to benefit upland sandpiper, grassland bird species of conservation concern, and pollinators ◆ Maintain through mowing the (6 acres) fields along the Ferry Way Trail as wildlife viewing sites ◆ Manage the Woodman Field (15 acres) as nesting habitat for bobolink, singing grounds for woodcock, and as migration habitat for Lepidoptera. ◆ Allow eight patches of grassland to revert to forest ● Partner with New Hampshire Audubon to develop methods for attracting upland sandpipers to the refuge. ◆ Evaluate site capacity of grassland units to determine ideal species composition and structure, fire regime and needed restoration ● Evaluate managing the Woodman Point Field and the red pine plantation area for grassland species *Within 5 years of CCP approval:* ● Remove remaining Weapons Storage Area fence and remaining military structures in the grassland management area. Remove hedgerows at and small woodlots at the Thomas Field to enlarge the grassland area. ● Complete inventory of invasive species and prioritize control efforts	*Within 5 years of CCP approval:* ● Allow all grassland on refuge to naturally succeed to forest ● Complete inventory of invasive species and prioritize control efforts ◆ Except as discussed elsewhere under historic resources, remove any remaining structures, incl uding those within the Weapons Storage Area ● Discontinue use of refuge management roads to grassland areas that are no longer needed and restore roads to natural vegetation

	Alternative A–Current Management	Alternative B–Service-preferred Emphasis on Habitats and Focal Species	Alternative C–Emphasis on Natural Processes
Goal 3 Foster and maintain conservation, research, and management partnerships to promote protection and stewardship of the ecological resources of the Great Bay Estuary.			
Issues Addressed: What role should the Service play in conserving lands and habitats in the Great Bay watershed? How can the refuge enhance its partnerships within the region? How can the refuge work with partners to improve the water quality of the Great Bay Estuary? What actions can the refuge take, in partnership with others, to minimize impacts from and adapt to climate change? What role should the refuge have in research collaborative that address management issues of concern to the Service? How will we work with the Pease Airport Authority to protect water quality and address potential airport/wildlife conflicts?			
Objective 3.1 Great Bay Resource Conservation, Research, and Management Partnerships	*Continue to:* • Be an active member of GBRPP and serve on the land protection and management committees • Serve on the Pease Development Authority Wildlife/ Bird Airstrike Hazard Committee and PREP committees • Participate in oil spill response training and coordination • Partner with the town of Newington, NHFG, and regional Service personnel on law enforcement on and around the refuge • Attend CWIPP meetings and actively participate in coordinated invasive species control and outreach efforts.	*In addition to alternative A and within 2 years of CCP approval:* • Work with the New England Cottontail Working Group to implement habitat improvements and opportunities for their recovery. • Support and facilitate research by partners on conservation and management of eelgrass and oyster restoration, Great Bay water quality, and other topics linked to refuge's goals and objectives • Identify refuge research needs and partners to assist in researching specific management questions • Work with the Service's Ecological Services Private Lands Program to identify and evaluate projects that would support or enhance refuge goals and objectives *Within 5 years of CCP approval:* • Work with partners around Great Bay to create habitat management demonstration areas on the refuge and elsewhere to demonstrate invasive species control, grassland and shrubland management, dam removal, and oyster bed restoration • Strengthen collaboration with UNH's Jackson Lab to research and restore Great Bay Ecosystem • Facilitate technical workshops pertaining to the demonstration areas • Become a signatory to the CWIPP agreement *Within 10 years of CCP approval:* • Establish partnership with Pease and Great Bay Country Clubs to develop management plans for their lands that contributes to the goals and objectives of the refuge and local conservation partnerships	*Same as alternative B, except that:* • The research and management topics will be more focused on restoring and maintaining natural communities, understanding ecosystem processes, and controlling invasive plant populations

	Alternative A–Current Management	Alternative B–Service-preferred Emphasis on Habitats and Focal Species	Alternative C–Emphasis on Natural Processes
Goal 3 Foster and maintain conservation, research, and management partnerships to promote protection and stewardship of the ecological resources of the Great Bay Estuary. (cont.)			
Objective 3.2 Landscape-scale Conservation Partnerships	*This objective is not part of current management*	*Within 5 years of CCP approval:* • Conduct a research needs assessment for the refuge, emphasizing projects related to the assumptions, objectives, strategies of our species and habitat management • Develop information exchange for research and seek research partnerships to foster regional collaborations • Collect information that contributes to regional information needs such as winter banding of waterfowl to help determine population numbers • Identify the role of the refuge in contributing to the Service's 5-Year Action Plan on climate change and support similar initiatives in the State Wildlife Action Plans and Coastal Programs • Participate in and support the priorities of the North Atlantic Landscape Conservation Cooperative • Collaborate with GBNERR on monitoring sea level rise as part of national effort • Work with PREP to support the EPA climate ready estuary project; work with GBNERR and Great Bay Stewards to develop and outreach impacts of human land use and climate change on the bay's resources, and facilitate implementation of mitigation measures by the bay's residents and visitors	*Same as alternative B, except that:* • The research and management topics will be more focused on restoring and maintaining natural communities and understanding ecosystem processes.

	Alternative A–Current Management	Alternative B–Service-preferred Emphasis on Habitats and Focal Species	Alternative C–Emphasis on Natural Processes
Goal 3 Foster and maintain conservation, research, and management partnerships to promote protection and stewardship of the ecological resources of the Great Bay Estuary. (cont.)			
Objective 3.3 Education and Outreach Partnerships	*Continue to:* • Support programs that engage youth and young adults in activities that advance conservation goals including the YCC, STEP, SCEP, and Phillips-Exeter Sustainable programs	*In addition to alternative A, and within 2 years of CCP approval:* • Work with GBRPP to create regional maps and other resources that that show locations of recreational opportunities around Great Bay Estuary; update refuge Web site to provide links to key resources and partnerships • Collaborate with the Great Bay Discovery Center and GBRPP on education al and interpretive programs, materials, and maps • Develop collaborations with Great Bay Stewards and volunteers and Friends group to develop and conduct programs; seek new potential volunteers • With partners, develop stewardship outreach material and program to reduce pollution and fertilizer runoff from residential and commercial facilities • Collaborate with local schools, GBNERR, and Gulf of Maine Institute, to establish a coastal environmental stewardship and advocacy team with high school students in NH; emphasize programs that would engage more youth on the refuge and on partner lands • Expand relationship with faculty and student programs at Phillips-Exeter to expand research projects • Seek a volunteer willing to coordinate the volunteer program to improve organization, recruit new volunteers, and help prioritize and implement work • Create an orientation program for all volunteers; expand volunteer corps. • Work with the Pease Development Authority and Great Bay Stewards to establish a Friends of Great Bay Refuge group. • Partner with the New Hampshire Office of Tourism, New Hampshire Department of Transportation, Pease Development Authority, and others to provide information on the refuge, including signs, maps, and directions to the refuge	*Same as alternative B*

	Alternative A–Current Management	Alternative B–Service-preferred Emphasis on Habitats and Focal Species	Alternative C–Emphasis on Natural Processes
Goal 4 Promote enjoyment and awareness of the Great Bay Refuge and Great Bay Estuary by providing high-quality, compatible, wildlife-dependent public uses on refuge lands and on partner lands and waters around the refuge.			
Issues Addressed: What is the appropriate type and level for wildlife-dependent public uses on the refuge? How will the refuge manage compatible non-priority public uses on the refuge? What partnership opportunities exist to increase environmental programs, interpretation, and outreach? How will we build and maintain an active volunteer program? How will the refuge cultivate an informed and educated public to support the mission of the Refuge System and the purposes for which the refuge was established? What staffing levels are needed to enhance onsite interpretation and education and outreach programs?			
Objective 4.1 Wildlife Observation and Photography	*Continue to:* • Maintain two existing trails ◆ Ferry Way Trail (2 miles) ◆ Peverly Pond Trail (0.5 miles) ◆ Pursue funding to construct a boardwalk along the entire Peverly Pond Trail to meet accessibility standards ◆ Maintain the view from the Ferry Way Trail observation deck by pruning shrubs and brush ◆ Maintain kiosk and the parking lot	*Similar to alternative A* • Pursue funding to construct a boardwalk along the entire Peverly Pond Trail to meet accessibility standards • Maintain the view from the Ferry Way Trail observation deck by pruning shrubs and brush • Maintain kiosk and the parking lot *Within 3 years of CCP approval:* • Re-route the Peverly Pond Trail and modify Ferry Way Trail to improve wildlife viewing opportunities • Add benches and an interpretive sign to the wildlife observation blind • Highlight wildlife observation and photography opportunities on the Great Bay Refuge Web site • Improve trail sign location, including signs for "No Dogs" and "No Bicycles" for trailheads • Construct an elevated observation platform with an interpretive panel overlooking the former Weapon Storage Area • Develop a bird/watchable wildlife checklist for the refuge • Create a hotspot for the refuge on eBird and encourage visitors to post their sightings; include a link to eBird on the refuge's Web site • Conduct an annual refuge photo contest between June and August *Within 10 years of CCP approval:* • At Fabyan Point pursue acquisition of a public access right-of-way and upgrade road. • If right-of-way is acquired: ◆ Construct a trail and viewing platform ◆ If feasible, construct a car top-only boat launch	*In addition to alternative A, and within 3 years of CCP approval:* • Develop new interpretive materials that describe the Service's goal of restoring natural communities on the Great Bay Refuge • Create a new trail out to Woodman Point using the existing management access road • Highlight wildlife observation and photography opportunities on the refuge Web site • Improve trail sign location, including installing "No Dogs" and "No Bicycles" signs at trailheads • Develop a bird or watchable wildlife checklist for the refuge • Create a hotspot for the refuge on eBird and encourage visitors to post their sightings. Include a link to eBird on the refuge's Web site • Conduct a refuge photo contest during June through August. Check with local businesses for potential prize donations • Establish a hiking trail and observation deck at Fabyan Point

	Alternative A–Current Management	Alternative B–Service-preferred Emphasis on Habitats and Focal Species	Alternative C–Emphasis on Natural Processes
Goal 4 Promote enjoyment and awareness of the Great Bay Refuge and Great Bay Estuary by providing high-quality, compatible, wildlife-dependent public uses on refuge lands and on partner lands and waters around the refuge. (cont.)			
Objective 4.2 Environmental Education and Interpretation	*Continue to:* • Provide limited environmental education and interpretation programs upon request • Use volunteers, when available, to conduct guided walks on refuge trails	*Within 2 years of CCP approval:* • Update exhibits and information panels and refuge Web site • Set up a wildlife observation logbook and a visitor register at the main kiosk • Re-route the Peverly Pond Trail and modify Ferry Way Trail to improve wildlife viewing opportunities; once the former Weapons Storage Area fence is removed, shift the Ferry Way Trail as appropriate • Initiate guided interpretive walks led by partners and volunteers • Investigate opportunities to engage more youth programs on the refuge and on partner lands • Investigate opportunities to expand relationship with faculty and student programs at Phillips-Exeter to expand research projects *Within 5 years of CCP approval:* • Develop three to five key environmental education messages and activities related to refuge wildlife, plants, and habitats that can be used in environmental education programs with local school teachers, college faculty, and youth group leaders • Collaborate with GBNERR on creating shared stewardship messages and interpretive materials • Develop curriculum-based, multi-sensory, interdisciplinary, and learner-based environmental education activities that can be lead by volunteers; partner with others such as UNH Cooperative Extension Coverts Project, UNH Marine Docents, Seacoast Science Center, Great Bay Discovery Center, and others • Develop interpretive materials to highlight the cultural history of refuge lands, including historic buildings, Weapons Storage Area, air force history • Change the current paved parking lot to a permeable surface; consult with the UNH Stormwater Management Center to determine appropriate design and materials, and develop interpretive materials related to design	*Same as alternative B*

	Alternative A–Current Management	Alternative B–Service-preferred Emphasis on Habitats and Focal Species	Alternative C–Emphasis on Natural Processes
Goal 4 Promote enjoyment and awareness of the Great Bay Refuge and Great Bay Estuary by providing high-quality, compatible, wildlife-dependent public uses on refuge lands and on partner lands and waters around the refuge. (cont.)			
Objective 4.3 Hunting	• Continue to: • Offer a quality annual deer hunt to manage the white-tailed deer population and provide recreational opportunity • Work with NHFG to handle the permit applications for the existing refuge deer hunt	*In addition to alternative A, and within 3 years of CCP approval:* • Evaluate the opportunity to expand the hunt program to include a fall bow season for deer and a turkey season • Work with NHFG to evaluate closing the shoreline of the refuge, including Herods Cove, to waterfowl hunting to protect estuarine habitats and associated species	*Same as alternative B, with the addition of the following, within 3 years of CCP approval:* • Evaluate need to vary deer hunt locations, given greater public access proposed under this alternative. • Explore expansion of hunting opportunities to include wild turkey hunting and fall bow season for white-tailed deer • Evaluate the program through staff observation and hunter contacts • Partner with other organizations, such as the National Wild Turkey Federation, to conduct hunter education classes
Objective 4.4 Fishing	*Continue to:* • Keep refuge closed to fishing • Prohibit boats from landing on refuge shoreline • Conduct outreach about and enforcement of fishing closure	*In addition to alternative A, and within one year of CCP approval:* • Promote fishing opportunities available at established sites off-refuge around Great Bay; develop outreach materials to explain fishing closure and identify other regional opportunities • Train volunteers to answer questions about fishing • Within 5 years of CCP approval: • In conjunction with water quality studies in the Peverly Brook system, establish a schedule to conduct periodic sampling of fish to determine whether they continue to pose a risk to human health if consumed. Establish conditions under which, over time, the refuge might consider opening up to recreational fishing	*Same as alternative B*

	Alternative A–Current Management	Alternative B–Service-preferred Emphasis on Habitats and Focal Species	Alternative C–Emphasis on Natural Processes
Goal 5 Contribute to the recovery of the federally listed endangered Karner blue butterfly and other rare Lepidoptera through the conservation, protection, and restoration of the pine barrens habitat.			
Objective 5.1 Habitat Management	*Continue to:* • Support NHFG management activities on the 29-acre Karner blue butterfly easement, when resources allow • Post and maintain easement boundary • Identify funding sources to continue habitat management • Identify additional inventories needed to protect cultural resources	*In addition to alternative A, and within 3 years of CCP approval:* • Work with Ecological Services to conduct programmatic Section 7 consultation to cover incidental take associated with habitat management on the easement and adjacent airport • Update HMP to include habitat management for the Karner blue butterfly easement. Potential treatment methods including prescribed fire, hydroaxing or brushhogging, herbicides, manual pulling, planting, or seeding of native lupine • Facilitate NH Fish and Games's efforts to seed native lupines and avoid conflict with cultural resources; schedule archaeological surveys as soon as practicable in high priority lupine seeding sites • Support NHFG and Ecological Service's efforts to protect and manage additional acreages to meet revised population and goals identified in latest population viability model	*Same as alternative B*
Objective 5.2 Species Management	*Continue to:* • Support NHFG in the captive rearing and translocation of Karner blue butterflies • Implement recovery plan actions when and where possible	*In addition to alternative A and within 2 years of CCP approval:* • Evaluate effectiveness of captive-rearing program and develop milestones for reaching recovery goals • Support NHFG and the Service's Ecological Service's efforts to update recovery population goals based on latest population viability model • Determine if easement lands are being managed sufficiently and effectively to contribute to Karner blue butterfly management and recovery	*Same as alternative B*

	Alternative A–Current Management	Alternative B–Service-preferred Emphasis on Habitats and Focal Species	Alternative C–Emphasis on Natural Processes
Goal 5 Contribute to the recovery of the federally listed endangered Karner blue butterfly and other rare Lepidoptera through the conservation, protection, and restoration of the pine barrens habitat. (cont.)			
Objective 5.3 Outreach and Education	*Continue to:* • Maintain existing kiosk • Partner with "Kids for Karners" program in Concord schools • Partner with the New England Zoo and Aquarium Association to engage volunteers	*In addition to alternative A, and within 3 years of CCP approval:* • Add approximately 0.1-mile to the existing 0.4 mile trail and establish self-guided interpretive panels along its length. Panels will explain butterfly ecology and management, and thereby enhance the visitor understanding and experience. The trail will be clearly designated as the approved footpath to reduce impact on sensitive resources off-trail • Upgrade existing kiosk with interpretive information about butterfly recovery efforts, pine barrens ecology, and warnings about Lyme disease. Construct an additional kiosk on east end of property with similar information • Provide volunteer-led group tours and interpretive talks onsite • Work with NHFG to develop interpretive materials and information • Improve Web site information and link to refuge and NHFG Web sites • Develop brochure that describes pine barrens ecology, other dependent species and aspects of biological diversity, in addition to butterfly ecology • Have Service law enforcement officers contact NHFG Conservation Officers and Service Special Agents to coordinate on visiting the site and enforcing against unauthorized uses	*Same as alternative B*
Objective 5.4 Land Protection	*This objective is not part of current management*	*Within 2 years of CCP approval:* • In partnership with NHFG, the Service's Ecological Services, city of Concord, landowners, and other partners, evaluate role of the refuge in acquiring additional lands–in fee simple or conservation easement–from interested landowners within the focus area, to expand protection and management for the federally endangered Karner blue butterfly • If determined that refuge has a role, then proceed with necessary administrative process; the Service will only acquire lands from willing sellers, either in fee simple or as conservation easements.	*Same as alternative B*

	Alternative A–Current Management	Alternative B–Service-preferred Emphasis on Habitats and Focal Species	Alternative C–Emphasis on Natural Processes
Goal 5 Contribute to the recovery of the federally listed endangered Karner blue butterfly and other rare Lepidoptera through the conservation, protection, and restoration of the pine barrens habitat. (cont.)			
Objective 5.5 Partnerships	*This objective is not part of current management*	*Within 5 years of CCP approval:* • Participate in NH Prescribed Fire Council to enhance safety and share resources while implementing prescribed burning on the easement • Develop an MOU with NHFG regarding cooperation and funding for species and habitat management, monitoring and law enforcement of easement lands • Develop stronger partnerships with local land conservation groups to assist with recovery of Karner blue butterflies and pine barrens habitat in the area • Engage at least 20 percent of the corporate business employees in adjacent industrial park in developing and implementing a volunteer/community service program within the next 5 years	*Same as alternative B*

Chapter 4

Steve Hillebrand/USFWS

Great blue heron

Environmental Consequences

- Introduction
- Chapter Organization
- Regional Scale Impacts
- Refuge-specific Impacts
- Cumulative Impacts
- Relationship Between Short-term Uses of the Human Environment and Enhancement of Long-term Productivity
- Unavoidable Adverse Effects
- Potential Irreversible and Irretrievable Commitment of Resources
- Environmental Justice
- Summary of the Impacts of the Alternatives

Introduction

This chapter describes the foreseeable environmental consequences that we predict from implementing the refuge management alternatives presented in chapter 3. Specifically, we predict the beneficial and adverse effects of implementing the management actions and strategies for each of the alternatives:

- **Alternative A**–"Current Management" (which serves as a baseline for comparing against the other two alternatives)
- **Alternative B**–"Emphasis on Habitats and Focal Species" (Service-preferred)
- **Alternative C**–"Emphasis on Natural Processes"

In this chapter, we describe the direct, indirect, short-term, and cumulative influences of effects likely to occur over the 15-year life span of this CCP. Beyond the 15-year planning horizon, we give a more approximate description of environmental consequences. Where detailed information is available, we present a scientific and analytic comparison of the alternatives and their anticipated impacts and effects on the environment. When detailed information is not available, we base those comparisons on our professional judgment and experience. At the end of this chapter, table 4.2 summarizes the effects predicted for each alternative and provides a side-by-side comparison. Our discussion also relates the predicted impacts of the alternatives to the refuge goals and the key issues identified in chapter 1.

The Council for Environmental Quality (CEQ) and Service regulations on implementing NEPA require that we assess the significance of the effects of all alternatives based on their context, duration, and intensity. The context of our impact analysis ranges from site specific to regional and landscape-scale, depending on how widely the effect of an action can be observed. Certain actions (such as removal of invasive plant species) may have effects only in a very local context, while others (such as participation in regional partnerships) may have effects in a much broader context (see table 4.1). However, it is important to note that even local actions may have cumulative effects in a larger context, when combined with other actions. For example, invasive plant control on a local scale, when combined with other control efforts across that landscape, could result in combined, significant effect by reducing the overall abundance and distribution of invasive species. Although the refuge is only a small percentage of the larger ecoregion, we developed the three management alternatives to contribute toward regional conservation goals. Our proposed conservation objectives and strategies for species and habitats are consistent with regional, State, and Service landscape-level plans identified in chapter 1, including the PREP Management Plan, NHWAP, and the BCR 30 Plan.

We based our evaluation of the intensity of the effects from implementing the alternatives on these factors:

- The expected degree or percent of change in the resource from current conditions
- The frequency and duration of the effect
- The sensitivity of the resource to such an effect, or its natural resiliency to recover from such an effect

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Beaver with branch

- The potential for implementing effective preventive or mitigating measures to lessen the effect

Effects range in duration from short-term (a matter of days or weeks, as with noise produced by construction) to effectively permanent (e.g., dam and other structure removal).

Finally, we consider the

- cumulative effects;
- relationship between short-term uses of the human environment and the enhancement of long-term productivity;
- the potential irreversible and irretrievable commitments of resources; and
- environmental justice impacts.

We do not fully evaluate the environmental impacts of certain proposed projects in this chapter. These include aspects of management that are both common to all alternatives and do not individually or cumulatively have a significant effect on the quality of the human environment. The following would qualify for exclusion under the Service's list of categorical exclusions, if individually proposed:

- Environmental education and interpretive programs (unless major construction is involved or significant increase in visitation is expected)
- Research, resource inventories, monitoring, and other resource information collection
- Operations and maintenance of existing infrastructure and facilities (unless major renovation is involved)
- Certain minor, routine, recurring management activities and improvements

- Small construction projects (e.g., fences, kiosk, interpretive signs, and RV pad)
- Native vegetation planting and invasive plant control
- Minor changes in amounts and types of public use
- Issuance of new or revised management plans when only minor changes are planned
- Law enforcement activities

We describe in chapter 3, under the heading "Additional NEPA Analysis," those future management decisions that may require more detailed analysis before a choice is made. We analyze the impacts of available choices in this document to the extent possible, but more detailed analysis will inform the final choice.

Chapter Organization

Our analysis first focuses on broad, regional-scale impacts, then examines more refuge-specific impacts. The chapter is organized as follows:

- Regional-scale Impacts
  - Air quality
  - Hydrologic systems and water quality
  - Socioeconomic resources
- Refuge-specific Impacts
  - Soils
  - Vegetation
  - Migratory birds
  - Fish
  - Threatened and endangered species
  - Biological integrity, diversity, and environmental health
  - Public uses and access
  - Cultural resources

Under each heading we discuss the resource context, benefits, and adverse impacts of management actions that would occur regardless of which alternative is selected, and finally the benefits and adverse impacts of each of the alternatives. We examine the impacts of current and proposed administrative or general operations, habitat management, and visitor services/public uses on each of the physical, biological, and cultural resources noted above. Impacts on the Karner blue butterfly easement are under separate subheadings under each major resource area topic.

We end the chapter with discussions on:

- Cumulative impacts
- The relationship between short-term uses of the human environment and enhancement of long-term productivity
- Unavoidable adverse effects
- Potential irreversible and irretrievable commitments of resources, and
- Environmental justice.

We provide some context for evaluating impacts in table 4.1

Table 4.1. Existing Context for Impacts Analysis at Great Bay Refuge and Karner Blue Butterfly Conservation Easement.

Gulf of Maine Watershed	44.2 million acres (69,115 square miles)
New England/Mid-Atlantic Coast–Bird Conservation Region 30	24.4 million acres
New Hampshire Coastal Watersheds	525,000 acres
Great Bay Estuary	6,000 acres
Peverly Brook Watershed	907 acres
Length of Peverly Brook within Refuge	1.5 miles
Town of Newington*	5,214 acres
Great Bay Refuge	1,103 acres
Forest Habitat	659 acres
Grassland/Shrubland Habitat	195 acres
Forested Wetlands	149 acres
Impounded Waters	62 acres
Salt Marsh	36 acres
Rocky Shoreline	2 acres
Footprint of Existing Refuge Headquarters, Residence, and Parking Lot	0.6 acres
Footprint of Existing Maintenance Facility	0.03 acres
Length of Trail Network	2.5 miles
Footprint of Remaining Military Infrastructure in Weapons Storage Area (Road, Buildings, and Parking)	7 acres
Refuge Road (Paved and Gravel) Network	7.9 miles
Karner Blue Butterfly Conservation Easement	29 acres
Additional Area Managed by New Hampshire Fish and Game for Karner Blue Butterflies	350 acres
City of Concord*	43,136 acres

**The Great Bay Refuge is in the town of Newington and the Karner blue butterfly conservation easement is in the city of Concord.*

Regional Scale Impacts

Air Quality Impacts

Impacts on Air Quality that Would not vary by Alternative
Regional air quality should not be adversely affected by refuge management activities regardless of which alternative is selected. There are no major stationary or mobile sources of air pollutants at the refuge. None of the alternatives would violate EPA standards and all three would comply with the Clean Air Act. Since most of the impacts to regional air quality originate from sources off the refuge, management actions on the refuge would have negligible effect on regional air quality.

In our opinion, all management alternatives would help reduce adverse impacts on air quality by

- maintaining natural vegetative cover on the refuge's 1,103 acres;
- requiring that all new facilities and upgrades to existing facilities be energy efficient; and,
- limiting public uses to those that are appropriate, compatible, and wildlife-oriented activities.

Collectively, these management actions would help reduce the potential for additional sources of emissions in the surrounding landscape.

We do not expect refuge visitors traveling in motor vehicles to add measurably to the current level of emissions, as described under each alternative below based on projected visitation numbers. Except for the paved entrance road and parking lot, public access on the refuge is limited to non-motorized pedestrian traffic only.

The following management actions have the greatest potential to adversely affect air quality:

- Prescribed fire
- Mowing and cutting of vegetation
- Trail maintenance
- Demolition of buildings
- Removal of impoundment infrastructure
- Restoration of these sites

The degree to which we would implement these activities varies by alternative.

Karner Blue Butterfly Conservation Easement
There are no buildings on, and no motorized vehicle visitor access to, the 29-acre Karner blue butterfly easement. We are not proposing any new construction or access that would cause air quality impacts under any of the alternatives. On average, 1 to 2 acres of the easement are burned annually using prescribed fire. NHFG also burns an additional 60 to70 acres annually of nearby land owned by the city of Concord. The acreage burned on the Karner blue butterfly easement would be the same under all three alternatives. The refuge follows a prescribed fire burn plan to minimize smoke impacts on the neighboring Concord airport and to address other air quality issues during the burn. We anticipate no differences in impacts to air quality among the three alternatives since the proposed management prescriptions are the same.

Impacts on Air Quality Under Alternative A
Benefits
Alternative A would include few new ground-disturbing activities and would introduce few additional emission sources. The refuge would remain open to pedestrian traffic only, except for the paved entrance road and parking area, thus minimizing emissions from motorized vehicles. We would continue to use energy efficient practices and adopt additional practices, as feasible, including the use of energy efficient vehicles and lighting. There would be continuing benefits to air quality from maintaining native vegetation on the refuge, including 659

acres of upland forest. Trees serve as long-term carbon "sinks" reducing the amount of atmospheric carbon dioxide which contributes to global climate change (USEPA 2010).

Adverse Impacts
The refuge currently receives approximately 30,000 visitors annually and we do not expect visitation to increase to the point that its impacts on air quality become problematic. We expect very short-term, negligible localized effects on air quality by emissions from

- motor vehicles used by refuge staff;
- refuge equipment;
- annual prescribed burns of grassland habitat on up to 60 acres of the refuge and 1 to 2 acres of the Karner blue butterfly easement;
- mowing and cutting of grasslands (up to 169 acres) and shrubland habitat (up to 26 acres);
- removal of buildings and paved surfaces in the Weapons Storage Area; and,
- management of 62 acres of impounded wetlands.

However, no foreseeable long-term or cumulative impacts on air quality would result from any current refuge activities, nor would these activities contribute to any substantial increase in ozone levels, particulate matter, or other negative air quality parameters.

The major pollutants from prescribed burning are particulates and gases. Particulates—consisting of small particles of ash, partly consumed fuel, and liquid droplets—can reduce visibility or cause negative effects on the health of people with respiratory illnesses. The gases released by prescribed burns include carbon monoxide, carbon dioxide, hydrocarbons, and small quantities of nitrogen oxides. However, low intensity prescribed burning, such as the current program on the refuge, releases inconsequential amounts of these gases (USDA 1989). We would follow prescribed burn plans at both the refuge and the easement, which consider smoke management and other environmental and geographical factors, to minimize impacts on surrounding areas, including the adjacent airports. Based on our experience, we expect the level of prescribed burning we are propose under alternative A to produce no major, long-term adverse air quality impacts.

The ongoing removal of structures and roads in the former Weapons Storage Area may contribute localized and negligible short-term effects from dust and exhaust from vehicles and heavy equipment. To mitigate for this, we would follow dust abatement practices and minimize exposure of bare soil through establishing native vegetation as quickly as possible.

Impacts on Air Quality Under Alternative B
Benefits
The beneficial effects on air quality under alternative B would be similar to those under alternative A. There would be no substantive change in air quality, no violation of air quality standards under the Clean Air Act, and no cumulative effects on ozone and particulate matter. Having refuge staff stationed onsite would reduce emissions from the approximately 30-mile commute between

the Refuge Complex headquarters at Parker River Refuge and Great Bay Refuge. However, this would be offset by more vehicle use by refuge staff to conduct increased monitoring and management. The construction of a new low emissions Leadership in Energy and Environmental Design (LEEDS)-certified headquarters/visitor contact station and maintenance facility would provide long-term air quality benefits under alternative B, through the use of energy efficient materials and green technology. For example, we would consider water conservation measures and alternative energy sources and implement these practices to the extent practicable.

Adverse Impacts
We anticipate some short-term adverse impacts during the construction phase of the new headquarters/visitor contact station and maintenance facility. We would minimize dust during construction of the facilities through practices such as the following:

- Use, where possible, water and approved chemicals for dust control.
- Install and use hoods, fans, and fabric filters to enclose and vent the handling of dusty materials,
- Cover open equipment for conveying materials.
- Remove spilled or tracked dirt promptly and remove dried sediments resulting from soil erosion.

As the new building would be larger than the existing refuge office, its operation would require greater energy use. We would offset this increase in energy usage over the long term through energy efficient construction and design and other conservation measures.

We anticipate negligible increases in regional vehicle emissions from a projected 10 percent increase in visitation, as much of the refuge would remain closed to motorized vehicles. We also expect minimal windborne dust resulting from management vehicles traveling on refuge gravel roads.

Similar to alternative A, we anticipate negligible adverse effects from our grassland and shrubland habitat management activities. Under alternative B, we would manage 152 acres of grassland and shrubland through a combination of mowing, brushhogging, and prescribed burning. We would use prescribed fire on up to 60 of these 152 acres annually. Each of these management techniques would contribute negligibly to regional emissions. As under alternative A, we would follow burn plans which consider smoke management and other environmental and geographical factors, to minimize impacts on surrounding areas, including the adjacent airports.

We expect a short-term increase in windborne dust and other particles during

- the removal of impervious surface on refuge roads,;
- demolition of remaining buildings in the former Weapons Storage Area;
- removal of structures at Fabyan Point, removal of the Lower Peverly Pond Dam infrastructure; and
- restoration of these sites.

Impacts on Air Quality Under Alternative C

Benefits

Similar to alternative B, we would continue energy efficiency practices and would realize similar long-term benefits from a new LEEDS-certified energy efficient headquarters/visitor contact station and maintenance facility. We expect that long-term carbon sequestration would be modestly higher with the increase in forest cover to 852 acres. We anticipate slight improvements to air quality under alternative C with the cessation of all management of grasslands and shrublands and a reduction in management actions overall. This would eliminate any emissions associated with prescribed fires and the equipment used for mowing. Small wildfires that do not threaten public health, safety, or operations of the adjacent airfield may be allowed to burn under this alternative. However, we would expect that this would happen very infrequently (approximately 50 to 70 year intervals). The removal of all impoundment infrastructures and restoration of Peverly Brook to stream habitat would reduce the amount of refuge vehicle traffic that is currently associated with management of the three impoundments. This would also allow for closure of some refuge management roads, leading to a long-term decrease in windborne dust due to vehicles.

Adverse Impacts

We anticipate a 10 to 12 percent increase in visitation due to an increased emphasis on interpretive programs, a modest increase in trail length, and expanded access to the refuge. This would cause a slight increase in vehicle emissions from visitors arriving to the refuge by car.

Similar to alternative B, there would be a slight short-term increase in windborne dust and other particles from the demolition of the remaining buildings in the former Weapons Storage Area, removal of all impoundment infrastructure and associated access roads, and the restoration of these sites. This would be offset by the long-term benefits of restoring these sites to natural conditions and by relying on passive management by natural disturbances, rather than active management requiring motorized equipment.

Hydrologic Systems and Water Quality Impacts

Impacts on Hydrologic Systems and Water Quality that would not vary by Alternative

Benefits

We would continue to partner with several ecological research and management organizations that are focused on improving the health of the Great Bay Estuary and its watershed. These include GBNERR, GBRPP, NHFG, NHDES, PREP, TNC, and UNH. Although the estuarine system is relatively intact and remarkably resilient, it has been significantly altered and degraded. PREP has documented several negative and cautionary environmental trends in Great Bay (chapter 2, table 2.1).

Under all alternatives, Great Bay Refuge would continue to partner with local, State, and Federal agencies to help restore and maintain the water quality of the Great Bay Estuary. We would continue to remove unnecessary buildings and other infrastructure, such as in the former Weapons Storage Area, amounting to approximately 7 acres, and rehabilitate contaminated sites to improve hydrology, water quality, and groundwater recharge.

Adverse Impacts

We expect that none of our proposed refuge management activities would adversely affect regional water quality. Each alternative would comply with the Clean Water Act and no activities would violate Federal or State standards for contributing pollutants to water sources.

We do not expect that visitation would increase enough under any alternative to have an adverse impact on water quality.

All the alternatives include some level of invasive plant control using mechanical, chemical, and biological control methods. The use of herbicide has the potential to impact water quality; however, the refuge would only use chemical controls as a last option if the other techniques are not effective. We would only use herbicides approved by the regional contaminants coordinator and only in accordance with approved rate and timing of application.

Oil spills and release of other contaminants from refuge activities are also a possibility within the Great Bay estuarine system. However, we closely monitor and mitigate all of our routine activities that have some potential to result in chemical contamination of water directly through leaks or spills or indirectly from soil runoff. Potential sources include motorized watercraft, control of insects and weeds around structures, use of chemicals for de-icing roads and walkways, and the use of soaps and detergents for cleaning vehicles and equipment. Refuge staff would continue to participate in oil spill response training and coordination to prevent and prepare for possible leaks or spills. The adjacent Tradeport and associated airfield (including the new de-icing pads) continue to pose potential risks to water quality. The refuge would continue to communicate with Tradeport personnel about potential runoff and water quality issues. We would also continue to take the following precautions to minimize the potential for chemicals and petroleum products to be introduced into aquatic systems:

- Ensuring all staff are up-to-date on the spill prevention plan
- Obtaining advanced training in spill prevention and spill response
- Pouring or mixing chemicals or petroleum products will be conducted no closer than 25 feet from surface water

While some potential risk exists from the existing or increased visitor activities we are predicting under all alternatives, we believe these would be negligible when managed properly. We recognize that visitor activities near wetlands may directly impact water quality and aquatic species over the long term, especially if people wander off-trail. However, we conduct outreach and enforcement in visitor areas to minimize this potential, although our capabilities vary by alternative. Potential adverse affects to wetlands could also occur if visitor facilities are improperly placed in wetland habitats, or if erosion is allowed to occur unchecked during maintenance or construction. We try to minimize those effects in a variety of ways. Our refuge parking lot is located away from streams, rivers, or other wetlands. Refuge staff and volunteers monitor roads and trails for damage and remediate any problems encountered. We would also be vigilant during maintenance and construction activities to watch for resource damage and will stop activities as soon as they are observed. Where ever there is the potential for runoff we use silt fences or other best management practices to avoid impacts.

Karner Blue Butterfly Conservation Easement
The easement is predominantly an upland site, with only one small stream. Our proposed management activities do not differ between the alternatives. We plan to use prescribed fire on 1 to 2 acres annually and may occasionally require the use of herbicides to control invasive species. As noted above, we would only use those herbicides approved by the Regional Contaminants Coordinator and only in accordance with approved rate and timing of application. We anticipate that these management activities would not impact water quality or hydrology given the easement's relatively flat topography.

Impacts on Hydrologic Systems and Water Quality Under Alternative A

Benefits

Under alternative A, the major water quality and hydrological benefits would be maintaining mostly natural cover on the 1,103 acre refuge and minimizing the amount of impervious surface. We would continue to remove buildings and other impervious surfaces on approximately 7 acres in the former Weapons Storage Area, resulting in a benefit to water quality and hydrologic systems due to the ability of soils and vegetation to filter out pollutants. We would also continue to work with GBNERR, GBRPP, and other partners to help restore and maintain water quality within the Great Bay Estuary. Under alternative A, we do not propose any new trails or roads and would continue to prohibit wheeled and motorized public access outside of the paved entrance road and parking lot.

Adverse Impacts

Under current management, we would maintain the three impoundments on the 1.5 mile Peverly Brook, thereby providing limited ability to restore hydrologic function and improve water quality within the Peverly Brook system. Erosion continues to undermine the integrity of the Lower Peverly Pond Dam. Given its deteriorating condition, we would potentially have a greater adverse impact on water quality under alternative A, as compared to alternatives B and C, if the structure abruptly fails and a flush of sediment results at a time of year when aquatic biota downstream are vulnerable. We would continue to minimally maintain the infrastructure to ensure that it does not create a safety hazard; however, no portion of the Peverly Brook drainage is slated for restoration in current management. With the current lack of staff at Great Bay, we would have limited ability to inventory and control of invasive aquatic plants including brittle waternymph. We would likewise have limited ability to routinely monitor sediments and water within the impoundments for contaminants and to implement any remediation or restoration of water resources. The Air Force will continue its long-term monitoring of groundwater wells, which occurs four times per year, and is scheduled to occur for at least the next 50 years.

Impacts on Hydrologic Systems and Water Quality Under Alternative B

Benefits

Under alternative B we propose a greater role for the refuge in conserving ecologically significant lands around Great Bay in partnership with the GBRPP. This would provide greater long-term protection for Great Bay Estuary's water quality by maintaining these lands in natural cover and preventing increases in impervious surfaces. Vegetated buffers along shorelines have been shown to reduce drastically the sediments, nutrients, and other pollutants entering waterways, especially when near agricultural fields and developed areas (Klapproth and Johnson 2000). We would work with the GBNERR, UNH, and others to improve and maintain water quality in the Great Bay Estuary through restoration of oyster reefs and eelgrass beds in intertidal waters off the refuge. Both oyster reefs and eelgrass beds help improve water quality and water clarity by filtering pollutants from water (Short et al. 1992a). Some of the most significant reefs and beds are found just offshore of the refuge in Herods Cove, around Nannie Island, and off Woodman Point.

In addition to other planned ongoing restoration activities identified above with regards to Weapons Storage Area facilities, under alternative B, converting the paved road past the Service residence (e.g., toward the Margeson Estate) to gravel or other more permeable surface would also result in improved water quality and groundwater recharge by reducing imperviousness and increasing infiltration.

The proposal to remove the Lower Peverly Dam and associated infrastructure is one of the actions proposed under alternative B with the greatest potential to affect water quality. This dam impounds approximately 7 acres of water. The

objective would be to restore a 1,100 foot section of Peverly Brook to stream habitat. This would improve hydrologic function over the long term along this central portion of the 1.5-mile brook. The restoration would contribute to improved water quality by removing the existing deteriorating infrastructure that is causing erosion and sedimentation and by the removal and control of invasive plants that currently grow in Lower Peverly Pond. We would try to minimize any concern about large amounts of sediment washing into Peverly Brook downstream during and after dam removal by installing silt fences, sediment traps, or otherwise following best management practices, as warranted. American Rivers, in their report on "The Ecology of Dam Removal" (American Rivers 2002), state that any short-term consequences associated with dam removal can be minimized through careful planning and timing of the removal process. We would plan to work with NHFG, NHDES, NEFO, the Service's Central New England Fishery Office, and others to develop a detailed plan.

Greg Thompson/USFWS

Upper Peverly Pond

With onsite refuge staff, we would be able to work with partners to help conduct sediment and water quality monitoring in the Peverly Brook system. This would lead to improved water quality in the long term by alerting the refuge to potential threats to water quality (e.g., such as in case of runoff from nearby airfield) in a more timely, reliable, and consistent manner. It would also provide more detailed data on the need for remediation of contaminated sediments, where feasible.

Adverse Impacts

We would continue to maintain the Stubbs Pond impoundment to benefit waterfowl and waterbirds because of the regional significance of this freshwater wetland. Also, the level of sediment contamination in Upper Peverly Pond remains sufficiently high such that removal of that impoundment at this time would cause potential adverse impacts to downstream water quality by releasing these sediments into the Peverly Brook system.

Some sediment would likely be released downstream from the proposed removal of Lower Peverly Pond Dam, but according to our records, those sediments are not contaminated (appendix I). As noted above, we would work with partners to design the dam removal project to minimize impacts. Hart et al. (2002) recommend that dam removals be designed after careful consideration of the expected magnitude, timing, and range of physical, chemical, and biological responses (Hart et al. 2002). Lenhart (2000) recommends that certain basic information should be obtained before proceeding with restoration and management. This information includes the following:

- Characterization or model of surface sediment deposit
- Depth of water-restraining layers
- Depth to water table and groundwater gradient
- Location of original stream channel
- Identification of reference sites to serve as models for restoration

There are few definitive studies on the impacts of small dam removal that relate directly to our proposed project. In the studies documented, it was difficult to draw general conclusions about the impacts on water quality resulting from such disturbances as increased sedimentation. The observed rates and patterns of sediment transport are quite variable after removing small dams, and depend on the amount and type of sediment, channel slope, and flow magnitude (Hart et al. 2002). Most projects documented a flux of sediment following dam removal, but in very small impoundments, or those with limited accumulation, sediments can be flushed out relatively rapidly (Stanley et al 2003). Assuming there are no toxic substances in the pond's sediments, some studies indicate that flushing of sediment from the pond area may speed recovery of the former pond area by providing more favorable conditions for native vegetation in the floodplain and fish in the stream (Lenhart 2000). The stability of the streambanks would be important to assess as well prior to dam removal. Erosion can be severe, depositing additional sediments into the stream and affecting water quality (Lenhart 2000). Streambank stabilization and grading may be necessary to prevent this. Our plan to work with partners to design the project with consideration of the risks noted above would minimize those effects on water quality.

Given that only one of the three dams would be removed under alternative B, hydrologic function would not be restored to the entire Peverly Brook drainage. However, the Service would develop a protocol for ongoing evaluation of Upper Peverly to determine if the pond should be maintained, dredged, or breached over the next 15 years. We would establish threshold or trigger levels that would inform management based on regional landscape context, contribution to Federal trust resource conservation, potential management implications and commitments, changes in visitor services, and long-term solutions to contaminant issues.

Greg Thompson/USFWS

Ferry Way Trail

Another concern with dam removal is that the potentially nutrient rich sediment in the former reservoir may represent prime habitat for quickly establishing invasive species (Stanley and Doyle 2003). We would minimize this by treating the site as warranted. Any potential risks to water quality from treatment of aquatic invasive plants would be mitigated by using only herbicides approved by the regional contaminants coordinator and only in accordance with approved rate and timing of application. In addition, we envision long-term benefits to hydrologic function through invasive plant removal Other water quality impacts from dam removal would be minimized by adhering to a project design and an implementation plan developed in partnership with State and Federal agencies, and other experts. As recommended by Lenhart (2000), we predict our focus in the few years post dam removal would be on ensuring stream banks are stable, and controlling undesirable vegetation.

We anticipate a 10 percent increase in visitation from expanded interpretive programs and a modest expansion of the trail network. We would open a portion of the restored former Weapons Storage Area, linking it to the Ferry Way Trail. In addition, we would add another overlook of Great Bay off the Ferry Way Trail and also add an overlook on Fabyan Point, once access issues there are resolved. All of these trails would remain open to foot traffic only, minimizing potential water impacts associated with wheeled or motorized vehicles. Trail maintenance and up to 1 mile of new trail construction activities would increase the potential for sedimentation and turbidity in streams and wetlands if erosion occurs from exposed soils. Because these activities may occur in proximity to shorelines and wetlands, we would adhere to best management practices during

trail construction and for long-term trail stewardship. For example, proper site preparation and use of standard mitigation practices, such as silt fences, would be implemented and further limit any potential for impacts.

We do not predict any major water quality impacts from the construction of a new headquarters/visitor contact station and maintenance facility. In planning and designing our new facilities, we would consider the potential effects on water quality and hydrology. There is the potential to create runoff of sediments through increased soil disturbance and removal of ground cover. We would design silt-fences and sediment traps, as warranted, to prevent runoff.

Impacts on Hydrologic Systems and Water Quality Under Alternative C
Benefits
Similar to alternative B, we would work more actively with partners to conserve ecologically significant lands around Great Bay and to restore and maintain oyster and eelgrass populations leading to improved water quality in the Great Bay Estuary.

Under alternative C, our emphasis would be on natural ecological processes. We would plan to remove all three impoundments –Upper Peverly Pond, Lower Peverly Pond, and Stubbs Pond. This alternative would offer the most complete restoration of hydrologic function in the Peverly Brook system. After the three dams are removed, the brook and associated riparian areas would be restored to native vegetation. We would rely on beaver and other aquatic organisms to continue to "modify" this drainage. The removal of those impoundments, as well as access roads and Weapons Storage Area infrastructure in the Peverly Brook system, would further restore hydrological flow and riparian vegetation, improve resiliency in the system, and result in improved water quality over the long term. We anticipate a reduced need for invasive plant control as edge habitat and disturbances would be minimal once the habitats revert to forests. Restoration of the Peverly Brook system should eliminate the invasive aquatic brittle waternymph, which prefers ponded open water.

Adverse Impacts
Compared to alternatives A and B, under alternative C there is greater potential for sediments and contaminants to enter Peverly Brook. Ultimately this could affect Herods Cove and the eelgrass and oyster beds in the Great Bay Estuary, because of the magnitude of soil disturbance associated with the removal of the three dams. Before removal, however, contaminated sediment and other water quality issues (such as invasive aquatic plants) would be remediated to the point that we do not feel it would jeopardize ecological and human health. We would work with State partners to establish acceptable thresholds which would need to be achieved prior to the dam removals. We anticipate short-term impacts to water quality during removal and restoration of the impoundments on Peverly Brook to be similar to those detailed under alternative B. These impacts would be offset by the long-term benefits to water quality and hydrologic function.

We would also continue to control invasive plant species. The use of herbicides would pose continued potential risks to water quality; however, we would use only herbicides approved by the regional contaminants coordinator and only at approved rates and timing.

In addition to the new trail segments proposed in alternative B, we would create a spur trail off the Upper Peverly Trail, paralleling Peverly Brook a short distance, then continuing along a refuge management road out to Woodman Point. Total trail construction would be less than 1 mile. We would use best management practices during trail construction and for long-term trail stewardship to minimize any potential impacts to water quality. Trails would

remain open to pedestrian traffic only. Any potential impacts to water quality from existing refuge management roads would be sharply reduced with the closure of many of these roads as we discontinue management of grasslands, shrublands, and impoundments. Roads to be closed include Nottingham Road, Lower Peverly, Stubbs Pond, and all roads in the former Weapons Storage Area.

Socioeconomic Resources Impacts

Impacts on Socioeconomic Resources that Would not vary by Alternative
National wildlife refuges provide economic value to local and regional economies in several ways. Direct infusion of funds into the local economy come from refuge purchases of goods and services, personal spending in the local community by refuge employees and visitors, and refuge revenue sharing payments. Refuges also provide nonmarket values (values for items not exchanged in established markets) such as maintaining species of conservation concern, preserving wetlands, educating future generations, providing enjoyment of natural habitats and wildlife for the public, and adding stability to the ecosystem (Carver and Caudill, 2007). Unfortunately, Great Bay Refuge has limited data on direct expenditures into the local economy, in part because the refuge was de-staffed in January 2008. We anticipate modest differences among the alternatives in terms of socioeconomic impacts based on estimates of refuge visitation. Regardless of which alternative we select, we would continue to pay refuge revenue sharing payments each year to the town of Newington. Numerous studies show that open space lands, such as refuges, contribute more in revenue that they require in expenditures (Auger 1996, American Farmland Trust 2010). In addition, conserved lands can stabilize or increase nearby or adjacent property values (Gies 2009). Therefore, maintaining Great Bay Refuge as conserved open space likely affords economic benefits to the surrounding community.

Karner Blue Butterfly Conservation Easement
The Service does not own the Karner blue butterfly easement in fee and therefore does not provide the city of Concord with refuge revenue sharing payments. In addition, there are no onsite staff and few visitors so there is minimal contribution to the regional economy through local expenditures. The permanent protection of this parcel may provide some of the same economic benefits as Great Bay Refuge to the surrounding community. However, due to the easement's small size and location, these benefits would be on a much reduced scale. Easement lands lie adjacent to an active airport, business park, and other industrial development, and are not in close proximity to residential areas.

Impacts on Socioeconomic Resources Under Alternative A
Benefits
Given the lack of current staffing at the refuge, our contributions are negligible to the local economy in terms of refuge staff jobs, income, expenditures, and purchase of goods and services for refuge activities.

Adverse Impacts
No adverse impacts are anticipated.

Karner Blue Butterfly Conservation Easement
We do not envision any additional benefits or adverse impacts under alternative A that were not already addressed above under impacts that would not vary by alternative.

Impacts on Socioeconomic Resources Under Alternative B
Benefits
Filling the four approved refuge staff positions would minimally increase benefits to the local economy in terms of jobs, income, and expenditures. We also anticipate an increase in the need for seasonal biological technicians and hiring local contractors to assist with building demolition, dam removal, and site restoration would provide additional income into the local economy.

Likewise, construction of a new refuge headquarters/visitor contact station and maintenance facility would provide short-term income to the local economy for labor, materials, and services.

The 2006 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation reported that people spent $560 million on wildlife-related recreation in New Hampshire in 2006 (USDOI and US DOC 2006). We predict enhancing refuge visitor services programs, particularly refuge trails and interpretive programs, would increase visitation by approximately 10 percent from current numbers. This would also likely provide an associated increase in visitor expenditures in the local economy. Although the majority of visitors to the refuge participate in wildlife watching, hiking, and snowshoeing, a small percentage also participate in hunting. The proposed expansion of hunting under alternative B, may also contribute to the local economy. This increase, however, would remain negligible in the context of the economies of the surrounding communities. Under alternative B, we would anticipate up to 42 additional hunters visiting the refuge annually (30 hunters during the fall archery deer hunt, and 12 during the turkey hunt). The 2006 National Survey reports that an individual hunter in New Hampshire spends $122 annually. These numbers are estimates and a more detailed hunt program description (including open areas, numbers of hunters, timing, etc.) would be forthcoming in a separate NEPA analysis and administrative process. Given our estimate of 42 additional hunters, the potential additional contribution to the local economy from the refuge's expanding the hunting program would be up to $5,124.

Greg Thompson/USFWS

Viewing wildlife on Ferry Way Trail

Adverse Impacts
No adverse impacts are anticipated.

Karner Blue Butterfly Conservation Easement
Under alternative B, we would improve the existing self-guided interpretive trail and create a more informative kiosk. We anticipate a slight increase in visitation as a result of these improvements. We predict that visitors to the easement would have a higher quality outdoor experience and gain a greater appreciation of the habitat and its inhabitants. The creation of a pine barrens brochure and improved information on the refuge Web site would make the easement available to a wider audience. Expanded cooperative law enforcement between NHFG and the Service would further improve the quality of visitor experiences by enhancing safety and minimizing unauthorized uses that could damage the ecology of the site.

Impacts on Socioeconomic Resources Under Alternative C
Benefits
Under alternative C, we anticipate an increase in visitation by up to 12 percent a year given the increase in public programs and expanded trail access. This would lead to an associated increase in visitor expenditures in the local economy. There would also be a slight increase in short term contract work associated with the proposed restoration projects (impoundments, removing roads, etc.). Again, we anticipate that the expansion of hunting proposed under alternative C would also contribute a negligible amount of money to the local economy because of hunter-related expenditures. Under alternative C, we would anticipate up to 300 additional hunters visiting the refuge annually (up to 100 hunters during

the fall archery deer hunt, up to 200 during turkey hunt(s) [up to 100 in a spring turkey hunt and up to 100 in a fall hunt]). As mentioned under alternative B, the 2006 National Survey reports that an individual hunter in New Hampshire spends $122 annually. Based on our estimate of 300 additional hunters, the potential contribution to the local economy from the refuge's expanded hunt would be $36,600. Again, more detailed description of the hunt program would be forthcoming, along with a separate NEPA analysis.

Adverse Impacts
No adverse impacts are anticipated.

Karner Blue Butterfly Conservation Easement
The impacts under alternative C would be the same as those under alternative B.

Refuge-specific Impacts

Soils Impacts

Impacts on Soils that Would not vary by Alternative
Soil is composed of small particles of chemically weathered rock, decaying organic matter, gases, water, and living organisms. The soil layer is one of the most active sites of energy exchange, and it plays a critical role in ecosystem processes such as the carbon, nitrogen, and oxygen cycles. Healthy soils are critical to nutrient cycling and plant productivity on the refuge and must be protected to sustain the variety of wetland, riparian, and upland habitats. Conversion from natural land cover to a developed use with impervious surfaces is predicted to have the most severe impacts to soils. Under all alternatives, we would strive for the greatest amount of natural cover and the least amount of impervious surface.

Less intense uses, such as hiking, can also degrade soil qualities. Trails and roads by design are typically barren and compacted, so some loss of productivity is expected with such infrastructure. All wheeled vehicles, motorized or otherwise, which have the potential to cause severe erosion and rutting, are not allowed on the refuge. Camping and fires are also not allowed on the refuge. Regardless of which alternative is selected, we would continue to use best management practices in all management activities to maintain the health and productivity of refuge soils and to minimize erosion, compaction, and other impacts.

Overall, Great Bay Refuge's soils are productive and in relatively good condition. The refuge is also relatively flat, which reduces the risk of soil erosion. However, some erosion and contaminated sediments are associated with the Peverly Brook system. This is likely the result of past land uses, particularly the former Air Force Base. Our proposed actions to restore the productivity and integrity of these soils vary by alternative.

All of the alternatives propose using integrated pest management (IPM) to control invasive species. The IPM approach combines mechanical, manual, biological, and chemical controls. Mechanical and chemical controls have the greatest potential to affect soils. Mechanical methods that disturb the soil, such as hand pulling or digging, would only be used if we determine that soil disturbance would be minimal and the potential for recolonization by invasive species is low. The advantage of chemical controls is that they are often the most effective, particularly when treating large areas or an established site. The disadvantages are that the chemicals may affect non-target species at the site and may contaminate soils and surface or groundwater. We would take all appropriate

steps when applying herbicide including use of minimum effective dosage, using application methods that minimize non-target effects, applying during optimal growth stage for effectiveness, and adhering to licensing requirements and other regulations. Again, we would only use herbicides approved by the regional contaminants coordinator and only in accordance with approved rate and timing of application.

Prescribed fires help reduce fuel loads and thereby prevent excessively hot fires that could damage soils. Also, prescribed fires provide benefits by releasing nutrients stored in plant materials back into the soil, off-setting any short-term adverse impacts to the soils immediately following a burn. Soil damage from fires, or from erosion on fire-damaged sites, is unlikely to occur on the refuge because of the rarity of wild fires and due to the relatively flat topography of the area.

Karner Blue Butterfly Conservation Easement
Similar to Great Bay Refuge, prescribed fires at the Karner blue butterfly easement would reduce fuel loads and prevent excessively hot fires that could damage soils. The easement is within the pine barrens ecosystem, which is a fire-dependent system. Therefore, fire is a necessary and beneficial disturbance. However, given the small size and proximity to development of the easement, all wildfires on it would be suppressed to avoid risk to adjacent properties. We would develop a prescribed burn plan that would minimize any other potential adverse impacts to soils. No new trails are proposed that would further compact soils or cause erosion.

Impacts on Soils Under Alternative A
Benefits
The greatest benefit to soils under alternative A would be the ongoing work of GBRPP, which the refuge is a member of, to conserve additional ecologically significant lands around Great Bay, thus maintaining more lands in natural cover and controlling the amount of impervious surfaces which degrades soil properties. Alternative A includes no expansion of the trail network that would cause additional soil compaction. The ongoing removal of existing infrastructure and impervious surface in the former Weapons Storage Area would provide some modest benefits to soils.

Adverse Impacts
Alternative A offers limited ability to address existing sediment contamination in the Peverly Brook system, particularly in Upper Peverly Pond. The lack of staffing provides insufficient capability for sampling and remediation of poor soil and water quality conditions. In addition, the existing Lower Peverly Pond impoundment infrastructure is failing, eroding, causing downstream sedimentation, and other adverse impacts to soils. There are no plans for removal and restoration or stabilization of this failing structure under current management. Alternative A would maintain the existing management road network and proposes a much slower pace for removing buildings in the former Weapons Storage Area and elsewhere, as well as for restoring the soils and natural vegetation to these sites.

The use of prescribed fire and mowing to maintain grasslands and shrublands would have the potential to cause some soil compaction through use of heavy equipment.

Karner Blue Butterfly Conservation Easement
We do not envision any additional benefits or adverse impacts under alternative A that were not already addressed above under impacts that would not vary by alternative.

Impacts on Soils Under Alternative B

Benefits

The removal of the Lower Peverly Pond impoundment infrastructure and its restoration to stream habitat would improve soil conditions by eliminating the existing soil erosion and sedimentation input occurring in the vicinity of the deteriorating dike. We anticipate a greater ability to address existing and potential sediment contamination in the Peverly Brook system through monitoring and remediation, where feasible, and greater ability to manage remaining infrastructure to prevent erosion, the creation of gullies, and other adverse soil impacts.

Conversion of paved road to gravel, or other more permeable surface, in the stretch past the residence (toward the Margeson Estate) and removal and restoration on approximately 7 acres of unnecessary buildings in the former Weapons Storage Area and at Fabyan Point would benefit long-term soil conditions.

Adverse Impacts

Soil displacement and loss would result from construction of the proposed new headquarters/visitor contact station and maintenance facility and from removing unnecessary buildings and restoring those sites to native vegetation. Soil impacts resulting from building construction and/or removal would be partially offset by locating the new buildings in an area that is already disturbed as part of the former Weapons Storage Area footprint. Site selection for the building would include consideration of subsurface water, geology, water quality and quantity, and compatible soils, along with other necessary surveys to assure proper location of the facility and to minimize the impacts to refuge resources. Best management practices would be used to minimize impacts to soils from new construction and/or building removal, but there may be localized compaction and some erosion losses while work is being done on the site. While some permanent loss of soil productivity would occur, seeding with native grasses and other protective native vegetation would be used to return open areas of the site to a vegetated status as soon as practicable to protect soils. We would obtain all required Federal, State, and local permits applicable for constructing and/or removing buildings on refuge lands before activities begin.

The design of new and improved trails and associated infrastructure (e.g., information kiosks) to enhance visitor experiences and other infrastructure would include consideration of the potential to effect soils. The projected 10 percent increase in annual visitation (resulting in approximately 33,000 visitors total per year) might result in increased trampling and soil compaction along trails and around visitor facilities. Some compaction may also result from construction. We would also increase monitoring of intensive public use areas, reducing the potential for long-term impacts from unauthorized access. In addition, outreach, education, and enforcement on site would increase once proposed new staff is in place.

The expansion of the deer hunting season in the fall and the addition of a turkey season could also lead to a small increase in soil compaction in off-trail areas frequented by hunters. This is partially off-set by the nature of hunting, which is typically dispersed; and often hunters are either in a treestand or moving somewhat randomly through upland areas. Additionally, only a small number of visitors to the refuge would be engaged in hunting (hunters account for fewer than 90 visits to the refuge annually; 0.3 percent of an estimated visitation of 33,000), so we predict the amount of off-trail soil compaction would be negligible.

In our discussion under water quality, under alternative B we describe some soils impacts associated with the proposed removal of Lower Peverly Pond Dam. One

primary soils concern would materialize if stream banks become unstable once the dam is removed and a higher intensity flow is more established. However, we would prioritize establishing native riparian vegetation, and grading of banks as warranted, to minimize this concern.

Similar to alternative A, the use of prescribed fire and mowing to maintain grasslands and shrublands has the potential to cause some soil compaction through use of heavy equipment. However, annual burn plans and management prescriptions would be designed to ensure risk is negligible.

Karner Blue Butterfly Conservation Easement
In addition to the impacts outline under alternative A, the construction of a proposed kiosk at the east end of the interpretive trail would cause short-term, localized minor soil disturbance on less than 100 square feet in an area already impacted (adjacent to trail and parking area). This would also be off-set by the enhanced visitor interpretation provided on the kiosk, raising awareness about the ecology of the Karner blue butterfly and pine barrens habitat.

NHFG, who coordinates management on the easement, is shifting from planting lupine seedlings to seeding lupine. Sowing seeds would reduce the overall amount of soil disturbance compared to that required when planting seedlings. This would reduce impacts to soil condition and minimize disturbances to cultural resources.

Impacts on Soils Under Alternative C
Benefits
Under alternative C, the long-term benefits to soils would exceed those of alternatives A and B. We would remove all three impoundments and restore those areas to stream habitat and native vegetation. We would also eliminate grassland and shrubland management. Additionally, we would remove all remaining structures and unnecessary management access roads, and then restore these sites to natural conditions. In the long term, restoring native habitats and natural communities throughout the refuge would help restore and maintain soil health.

Adverse Impacts
Similar to alternative B, soil displacement and loss would result from the construction of the proposed new headquarters/visitor contact station and maintenance facility. We would partially offset impacts to soils by locating the building in an already disturbed area.

As in alternative B, there would still be some localized increase in soil impacts where public access and use occurs. The existing 2.5-mile trail network would be expanded to include up to an additional 1 mile of trail. All trails would remain open to pedestrian traffic only, thus minimizing potential impacts from wheeled or motorized vehicles. We would design our outreach, education, and monitoring programs to reduce risk to soils from the proposed new trails, of which only about 0.2 miles would not use existing roads. In addition, we would close and restore several miles of existing refuge management roads. We anticipate the potential for soil compaction to be slightly higher under alternative C from the proposed expansions to the hunting program and opening more areas of the refuge to hunters. However, we anticipate the number of hunters annually visiting the refuge would still remain a relatively small proportion (less than 1 percent) of overall visitation.

Karner Blue Butterfly Conservation Easement
Same as alternative B.

Vegetation Impacts

Impacts on Vegetation that Would not vary by Alternative

Benefits

Under all the alternatives, we would continue to map, monitor, prioritize, and controls invasive plant species across all habitat types. This would benefit all native vegetation. Alternatives B and C would realize greater invasive plant control given increased staffing of the refuge. Managing the deer population through a fall deer hunt offers benefits to vegetation, as heavy deer browsing can suppress natural regeneration and promote invasive plants. We would also continue to work with NHFG to control the nonnative mute swan, which are known to negatively impact native wetland plants important to waterfowl. We would continue to prohibit collecting of any vegetation by the public on the refuge, ensuring protection of all native plant materials.

Given the history of land use prior to the establishment of Great Bay Refuge, our management activities have helped previously disturbed areas recover. By maintaining most of the refuge in natural cover, we are able to maintain native vegetation through a combination of active and passive management. Vegetation in the forested wetlands and much of the upland forest is passively managed by natural processes.

Adverse Impacts

Refuge administrative activities and public uses on the refuge create some localized adverse impacts to vegetation. The presence of the trails and public visitation can introduce invasive plants to adjacent habitat, by up to 330 feet. Restricting public access on the trail network to foot traffic only helps limit potential adverse impacts to surrounding vegetation that might result from allowing bicycles or motorized vehicles. In addition, the boardwalk on the Upper Peverly Trail, refuge signs, and refuge outreach and education programs, require visitors to stay on the trail to minimize disturbance to wildlife and surrounding vegetation.

Some refuge management and restoration projects, including invasive species control, would have short-term negative impacts on vegetation, such as removal of plants, herbicide use, trampling and other damage to the plants structure. These would be off-set by providing long-term benefits to the diversity and health of the refuge's native plant communities.

Karner Blue Butterfly Conservation Easement

The goal of our vegetation management at the easement is to restore and maintain pine barrens habitat that supports wild lupine, the plant required by Karner blue butterfly larvae. We would accomplish this, in partnership with NHFG and others, by planting lupine and using prescribed fire and mechanical tools to maintain pine barrens conditions. Our use of prescribed fire is designed to mimic natural fire disturbances since pine barrens is a fire-dependent habitat type. These tools would create short-term negative impacts to vegetation, but provide long-term benefits to the diversity and health of the refuge's native plant communities. We would control invasive plants using a range of chemical, biological, and mechanical methods to further benefit native vegetation.

Impacts on Vegetation Under Alternative A

Benefits

Limited public access to the refuge provides overall benefits to vegetation. Salt marsh vegetation would also continue to benefit from invasive plant monitoring and control. Grassland and shrubland vegetation would continue to be actively managed through use of prescribed burning, mowing, or cutting. The ongoing removal of buildings and impervious surfaces in the former Weapons Storage Area would greatly increase the amount of grassland in that unit. The abundance

Greg Thompson/USFWS

Beaver pond on the refuge

and distribution of wetland vegetation varies from year-to-year based on our adaptive management strategies to control the ratio of open water to emergent vegetation and to control invasive aquatic plants.

Adverse Impacts
Given the lack of staff at the refuge under alternative A, we would not able to implement our biological objectives as effectively as under alternatives B and C. We would not be able to expand our invasive plant control program.

Impacts on Vegetation Under Alternative B
Benefits
Benefits to salt marsh vegetation would be slightly higher than under alternative A due to greater visitor education about sensitivity of salt marsh communities, enhanced monitoring of sea level rise, and establishing baseline conditions of salt marsh health. Under alternative B, the amount of grassland habitat would decrease, while the amount of shrubland and forest would increase. The increase in the shrubland and forest habitat is based on the proposal to allow small (less than 3 acres) isolated patches of grassland and shrubland habitat to naturally revert to mature forest, which is expected to take at least 50 years. Over the next 15 years, however, we anticipate that the grassland patches would only succeed to a shrubland-type and existing shrubland would only succeed to a sapling-pole stand (2 to 12 inches diameter at breast height).

Similar to alternative A, the abundance and distribution of wetland vegetation would vary from year-to-year based on our adaptive management strategies to control the ratio of open water to emergent vegetation (approximately 50 percent of each) and to control invasive aquatic plants. With the refuge staff under alternative B, we anticipate greater monitoring of vegetation responses to our management actions, providing better data to guide our management decisions. Riparian vegetation would be restored along a 1,100 foot section of Peverly Brook, once the Lower Peverly Pond Dam is removed. We would also monitor the pine plantations to determine if they are reverting to natural forest community types

on their own, and implement management strategies as needed. We would restore approximately 30 acres of buildings, roads, and fencing associated with the former Weapons Storage Area to native grassland or shrubland.

Adverse Impacts
The modest expansion of the trail network (less than 1 mile), and the proposed expansion of the hunting program, would potentially have negligible adverse impacts on vegetation. Minimal vegetation loss would also result from construction of the proposed new headquarters/visitor contact station and maintenance facility since the buildings are located in the existing disturbed and hardened former Weapons Storage Area. The footprint of the new refuge facilities, including parking, would amount to approximately 1.1 acre. Similar to the discussion under soil impacts, the proposed trail and hunting expansions would potentially result in a negligible increase in the trampling of vegetation throughout the refuge. The opportunity for hunters and other visitors to serve as vectors for invasive plant seeds or other propagules would also be greater under alternative B, compared to alternative A. According to NHFG, the deer population along the New Hampshire coast is high and there is the potential for deer to over-browse native vegetation. Reducing the deer population would alleviate this potential for overbrowsing.

Impacts on Vegetation Under Alternative C
Benefits
Alternative C restores more refuge area to native habitats than alternatives A and B. In addition to the strategies in alternatives A and B, under alternative C, we would restore estuarine habitats, including salt marsh, to Stubbs Pond once the impoundment infrastructure is removed. Approximately 44 acres of tidal salt marsh would be targeted for restoration. Native riparian vegetation would be restored to the entire 1.5 mile Peverly Brook drainage once all the impoundments are removed.

Forest vegetation would benefit the most under this alternative as areas of grass and shrub are allowed to succeed naturally to forest over time. The increase in the shrubland and forest habitat is based on the proposal to allow all of the refuge's grassland and shrubland habitat to naturally revert to mature forest, which is expected to take at least 50 years. Over the next 15 years, however, we anticipate that the grassland patches would only succeed to a shrubland-type and existing shrubland would only succeed to a sapling-pole stand (2 to 12 inches diameter at breast height). The emphasis would be on maintaining native forest types based on site capabilities, which includes considering soil type and water availability. With the reduction in access roads and edge habitat, we would expect a significant reduction in the introduction of invasive plants that are transported by equipment, vehicles, and people. The reduced need for invasive plant control would also minimize the short-term adverse effects of intensive invasive plant management. Establishing native forest and salt marsh vegetation allows the ecosystem to be more resilient to threats from climate change, pests, and pathogens.

Adverse Impacts
Under alternative C, we would discontinue our management of shrublands and grasslands, and allow these habitats to naturally succeed to forest thereby reducing vegetative diversity on the refuge. The only shrubland and grassland habitat on the refuge would be patches created and maintained by natural disturbances.

The expanded public use trails and hunting seasons under alternative C would cause greater impacts to vegetation, such as visitors and hunters trampling vegetation adjacent to and off-trails and serving as vectors for invasive plant

species. We predict these impacts would be negligible due to the relatively small number of hunters on the refuge and the fact that the majority of people stay on designated trail based on our observations. The new trail sections (less than 1 mile) are in areas already disturbed and would require minimal manipulation of native vegetation.

Migratory Bird Impacts

Impacts on Migratory Birds that Would not vary by Alternative

Benefits

There are no federally listed bird species on the refuge. However, there are many bird species of conservation concern as identified in various State and regional plans that occur on the refuge. The complete list is included as Appendix A, "Species and Habitats of Concern at Great Bay National Wildlife Refuge." The Service is committed to protecting and managing for migratory birds under all the alternatives; however, the benefits to landbirds, waterfowl, waterbirds, and shorebirds vary under each alternative based on the proportion of different habitat types and the management strategies employed to maintain those habitats.

Under all alternatives, we would protect the refuge's 2 acres of rocky shoreline habitat by limiting public access. Woodman Point, overlooking a portion of the shoreline, is an important roost site for bald eagles wintering on Great Bay. We would continue to monitor the wintering and potential nesting bald eagle population on and around the refuge. The new active nest site on Fabyan Point, in a closed area, would also be monitored and protected from disturbance. In addition, we would evaluate the importance of Nannie Island and surrounding waters to migratory birds and other Service trust resources to determine if the island should remain closed to public access or open for recreation or education purposes.

Under all the alternatives, we would continue to monitor and control invasive plant species such as purple loosestrife, *Phragmites*, brittle waternymph, autumn olive, nonnative honeysuckles, glossy buckthorn, among others. Controlling nonnative plants and allowing native plants to thrive, regardless of habitat type, would improve the quality of food resources and cover for all migratory birds. A growing body of research has indicated negative impacts to migratory birds from replacement of native plants by invasive species, including increased predation (Schmidt and Whelan 1999), reduced insect populations (Conover et al. 2010), and lower quality berries.

Adverse Impacts

We expect some disturbance to breeding and migrating birds from trail maintenance, herbicides and other invasive plant control methods, prescribed fire, mowing, and other management activities. Most adverse impacts are expected to be indirect and short-term, such as temporary reduction of cover and food resources. These impacts would be mainly limited to shrub habitats, as grassland plant community would recover within a growing season and invasive treatment in forested habitats would be targeted to understory species only. As discussed in the soil and water quality sections, the types of chemicals used on the refuge are expected to have a minimal effect on fish and wildlife species. We would apply herbicides only if other methods are shown to be ineffective. Only herbicides approved by the regional contaminants coordinator would be used, and only in accordance with approved rate and timing of application. We would apply herbicides using best management practices.

Some disturbance to breeding birds is likely from public use of the refuge. However, access would continue to be confined to only 2.5 miles of trails. The most sensitive nesting areas, including grasslands, salt marsh, and Stubbs Pond, would continue to be closed to the public.

Karner Blue Butterfly Conservation Easement
The restoration and maintenance of the pine barrens ecosystem on the easement would potentially support a suite of migratory birds that are declining due to habitat loss, including common nighthawk, whip-poor-will, eastern towhee, field sparrow, and prairie warbler. However, given the small size of the easement, it is unlikely to support any significant numbers of individuals of these species. We do not anticipate any management activities would have an adverse impact on any of these birds as management occurs outside of the breeding season when adults and young are mobile. There are likely to be short-term, localized, temporary disturbances during habitat management activities for the Karner blue butterfly, but we would not expect these activities to have an impact on local bird populations.

Impacts on Migratory Birds Under Alternative A
Benefits
Maintaining the three existing impoundments—Upper Peverly, Lower Peverly, and Stubbs Pond—would continue to provide habitat for a mix of open water, emergent marsh, and scrub-shrub wetland birds. According to NHFG, Stubbs Pond is unique within the Great Bay Estuary system, given its relatively large size (44 acres of freshwater wetland) and diverse emergent vegetation community. There are no other sites in coastal New Hampshire that support the amount or diversity of waterfowl documented at Stubbs Pond, particularly during the spring and fall migrations. A few shorebirds also use the refuge as stopover habitat during migration.

Grassland and shrubland dependent birds would continue to benefit from the management of 169 acres of grasslands and 26 acres of shrubland habitat. Forest birds of conservation concern, such as scarlet tanager and wood thrush, would benefit from the conservation of 659 acres of forested habitat on the refuge.

Adverse Impacts
Under alternative A, active refuge habitat management would focus on grassland, shrubland, and freshwater wetland habitats. As such, there would be less emphasis on managing and monitoring habitats for forest- and salt marsh-dependent bird species. The continued management for a mosaic of different habitat patches, and maintenance of the current trail and access road system under this alternative, would have an adverse impact on interior forest and interior grassland birds. Road and edge habitat increase predation, parasitism by brown-headed cowbirds, and facilitate invasive plant colonization. Use of trails and access roads cause repeated disturbance to wildlife, reducing quality of habitat for breeding and migratory stopover. Although we would continue to employ prescribed fire and mowing to manage grasslands and mechanized equipment for shrub management under alternative A, we would lack the staff to assess and monitor the structural characteristics of these habitats and to modify our management accordingly. Hence there would be less capacity to practice adaptive management if our wildlife objectives are not met.

Impacts on Migratory Birds Under Alternative B
Benefits
Benefits to grassland birds (with a focus on upland sandpipers) would increase through more intensive management of fewer grasslands. We would remove hedgerows, fencing, and structures in the Weapons Storage Area to enlarge individual grassland sites, and would implement best management practices for managing the fields. Increased staffing under alternative B would give the refuge a greater opportunity to employ adaptive management based on our ability to measure vegetative responses to our management and by monitoring year-to-year bird responses to habitat conditions. Due to consolidation of habitats, there would be a reduction of forest and grassland edge habitat, resulting in a slight benefit to interior forest and grassland migratory birds.

The salt marsh sparrow population on the refuge and around Great Bay would benefit from a greater focus on the health of the refuge's salt marsh habitat. The emphasis on invasive plant removal and maintaining native shrubs would benefit migratory birds, by providing a more nutritional native fruit and insect supply.

The amount of managed shrubland would increase by 33 acres under alternative B. These shrubland acres would be managed more actively for native plant diversity, dense cover, and biological integrity and health. This more active management would benefit shrubland birds and potentially the New England cottontail.

Adverse Impacts
The removal of the deteriorating Lower Peverly Pond Dam would have limited negative impact on birds, since few birds use this impoundment, as compared to Upper Peverly and Stubbs Ponds. Restoration of this section of Peverly Brook should enhance conditions for riparian birds, waterfowl, and waterbirds as native vegetation develops. Benefits to birds foraging in Stubbs Pond would be enhanced by removing a source of erosion and sedimentation that affects downstream water quality. Shrub habitat under alternative B would be consolidated and managed more actively for native plant diversity, dense cover, and biological integrity and health, resulting in improved benefits to shrubland birds and potentially New England cottontail. The proposed wild turkey hunt has the potential to disturb nesting birds. We would attempt to minimize such disturbance by establishing hunting zones and identifying excluded areas.

Impacts on Migratory Birds Under Alternative C
Benefits
Under alternative C, there would be a moderate increase in benefits for forest dependent birds as grassland and shrubland habitats are allowed to succeed naturally to forest. An additional 193 acres of forest would be managed over the existing 659 acres resulting in an increase in the quantity and quality of interior forested habitat on the refuge, with reduced edge effects and fragmentation.

The removal of Stubbs Pond impoundment and its restoration could result in an additional 44 acres of estuarine habitats including salt marsh. This would provide a significant benefit to species dependent on these habitats, including the salt marsh sparrow. Similar to alternative B, a greater focus on salt marsh habitats and the salt marsh sparrow populations around Great Bay would further benefit this species.

Adverse Impacts
Grassland and shrub dependent birds would be adversely affected, more so than under alternatives A and B, as these habitats would not maintained through active management. We anticipate that the 169 acres of grasslands and the 26 acres of shrubland would succeed to forest over time, and the species associated with these habitats—especially the area dependent upland sandpiper—would decline and eventually disappear from the refuge. This would potentially occur within the 15-year timeframe of the CCP.

With the removal of all the impoundment infrastructure, we anticipate a decline in open water and freshwater marsh birds on the refuge, such as waterfowl, herons, marsh wrens, and rails, and an increase in salt marsh dependent species, such as salt marsh sparrow, and possibly scrub-shrub (riparian and wetland edge) bird species. The loss of this open water habitat would have a major regional impact on freshwater birds. According to NHFG, Stubbs Pond is unique within the Great Bay Estuary system, given its large size (44 acres of freshwater wetland) and established population of wild rice. There are no other places in coastal New Hampshire that draw in the amount and diversity of waterfowl documented at Stubbs Pond, especially mallards and black ducks during

spring and fall migration (Ed Robinson, Waterfowl Biologist, NHFG, personal communication).

The potential impacts from a proposed turkey hunt are similar to alternative B, although with fewer areas excluded from hunting under alternative C, the impacts to migratory birds are likely to be higher.

Fish Impacts

Impacts on Fish that Would not vary by Alternative

Benefits

There are no federally listed fish species known to occur on the refuge. However, the refuge works with the Service's Fisheries Program to maintain self-sustaining, healthy populations of migratory fish. At Great Bay Refuge these species include American eel, alewife, and blueback herring. In addition to maintaining fish passage, where feasible, refuge management supports other Fisheries Program goals, including protecting the health of aquatic habitats. We would continue to work with our partners at the abutting the Tradeport to prevent any accidental spills from airport operations that might harm water quality and fisheries on the refuge.

Adverse Impacts

We would continue to be concerned about fish health due to contaminated sediments within the Peverly Brook system, specifically within Upper Peverly Pond. The sediments are routinely sampled and the trend indicates that the level of contaminants in the sediment is declining over time (see appendix I). However, the levels remain a concern. The Service would continue to monitor the sediments and water quality within the Peverly Brook system to work toward improved health of the water quality for fisheries and other aquatic organisms. An American Rivers (2002) report cautions that removing a dam where contamination is a concern can have a negative effect on the stream community. They state that in some cases, dams create a useful barrier between fish populations up- and downstream of a dam because it may prevent contaminated populations from migrating. Additionally, they state that dams can prevent the establishment of invasive species either above or below the structure. Overall, it is important to keep in mind the context of our project area. Peverly Brook is a relatively short drainage (approximately 1.5 miles) and has minimal spawning habitat due to the steep topography adjacent to the brook. Therefore, refuge lands would never be a major contributor to migratory fish populations in the bay.

Duane Raver/USFWS

American eel

Karner Blue Butterfly Conservation Easement
There are no fish species on the Karner Blue buttefly easement.

Impacts on Fish Under Alternative A
Benefits
Migratory fish, including alewife, American eel, and blueback herring coming into Great Bay, continue to use the fish passage into Stubbs Pond, although the effectiveness of the fish ladder is not entirely known. American eels are able to migrate furthest up Peverly Brook to Upper Peverly Pond. The deep pools in Upper and Lower Peverly Ponds serve as coldwater refugia for eels in summer. We would continue to monitor fish population and fish passages under alternative A. However, this monitoring would continue to be sporadic and occur when staffing and resources allow.

Adverse Impacts
The adverse impacts on fisheries would be similar to those described under adverse impacts on "Hydrological Systems and Water Quality under Alternative A."

Impacts on Fish Under Alternative B
Benefits
Under alternative B, we would evaluate the effectiveness of the Stubbs Pond fish passage to ensure it maximizes benefits to migratory fish. We would anticipate long-term benefits to fish from routine sediment and water quality sampling in the Peverly Brook system. We would respond responding to any concerns identified by this sampling, including the remediation of contaminated sediments, where that can feasibly occur. Other indirect benefits include the reduction of impervious surface as we continue to remove facilities in the former Weapons Storage Area.

The proposed removal of Lower Peverly Brook Dam would eliminate one barrier to fish passage and would enhance and restore habitat for riverine and cold water fish along approximately 1,100 feet of brook. We would expect reestablishment of other aquatic riverine species that occur up and downstream of this section of brook to occur within a relatively short timeframe. While we would not expect major changes in fish population sizes of migratory species that already occur in Peverly Brook following dam removal, we would expect fish species already known for the area to move into formerly inaccessible reaches (Stanley and Doyle 2003). The removal of impoundment infrastructure would be preceded by sediment, water quality, and invasive plant sampling, the installation of sediment controls and barriers, and remediation as feasible.

Adverse Impacts
The removal of the Lower Peverly Pond Dam is the only proposed refuge management activity that would have a direct impact on the fisheries resource and the result is expected to be mixed. In general, warm water fish species would decline dramatically due to the loss of ponded water, although there would be potential benefits to cold water riverine fish. This impact is likely to be permanent to warm water fisheries and warm water aquatic macroinvertebrates in the pond location. According to Stanley and Doyle (2003), "Riverine species should increase at the expense of reservoir taxa…Organisms present in the reservoir prior to removal may be washed downstream or stranded during surface water drawdown." In their studies of small dam removals in Wisconsin, these authors observed that fish and macroinvertebrates adapted to slow moving water and silty sediments gave way to riverine taxa within a year of removal. The recovery of riverine aquatic taxa reflected both recolonization of individuals that had previously resided upstream or downstream from the dam and successful reproduction within the newly created habitat. This recovery may be somewhat

limited in our management situation since the vicinity of Upper Peverly Pond precludes upstream riverine restoration as does the decision not to remove Stubbs Pond. On the other hand, beaver are very active in the area, and are creating ponded waters that would provide additional habitat for fish and aquatic macroinvertebrates.

The timing, duration, size, and amount of sediment release are the factors most likely to directly affect fish and other aquatic organisms downstream in the short term. These impacts are poorly understood and recovery rates are difficult to predict (Thomson et al. 2005). Generally, as reported by Thomson et al. (2005), the expectation is that downstream sediment deposition would continue until a relatively stable channel and floodplain have been developed above the former dam, after which particle sizes in downstream reaches would gradually increase as excess sediment decays (Pizzuto 2002)." In summarizing studies on small Wisconsin dam removal projects, Thomson et al. (2005) discuss that even severely depleted benthic communities often recover rapidly once sediments are flushed from the system. They report that other authors suggest that small dam removals are unlikely to have long-term negative impacts on downstream benthic communities as long as highly vulnerable species are not present. We would expect that fish and macroinvertebrate diversity and populations downstream would recover rapidly, and would be largely unaffected over the long term in our project area. Our assessment is primarily due to the small size of the area affected and the sediment controls we would put in place to minimize extreme flushing and depositions.

We anticipate that the long-term benefits associated with restoration of a stream corridor, including that area which was impounded, would outweigh the relatively short-term ecological impacts of downstream sedimentation following removal (Thomson et al. 2005).

Impacts on Fish Under Alternative C

Benefits

The removal of all impoundment infrastructures in the Peverly Brook system would provide the maximum benefit to fish passage compared to alternatives A and B. The restoration of the entire 1.5 mile Peverly Brook would be expected to enhance passage for American eel. An American Rivers report (2002) emphasizes that when the goal is promoting fish migration and passage, it is important to consider restoration of the entire system, and not fragmented pieces. Other benefits to fish and aquatic resources are identified under alternative B.

Adverse Impacts

In addition to those adverse impacts identified in alternative B, fully restoring the Peverly Brook system would potentially contribute contaminants to Herods Cove and Nannie Island, which hosts more than half the bay's oyster population. The refuge would continue to monitor contaminants in Upper Peverly and only restore after contaminants are mitigated. However, restoration may expose contaminants that are otherwise buried. A restored hydrological connection to the bay would also increase the potential for future contaminants from airport operations (e.g., the de-icing pad located at the head of the Peverly drainage) to reach eelgrass beds. In the short term, the removal of Stubbs Pond dam would dramatically reduce the existing spawning habitat for alewife, which prefer flooded pool habitat. However, over the long term, the removal of the dam and ladder would likely enhance passage for alewife. Furthermore, some alewife spawning habitat may be restored through beaver-created ponds, but it is difficult to predict where and when this might occur.

Federally Threatened and Endangered Species Impacts

Impacts on Federally Threatened and Endangered Species that Would not vary by Alternative

Karner Blue Butterfly

By 2003, no native populations of the federally listed endangered Karner blue butterfly remained in New England. The last native population occurred in the Concord pine barrens in Concord, New Hampshire, and was extirpated in 2000. This population lived in a powerline right-of-way and in the grassy median strips at the Concord Airport. It declined from an estimated 3,700 butterflies in 1983, to 219 butterflies in 1991, and finally to less than 50 in 1994 (Peteroy 1998). A reintroduction program was started in 2001 at Concord with the donor population from the Saratoga Airport in New York. The State of New Hampshire has since successfully reintroduced the butterfly into the wild. For 5 years in a row (2005 to 2009), NHFG biologists have documented Karner blue butterflies surviving on their own in the wild at the Concord pine barrens (Holman 2010 personal communication). The Karner blue butterfly conservation easement, administered by the Great Bay Refuge, is central to this success.

In addition to the federally listed Karner blue butterfly, the Concord pine barrens, including the Karner blue butterfly easement, support other State-listed rare species: frosted elfin butterfly, Persius duskywing skipper, and wild lupine. The Service, along with its state partners, are implementing the Karner blue butterfly recovery plan (USFWS 2003), with the long-range goal to remove the species from the Federal list of endangered and threatened wildlife and plants.

New England Cottontail

The Great Bay Refuge is within the historic range of the New England cottontail, a species that is being considered for Federal listing due to population declines. This is New England's only native rabbit. It is dependent on early successional habitat such as old fields, shrub thickets, young generating forests, and other shrubby areas. Habitat loss is one of the primary causes of the population decline, caused by widespread clearcutting for agriculture in the 1800s, followed by natural succession to forest in the late 1900s. Another major factor in the cottontail's population decline was the introduction of eastern cottontail (a Mid-Atlantic species) for recreational hunting in the mid 1900s, as the agricultural lands were being abandoned. The introduced cottontail outcompeted the native cottontail in the newly open landscape, and still has a competitive advantage to present day. Habitat fragmentation and major barriers, such as highways, have also reduced connectivity of the remnant populations, making them vulnerable to inbreeding and random events.

Traditionally, recovery efforts begin when the species is placed on the threatened or endangered species list. Since listing is a several year process, those years are a lost opportunity for recovery. In a paradigm shift, the Service's goal is to work aggressively on voluntary recovery efforts through land conservation and habitat management to prevent listing of the New England cottontail.

The refuge would continue to work with other Service personnel and partners, including GBRPP, to conserve ecologically important lands for the New England cottontail and Karner blue butterflies. In chapter 3, under "Land Protection Focus Areas," we identify a set of focus areas we propose to evaluate within the next 5 years. Under alternatives B and C, we would work with our partners to identify additional lands needing permanent protection through fee acquisition, conservation easement, or management agreement. The goal of our land protection activities would be to provide benefits to both Karner blue butterflies and New England cottontails by protecting habitat from development and providing corridors that facilitate genetic exchange within and among populations.

Impacts on Federally Threatened and Endangered Species Under Alternative A

Karner Blue Butterfly

The Karner blue butterfly population would continue to benefit from the Service's support of NHFG's habitat management and Karner blue butterfly captive rearing, release, and monitoring program. Under current management, we would continue to rely heavily on NHFG to carry out this program.

New England Cottontail

The refuge has had little previous involvement in New England cottontail conservation and management, in part because State and Federal partners are just beginning to implement a conservation strategy for the species. Since New England cottontail do not currently occur on the refuge, we anticipate no adverse impacts under current management.

Impacts on Federally Threatened and Endangered Species Under Alternative B

Karner Blue Butterfly

Benefits to the Karner blue butterfly population are expected to be significantly greater under alternative B, through increased emphasis on conserving additional pine barrens habitat, more coordinated habitat management, greater support for monitoring and evaluation of the captive rearing and release program, and more onsite outreach and education about Karner blue butterflies and pine barrens ecology. NHFG would continue to take the lead on all aspects of Karner blue butterfly conservation and habitat management.

New England Cottontail

The refuge would be more actively engaged in working with partners to conserve lands that support existing populations of New England cottontail in coastal New Hampshire. In addition, the refuge would place more emphasis on the management of shrubland habitat for a variety of shrubland dependent species, but with a particular focus for potential habitat to benefit the cottontail. Specifically, the refuge would create and maintain shrub habitat within a portion of the former Weapons Storage Area, which could be used as a captive rearing site or a reintroduction site for the cottontail if it fits in with regional efforts to restore the cottontail to its former range. We would work with the New England Cottontail Working Group and GBPP, to continue to evaluate this potential for New England cottontail to either occupy or be reintroduced to shrubland on the refuge (e.g., alder thickets).

Impacts on Threatened and Endangered Species Under Alternative C

Karner Blue Butterfly

Same as alternative B.

New England Cottontail

Under alternative C, our emphasis would be on natural ecosystem processes, which includes allowing the grasslands and shrublands to succeed naturally to forest cover. We would remove all structures, including fencing, within the former Weapons Storage Area. Therefore, under this alternative the refuge would not be a potential captive rearing or reintroduction site for New England cottontails.

Biological Integrity, Diversity, and Environmental Health Impacts

Impacts on Biological Integrity, Diversity, and Environmental Health that Would not vary by Alternative

Benefits

The 1997 National Wildlife Refuge System Improvement Act stated that in administering the System, the Service shall "… ensure that the biological integrity, diversity, and environmental health of the System are maintained…"

Biological integrity refers to the composition, structure and function of habitats, communities or ecosystems and the natural processes that shape them. Biological diversity is the variety of all living things. Environmental health encompasses the structure, function and health of soil, water, air, and other abiotic elements. We evaluated the impacts of our management actions on perpetuating, maintaining, or restoring the biological integrity, diversity, and environmental health of the refuge.

Under all the alternatives we would protect roosting sites, and active and potential nest sites for bald eagles and osprey, restrict public access to sensitive salt marsh and shoreline natural communities, and protect rare plants and exemplary natural communities. The refuge would remain closed to wheeled vehicles (with the exception of wheelchairs), motorized vehicles, dog walking, jogging, horseback riding, and camping, because of their potential to cause soil compaction, vegetation loss, or disturbance to wildlife and to provide greater protection of biological integrity, diversity, and environmental health on the refuge. Controlled deer hunting would be continued under all alternatives to manage a high deer population in the absence of any natural predators. Managing the deer population would reduce invasive plants, reduce the likelihood of disease (such as Lyme and chronic wasting disease), and contribute to healthier and more diverse plant communities.

Aquatic mammals, especially beaver and muskrat, would likely be affected differently across the alternatives depending on the extent of impoundment management or restoration of the Peverly Brook drainage. Our recent bat surveys indicate an opportunity to focus more on their habitat needs, which is addressed under alternatives B and C. Under all the alternatives the refuge would maintain forested and scrub-shrub wetlands and non-impounded freshwater wetlands that support amphibians and reptiles. We have little information on its invertebrate populations at Great Bay Refuge; without more data we cannot fully assess our management impacts.

In addition, our separate discussions of impacts to soils, water quality and hydrologic systems are pertinent here, since these are components of biological integrity, diversity, and environmental health.

Adverse Impacts
The unchecked spread of invasive plants threatens the biological diversity, integrity and environmental health of refuge habitats. In many cases, these plants have a competitive advantage over native plants and form dominant cover types, reducing the availability of native plants as food and cover for wildlife. Under all alternatives we would continue to survey for invasive plants, avoid transporting invasive plants elsewhere on the refuge, control existing populations, and educate the public about these invaders. Rapid response to small infestations is the most effective way to protect environmental health.

The control of invasive plant species has the potential to cause some short-term environmental health impacts with the use of herbicides. However, this would be offset by careful use of such herbicides and by the long-term benefits to biological integrity, diversity, and environmental health by removing invasive plants and maintaining native vegetation. All the alternatives propose some maintenance of trails and management roads, although the extent varies under each alternative. Roads and trails by their nature cause compaction, loss of vegetation, disturbance to wildlife, fragmentation, and cause edge effects, such as increased predation and invasive plants.

Karner Blue Butterfly Conservation Easement
Our management goal at the easement is to restore the biological integrity, diversity, and environmental health of the pine barrens ecosystem, with a focus on restoring the Karner blue butterfly population. Other rare species would benefit from this management, including several rare moths and a suite of migratory birds. There are also several mammal, amphibian, and reptile species on the refuge, including the hognose snake (State-listed endangered) and black racer (State-listed threatened). Although they would not be the focus of our management, they would also benefit.

Impacts on Biological Integrity, Diversity, and Environmental Health Under Alternative A
Benefits
Under alternative A, we would continue to enhance biological integrity, diversity, and environmental health by removing former military infrastructure (buildings and roads), restoring these sites to natural communities, and allowing numerous small forest openings to revert to forests. We would also continue the monitoring and mitigation of contaminated sites, as funding allows.

Adverse Impacts
The refuge would continue to rely on partners to restore and maintain the biological integrity of intertidal and shallow estuarine habitats in the estuary. Under alternative A, we would maintain all three impoundments, providing minimal opportunity to restore environmental health and biological integrity to the Peverly Brook watershed. Our habitat management activities, including prescribed burning and mowing of approximately 195 acres of grasslands and shrublands affect the natural succession of vegetation by artificially keeping it from becoming forest. Generally, grasslands and shrublands would not occur in this amount and distribution under natural conditions. However, these activities are intended to increase the diversity of certain declining grassland and shrubland species, such as grassland nesting birds and New England cottontail. The trade-off would be a decline of diversity of forest-dependent birds, amphibians, reptiles, mammals, and invertebrates.

Impacts on Biological Integrity, Diversity, and Environmental Health Under Alternative B
Benefits
Given landscape-scale negative impacts to their habitats and populations, bats and New England cottontails would likely benefit under this alternative, through active management of a portion of the former Weapons Storage Area. We would modify some of the bunkers as habitat for bats and the surrounding area would be managed as potential shrub habitat for New England cottontail. The co-occurrence of oak-hickory forests (roosting habitat) with open wetlands or grasslands provides ideal foraging habitat for breeding and migrating bats.

We would remove unnecessary buildings in the former Weapons Storage Area and at Fabyan Point and restore these areas to natural vegetation, thus improving the overall environmental health and biological integrity of the refuge.

Adverse Impacts
Under alternative B, we would reduce our grassland and shrubland management by 43 acres, which would succeed to forest habitat. While this would reduce habitat for grassland and shrubland-dependent species, it would reduce edge and benefit forest-dependent interior wildlife species.

Under alternative B, some contaminated sediments would remain within the Upper Peverly Pond impoundment. More routine sediment and water

quality sampling and the development of a protocol to periodically assess the health of this impoundment and options for restoring or remediating the impoundment would offset the short-term adverse impacts from maintaining the impoundment as is.

A modest expansion of the trail network would cause some adverse impacts to environmental health, specifically soil compaction and loss of vegetation. However, we would offset these impacts by maintaining pedestrian only access, improving the interpretive signs, offering public use programs to make visitors aware of the sensitivity of refuge habitats, and by using best management practices during construction of new trails.

As described under soils and vegetation, the proposed expanded hunting seasons could have minor impacts to the biological integrity, diversity, and environmental health of the refuge through greater soil compaction, trampling of vegetation, and spreading of invasive plants. However, deer hunting would help reduce the deer population, which could minimize the potential for overbrowsing of native vegetation by deer.

Long-term benefits to intertidal and other estuarine habitats and species, including oysters and eelgrass, would increase significantly under alternative B. The refuge would work actively with partners to protect and restore the health and function of these off-refuge habitats and to restore populations of oysters and eelgrass, including populations in Herods Cove and around Nannie Island. Partial restoration of the biological integrity of the Peverly Brook system would occur through removal of the Lower Peverly Pond Dam.

Impacts on Biological Integrity, Diversity, and Environmental Health Under Alternative C

Benefits

We expect the greatest benefit to biological integrity, diversity, and environmental health under alternative C, because we would focus on the restoration of natural processes. Specifically, we expect an increase in biological integrity and environmental health, but a decrease in biological diversity, as grasslands and extensive shrublands are eliminated. In addition to the impacts described under alternative B, the biological integrity, diversity, and environmental health of the intertidal and estuarine habitats off the refuge in Great Bay would likely improve with the restoration of Stubbs Pond. Natural communities and rare plants would be a focus under this alternative through restoration of habitats, control of invasive plants, and reliance on natural ecological processes. Restoration of the biological integrity of the entire Peverly Brook system would occur through the removal of all impoundment infrastructures and restoration of environmental health through removal of contaminated sediments and invasive species prior to dam removals. We would further improve the overall biological integrity, diversity, and environmental health of the refuge by removing all remaining structures in the former Weapons Storage Area and at Fabyan Point and the restoration of many existing refuge management roads to native vegetation.

By restoring natural processes and ecological function, we expect refuge habitats and wildlife would retain the greatest resiliency to adapt to climate change stressors. Restoration of a large continuous forested habitat (including removal of many access roads) would also reduce the need for invasive plant control and increase habitat quality for wildlife species, particularly rare plants, migratory birds, bats, and amphibians and reptiles.

Adverse Impacts
There would be some loss of biological diversity as grasslands and shrublands are allowed to succeed naturally to forest. However, we expect a proportionate increase in nonvertebrate species, such as amphibians, reptiles, and insects. This would be offset by benefits to the biological integrity of forest communities as natural disturbances and ecological processes would create a mosaic of habitat conditions.

The removal of all the existing impoundments under alternative C could result in direct transportation of contaminants to Great Bay and Herods Cove with possible impacts to existing eelgrass, oyster beds, clam flats, and other marine life. Similar to alternative B, a modest expansion of the trail network would cause soil compaction and loss of vegetation in those areas. The proposed trail to the Margeson Estate and Woodman Point would introduce some wildlife disturbances and potential for invasive plants. The potential impacts to biological integrity, diversity, and environmental health from expanded hunting are similar to those under alternative B, although the degree of adverse impacts would likely be higher given the level of hunting proposed under alternative C.

Public Use and Access Impacts

Impacts on Public Uses and Access that Would not vary by Alternative
Benefits
Great Bay Refuge would remain open to five of the six priority wildlife-dependent public uses: wildlife observation, nature photography, hunting, environmental education, and interpretation. The refuge would remain closed to fishing for reasons described below. According to a 1997 public opinion survey for New Hampshire—*Statewide Outdoor Recreation Needs Assessment*—one of the most popular activities in New Hampshire is wildlife observation (NHOEP 2007). This coincides with our focus on wildlife observation, photography, and hunting as the highest priority public uses for the refuge.

The refuge would continue to be open from sunrise to sunset and the trail network would remain open to pedestrian-only use. We would maintain the 2-mile Ferry Way Trail and the 0.5-mile Upper Peverly Trail under all the alternatives. We propose a modest adjustment of the trail layout under alternative B and a slight increase in the number of trails and extent of the trail network under alternative C. Under all alternatives, the 2-day deer hunting season would continue to be held each fall with support from NHFG. An expansion of the hunting program is proposed for alternatives B and C, subject to further NEPA analysis.

Adverse Impacts
Under all the alternatives we would continue to prohibit fishing, given the uncertainty about contaminated sediments in the Peverly Brook system and the sensitivity of salt marsh and other habitats along the shores of Great Bay. We would work with our partners around Great Bay to guide anglers to more appropriate fishing locations. Alternatives B and C propose to work with NHFG to evaluate closing the shoreline of the refuge to waterfowl hunting to protect sensitive shoreline, estuarine, and intertidal habitats in Great Bay Esturay, especially for oysters and eelgrass. This decision would be subject to further NEPA analysis.

Karner Blue Butterfly Conservation Easement
The 29-acre Karner blue butterfly easement is small in size and receives only a modest number of visitors. We would maintain the existing 0.4-mile pedestrian trail under all the alternatives. Wildlife observation and photography and environmental education and interpretation are the primary public uses that would occur here. Hunting and fishing are not available at this site.

Impacts on Public Uses and Access Under Alternative A

Benefits

We do not envision any additional benefits under alternative A that are not already addressed under impacts that would not vary by alternative.

Adverse Impacts

Under all the alternatives the refuge is open from sunrise to sunset. However, due to lack of staffing under alternative A, the refuge office would remain closed and there would only be an information kiosk available. This would limit our ability to provide quality wildlife-dependent outdoor experiences and to gauge the public's interest in the use of the refuge. The refuge would also continue to be closed to other public uses during the 2-day fall deer hunt; however this has not previously, to our knowledge, caused hardship or conflict with other user groups. During our CCP scoping process we did hear from at least one constituent who thought there should be no hunting on the refuge.

Karner Blue Butterfly Conservation Easement

We do not envision any additional benefits or adverse impacts under alternative A that were not already addressed under impacts that would not vary by alternative.

Greg Thompson/USFWS

Wildlife viewing blind at Peverly Pond Trail

Impacts on Public Uses and Access Under Alternative B

Benefits

Under alternatives B and C, a new refuge office and visitor contact station would be built, with up to four refuge staff, significantly increasing the interaction of visitors with refuge personnel. In addition, the hiring of a visitor services specialist would significantly increase the environmental education and interpretive offerings both on and off the refuge. The two existing trails would be enhanced with improved observation blinds and wildlife viewing platforms and better signage and interpretive displays, enhancing the experience of refuge visitors. A modest expansion of these two trails, including a new trail at Fabyan Point, would further enhance visitor opportunities and experiences.

Expansion of hunting opportunities to include wild turkey and fall bow season for deer would be pursued; however these actions would require further NEPA analysis. Working with partners on Great Bay who also provide wildlife observation and environmental interpretation opportunities, such as the GBNERR, to create and distribute more information would enhance the public's understanding and experience in and around the Great Bay Estuary.

Adverse Impacts
Much of the refuge would continue to be closed to public access due to the sensitivity of habitats and to avoid disturbances during critical periods, such as bird nesting season. By enhancing the existing trail network—through a modest expansion with better interpretive materials and facilities—we believe the public would have a better experience visiting those areas that are open to the public. With an expanded hunting program, there would possibly be additional days when the refuge is closed to other uses. However, the refuge would remain open to the public most of the year. To further reduce potential visitor conflicts, our proposal for additional hunting seasons would be weekdays only within specific zones and excluding trails. Karner Blue Butterfly Conservation Easement

Interpretive kiosk at refuge parking lot

Greg Thompson/USFWS

Under this alternative we would create more interpretive materials for the self-guided trail, the existing kiosk, and our Web site. In addition, we would install a kiosk on the east entrance, in an area already disturbed by the existing road right-of-way. Its placement would not affect butterfly habitat. These improvements would enhance the experience of visitors to the easement and raise awareness about the ecology of the pine barrens. The Service and NHFG law enforcement officials would coordinate site visits to enforce against unauthorized uses such as motorized recreation. This would reduce impacts to resources and minimize conflicts with approved public uses.

Impacts on Public Uses and Access Under Alternative C
Benefits
In addition to alternative B, we propose a new trail that would provide public access into areas—such as Woodman Point—that were previously closed to the public. Hunting opportunities would also be expanded beyond those proposed under Alternative B. These would include a fall archery season for wild turkey (following the State season) and a fall archery season for deer that would also span the State season (mid-September to mid-December). The other difference in the proposed hunting seasons under alternative C is that the refuge would be open to hunting 7 days a week and there would be fewer excluded areas.

Adverse Impacts
In addition to alternative B, we anticipate higher visitor conflicts under alternative C, since we propose opening up of the refuge to hunting 7 days a week from mid-September to mid-December.

Karner Blue Butterfly Conservation Easement
Same as alternative B.

Cultural Resources Impacts

Impacts on Cultural Resources that Would not Vary by Alternative
Regardless of the alternative, the Service is responsible for managing and protecting archaeological and historic sites found on national wildlife refuges. The consequences of past, current, and proposed management on cultural resources are the same across all alternatives. Any management actions with the potential to affect cultural resources would require review by the refuge

manager, as well as review by the Service's RHPO in consultation with the State of New Hampshire SHPO, as mandated by section 106 of NHPA. Therefore, determining if particular actions within an alternative have the potential to affect cultural resources is an ongoing, well-established, and regulated process that would occur during the planning stages of any proposed projects.

As indicated in chapter 3, we have initiated consultation with SHPO to determine the National Registry eligibility of the structures in the former Weapons Storage Area and the Fabyan Point cabins, and to determine the fate of the Margeson Estate, which is already listed on the National Registry. The results of the consultation will determine what specific management options and/or mitigation measures are available to us.

Karner Blue Butterfly Conservation Easement
There are no known historical or archaeological sites on the easement. However, under all alternatives, we would compile current cultural resource inventories and identify additional survey work needed to protect cultural resources in conjunction with habitat management and other site planning. We would also support NHFG's efforts to seed lupine, where possible, rather than digging and planting, to avoid potential conflicts with cultural resources.

Impacts on Cultural Resources Under Alternative A
The Margeson Estate is on the National Register and is currently in poor condition. Under alternative A, we would continue very limited maintenance of the site due to a lack of resources and staffing. It is predicted that, without extensive renovations, the buildings would continue to deteriorate in place. This would result in a total loss of the site's integrity.

Impacts on Cultural Resources Under Alternative B
We would plan to complete consultation with SHPO within 1 year of CCP approval. That consultation will determine whether additional structures on the refuge are eligible for the National Register. All ineligible buildings would be removed. If any of the structures are determined eligible, we would evaluate management options and/or mitigation measures with SHPO. For the Margeson Estate, we have indicated to SHPO that our preferred alternative is recording the site and then demolishing the buildings. While this would represent a loss of the physical structures, we would fulfill all requirements to document the buildings to ensure historical information is preserved. If we pursue demolition of eligible buildings, including the Margeson Estate, with SHPO concurrence, additional NEPA analysis may be required.

Impacts on Cultural Resources Under Alternative C
Same as alternative B.

Cumulative Impacts

Air Quality

Very high ozone levels occur in the seacoast regions of Maine, New Hampshire, and Massachusetts during the summer due to a combination of factors (e.g., dense population, local pollution sources, downwind of sources outside the region). On average, southern New Hampshire and coastal Maine experience 3 to 5 days per year of very unhealthy ozone levels, with some years (e.g., 1988) that are much worse. Air quality issues in the region are largely the result of the influx of airborne pollutants originating from industrial regions, metropolitan centers, and transportation corridors located upwind, primarily in the Midwest and Mid-Atlantic regions. The region's air quality is also affected by other factors, including industrial sources, transportation emissions, acid rain, weather patterns, and climate changes (Wake et al. 2004).

We predict only a negligible adverse impact on regional air quality from refuge activities due to the small number of staff, limited management activities, the relatively small size of the refuge (1,103 acres), and the fact that motorized public access is only allowed on the entrance road. Management actions and public uses at the refuge would contribute negligibly to regional vehicle emissions compared to other nearby emission sources. The refuge receives approximately 30,000 visitors each year compared to the 70,000 vehicles per day that travel on the nearby Spaulding Turnpike (Route 16) (VHB 2007). In addition, the adjacent Pease International Tradeport supports more than 36,000 aircraft flights per year (US DOT 2010; *http://www.gcr1.com/5010web/airport.cfm?Site=PSM;* accessed May 2011). Also, PSNH operates three 50-megawatt steam boilers (two coal boilers and one wood boiler) nearby in the town of Newington, which emit greenhouse gases.

With our partners, we would continue to contribute to improving air quality through cooperative land conservation and management of natural vegetation and wetlands. Great Bay Refuge is the largest block of protected land on Great Bay Estuary. Maintaining refuge land in natural upland vegetation or wetlands, assures these areas would continue to filter out many of the air pollutants harmful to humans and the environment. This is especially important in a region that is already densely developed with residential, industrial, and commercial buildings.

We would also support community proposals to develop a regional bike trail. This trail would encourage alternative transportation to regional destinations, including the refuge, which could reduce regional greenhouse emissions from motorized vehicle use.

Karner Blue Butterfly Conservation Easement

As described under regional air quality impacts above, the primary air quality impacts from habitat management activities come from prescribed burns. Collectively, the Service and NHFG burn approximately 70 acres per year, most on abutting city of Concord lands. These prescribed fires follow a detailed burn plan that addresses air quality issues. The Karner blue butterfly easement is surrounded by residential and commercial development, so maintaining the pine barrens as open space in an already densely developed region benefits air quality. In addition, the adjacent Concord Municipal Airport serves approximately 90,000 flights per year (US DOT 2010; *http://www.gcr1.com/5010web/airport.cfm?Site=CON;* accessed May 2011). Compared to these air quality impacts from aircraft, the refuge's cumulative impact is negligible.

Water Quality and Health of the Great Bay Estuary

Since the refuge lands were transferred from the Air Force to the Service, there has been a continual improvement in water quality. Any contaminants released by the military during their tenure that seeped into soils and water have been in decline according to routine sampling (see appendix I).

In chapter 2, we describe the environmental indicator trends for the Great Bay Estuary. We anticipate continued cumulative improvements in these trends from both refuge-specific actions and our partnerships off-refuge. Refuge-specific actions include removal of deteriorating impoundment infrastructure, continued sediment sampling and monitoring of water quality, remediation of contaminated sediments where feasible, and control of invasive plant species. The ability to implement each of these management actions varies across alternatives. We would continue to work with our conservation partners, including GBRPP, PREP, and GBNERR, to maintain and improve water quality in the Great Bay Estuary. Specifically, our collaborative efforts on land conservation and restoration of oysters and eelgrass in the Great Bay Estuary would lead to improved health of this ecosystem.

From 1990 to 2005, land consumption in the coastal watersheds of New Hampshire increased from 0.15 to 0.22 acres of impervious surface per person. Increasing rates of land consumption per person is an indicator of sprawl-type development, which is a threat to the habitats, wildlife, and environmental health of the watershed. The town of Newington has one of the highest levels of impervious surfaces, increasing from 0.694 acres/person in 1990 to 1.330 acres/person in 2005 (NHEP 2006). Great Bay Refuge is the largest unfragmented block in the town of Newington and is the largest block of protected land on the bay. We anticipate no net increase in the amount of impervious surface on the refuge based on the combination of building demolition and construction of a new headquarters/visitor contact station and maintenance facility. On over 1,000 acres of the refuge, we are preventing further degradation of regional water quality by maintaining natural vegetation, which has the ability to filter out sediments and pollutants.

Our proposal to remove one or more dams in Peverly Brook (the number depends on the alternative selected) would begin to reestablish a natural hydrological flow in the system. It would serve as a demonstration area for other potential stream restoration projects in the region and as a research and monitoring site for effects of these restoration activities on migratory fish, and oyster and eelgrass beds.

Evaluating opportunities for additional land acquisition would potentially lead to the permanent protection of undeveloped lands with high natural resource value, including those lands and waters that would further enhance the water quality and health of the Great Bay ecosystem.

Trust Resources and Biological Integrity, Diversity, and Environmental Health

All of the alternatives would maintain or improve Service trust resources and biological integrity, diversity, and environmental health on the refuge and in the region, although to varying degrees. The combination of our management actions with other organization's actions could result in significant, beneficial cumulative effects by

- increasing the conservation and management of federally and State-listed threatened and endangered species and other species of concern and associated habitats, through acquisition of ecologically important uplands and wetlands;
- using adaptive management and the best science available to manage and promote regionally important habitats and natural communities;
- removing deteriorating or unnecessary infrastructure and restoring areas, thereby improving soil, water, and air quality;
- controlling invasive plants and animals that are not native to the area; and
- partnering with GBNERR and others to offer educational and interpretive programs that help citizens improve the biological integrity and environmental health of the Great Bay Estuary.

Karner Blue Butterfly Conservation Easement

Similarly, on the easement our work with partners could result in a significant, beneficial cumulative effect by continuing to work with the NHFG and other partners to conserve and manage the federally listed endangered Karner blue butterfly and the ecologically significant pine barrens ecosystem.

Socioeconomic Environment

We expect none of the proposed alternatives to have a significant adverse cumulative impact on the economies of the town of Newington and Rockingham County. Nor would any of the alternatives alter the demographic or economic characteristics of the local community. We expect a net benefit to the adjacent

community by providing a natural setting for solitude, enjoyment of nature and wildlife, and outdoor recreation opportunities.

The actions we propose would neither disproportionately affect any communities nor damage or undermine any businesses or community organizations. Any new land acquisition that we propose would involve only willing sellers, and would be a result of a detailed analysis of ecological important lands in the coastal watersheds. New acquisitions would be in partnership with other conservation entities and would be consistent with local and regional conservation plans, such as the PREP plan, NHWAP, the Land Conservation Plan for New Hampshire's Coastal Watersheds, and other similar plans. Regardless of which alternative we select we would continue to pay refuge revenue sharing Payments to the communities where the refuge is located.

Fully funding the additional staffing in alternatives B and C would make a small, incremental contribution to the employment and income in the local community. With increased staffing and more emphasis on environmental education, interpretation, and wildlife observation on the refuge, we expect public use of the refuge to increase, thereby increasing the number of days visitors spend in the area and, correspondingly, the level of visitor spending in the local community. Interpretation of the cultural and land use history of the area—including the former military operations and farming and fishing legacies—would offer a unique interpretive experience for local residents and visitors from afar.

Our existing and expanding partnerships with local, State, and Federal entities around the Great Bay Estuary are key to successful conservation outcomes and building public understanding and support for this work. With onsite staffing, as proposed under alternatives B and C, we would be more responsive to our partners, to visitors to the refuge, and to local communities, schools and colleges, and others interested in learning more about Great Bay. Not all priority public uses would be available on the refuge, however we would guide people to other places around Great Bay that are more suitable to their recreational interest. More outreach could also positively affect land use decisions outside the refuge by local governments and private landowners, and thus, lead to benefits to the regions biological integrity, diversity, and environmental health.

Greg Thompson/USFWS

Gulls on Great Bay

Karner Blue Butterfly Conservation Easement

Similar to the Great Bay Estuary, our partnerships are key to successful pine barrens management and restoration of a viable Karner blue butterfly population. The actions we propose would neither disproportionately affect any communities nor damage or undermine any businesses or community organizations. Any new land acquisition that we propose would involve only willing sellers, and would be a result of a detailed analysis of ecological important lands in the Concord pine barrens region.

We expect none of the proposed alternatives to have a significant adverse cumulative impact on the economy of the town or county in which the Karner blue

butterfly conservation easement lies. Nor would any of the alternatives alter the demographic or economic characteristics of the local community. Interpretation of the ecology of the pine barrens and its inhabitants would offer a unique experience to visitors and residents of the region—highlighting an important part of the natural legacy of this region.

Global Climate Change

Department of the Interior Secretarial Order 3226 (January 16, 2009) states that "there is a consensus in the international community that global climate change is occurring and that it should be addressed in governmental decisionmaking…This Order ensures that climate change impacts are taken into account in connection with Departmental planning and decisionmaking." Additionally, it calls for the incorporation of climate change considerations into long-term planning documents, such as this CCP.

The Wildlife Society (TWS) published a technical review report in 2004 titled "Global Climate Change and Wildlife in North America" (Inkley et al. 2004). The TWS report interprets results and details from such publications as the IPCC 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, to predict 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, exotic species, disease, and other factors.

The effects of climate change on populations and range distributions of wildlife are expected to be species specific and highly variable, with some species benefiting and others vulnerable to extirpation or extinction. Generally, the prediction in North America is that the ranges of habitats and wildlife will generally move upwards in elevation and northward as temperature rises (Inkley et al 2004, Rodenhouse et al, in press). The TWS report, however, emphasizes 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 to ecosystem changes, their interactions with other species, and the impacts from other stressors in the environment. In October 2010, GBNERR and the Great Bay Stewards were awarded a grant to develop specific climate change predications for the Great Bay watershed and develop conservation and outreach adaption strategies.

To help meet the climate change challenge the Service drafted a *Climate Change Strategic Plan* (USFWS 2009b). The plan employs three key strategies to address climate change: adaptation, mitigation, and engagement. The Association of Fish and Wildlife Agencies developed guidance for states as they update and implement their respective wildlife action plans (AFWA 2009). This publication—Voluntary Guidance for States to Incorporate Climate Change into State Wildlife Action Plans and Other Management Plans—also includes strategies that will help conserve fish and wildlife species and their habitats and ecosystems as climate conditions change. The broad spatial and temporal scales associated with climate change suggest that management efforts that are coordinated on at least the regional scale will likely lead to greater success.

Our review of proposed actions in this CCP suggests that two activities may contribute negligibly to stressors affecting regional climate change: our grassland mowing and prescribed burn program and our use of vehicles and equipment for refuge management and administration. 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, driving hybrid vehicles, and using recycled or recyclable materials, along with reduced travel and other conservation measures. We mow or burn once a year, affecting less than 150 acres under any alternative. Alternative C outlines the most aggressive measures for addressing climate change by minimizing our carbon footprint and greenhouse gas emissions from management activities and maximizing resiliency of natural communities. In our professional judgment, most of the management actions we propose would not exacerbate climate change in the region or project area.

The TWS report provides 18 recommendations to assist land and resource managers in meeting the challenges of climate change when working to conserve wildlife resources (Inkley et al. 2004). Their position is that if land and resource managers collectively implement these recommendations, then cumulatively there would be a positive impact of addressing climate change. We discuss our actions relative to addressing some of these recommendations:

- *Recognize Climate Change as a Factor in Wildlife Conservation*
  The Service is taking a major role among Federal agencies in distributing and interpreting information on climate change. There is a dedicated Web site to this issue at: *http://www.fws.gov/home/climatechange/* (accessed May 2011), which links to the Service's recently released Strategic Plan for Climate Change. The strategic plan includes two key elements: Landscape Conservation Collaboratives and a National Fish and Wildlife Climate Adaptation Strategy; both elements bring together conservation partners to address climate change in a concerted effort. Strategies for adapting to and mitigating climate change are included in this CCP. Specific steps taken by the refuge will help reduce our greenhouse gas emissions, including using energy efficient equipment and vehicles where feasible, building and maintaining any structures using sustainable, green building technologies, conduct energy audits, and other strategies. In addition, we will rely on the habitat and species vulnerability assessments and other climate change research developed by the Northeast Climate Impacts Assessment and the Manomet Center for Conservation Science.

- *Manage for Diverse Conditions*
  The habitat management actions described in chapter 3 are intended to promote healthy, functioning native habitats, to protect biological integrity, and maintain the resiliency within these systems to adapt to changing conditions. We will implement an adaptive management approach as new information becomes available.

- *Do Not Rely Solely on Historical Weather and Species Data for Future Projections without Taking into Account Climate Change*
  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. A 3-week difference in timing has already been documented by some researchers. We are aware of these implications and plan to build these considerations into our IMP and AHWP so that we can make adjustments accordingly. Under alternatives B and C, with presence of onsite staff, we would prioritize climate change monitoring (such as phenology, timing of bird migrations, flooding regimes, and sea level rise).

- *Expect Surprises, Including Extreme Events*
  This CCP has incorporated extreme events (such as drought and increasing fire frequency) into future management strategies. We would continue to incorporate new information in future planning with the development of HMP, IMP, and Visitor Use Plans.

- *Reduce Nonclimate Stressors on the Ecosystem*
  The objectives of our habitat management program are to maintain and enhance the biological integrity, diversity and health of refuge lands. Objectives to restore at least a portion of Peverly Brook to stream habitat and to manage habitats for native vegetation would help maintain resilience in the face of climate change. Alternative C would maximize this recommendation by restoring ecological function and natural processes to much of the refuge.

- *Maintain Healthy, Connected, Genetically Diverse Populations*
  Small isolated populations are more prone to extirpations than larger, healthy, more widespread populations. Larger tracts of protected land facilitate more robust species populations and can offer better habitat quality in core areas. We would continue to work with our many conservation partners at the State and regional levels to support and complement restoration and protection efforts around the Great Bay Estuary and in the Concord pine barrens.

- *Translocate Individuals*
  It may sometimes be necessary to physically move wildlife from one area to another to maintain species viability. However, this tool has potential consequences and should only be used in severely limited circumstances as a conservation strategy. The Service supports the captive rearing and release of the Karner blue butterfly in the Concord pine barrens and is working with State and Federal partners to evaluate the feasibility of restoring New England cottontail to the Great Bay Refuge, specifically within the former Weapons Storage Area.

- *Protect Coastal Wetlands and Accommodate Sea Level Rise*
  We would continue to work with our conservation partners around the Great Bay Estuary and in coastal New Hampshire to protect coastal habitats. Refuge lands are not expected to be inundated by projected sea level rise due to its elevation. Because of this, the refuge may serve as an important corridor for movement of plants and animals in relation to climate change impacts. The area of the refuge most at risk from sea level rise is Stubbs Pond. We would work with partners to establish monitoring sites to measure the timing and extent of sea level rise in Great Bay Estuary. We will use the information gathered from these monitoring sites to adapt management to reduce the threat and maintain critical natural resources in the estuary.

- *Reduce Likelihood of Catastrophic Events Affecting Populations*
  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. We can help reduce this risk by managing for diverse conditions; biological integrity, diversity and environmental health; and connected genetically diverse populations. Under all alternatives, the refuge would work with regional partners to conserve and manage sufficient large patches of high quality habitat that are connected by suitable travel corridors. This is a main focus of the Service's newly formed North Atlantic LCC.

- *Prevent and Control Invasive Species*
  Climate change may increase 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 a major initiative within the Service. The Northeast Region, in particular, has taken a very active stand. In chapter 2, we describe the current extent of invasive species on the refuge and in chapter 3 we include strategies common to all alternatives for controlling existing and future invasive plant infestations. We also describe monitoring and inventorying strategies to protect against any new infestations.

- *Account for Known Climatic Conditions*
  Monitoring key resources through predictable short-term periodic weather phenomenon, such as El Niño, can aid in future management efforts. We plan to develop a monitoring program that would help us evaluate our hypotheses, assumptions, and successes in achieving objectives, as well as help us make future management decisions. Any restoration activities or pro-active habitat management actions would be carefully planned and their effectiveness monitored and documented so we can use this information in future management decisions.

- *Select and Manage Conservation Areas Appropriately*
  The establishment of 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. We would continue to work with our conservation partners in coastal New Hampshire and in the Concord Pine Barrens to identify and protect areas that maintain connectivity and biological integrity in the face of climate change and other stressors.

- *Ensure Ecosystem Processes*
  Managers may need to enhance or replace diminished or lost ecosystem processes. Manually dispersing seed, reintroducing pollinators, treating invasive plants and pests, are examples used. Our habitat goals and associated objectives include an emphasis on restoring at least a portion of Peverly Brook to stream habitat by removing impoundment infrastructures, encouraging natural forest communities, removing structures and restoring areas within the former Weapons Storage Area, and controlling invasive plant species. Alternative C would maximize this recommendation by restoring natural processes in most habitats on the refuge.

- *Use Monitoring and Adaptive Management*
  Managers 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 our CCP. We would develop a detailed step-down IMP designed to test 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.

Relationship Between Short-term Uses of the Human Environment and Enhancement of Long-term Productivity

In this section, we examined the relationship between local, short-term uses of the human environment and maintaining the long-term productivity of the environment. By long-term, we mean that the impact would extend beyond the 15-year period of this CCP.

Under all alternatives, our primary aim is to maintain or enhance the long-term productivity and sustainability of natural resources on the refuge, in the State of New Hampshire, and in the New England/Mid-Atlantic ecoregion. The alternatives strive to conserve migratory birds and fish, the federally listed endangered Karner blue butterfly, and other species of concern and the habitats that they depend on. The construction of a new refuge headquarters building/visitor contact station and maintenance facility represents a loss of long-term

productivity in a relatively small area, although it is on a site already disturbed as part of the Weapons Storage Area. However, staff at the visitor contact station will conduct outreach to the public about local, regional, and national conservation issues. Environmental education and interpretation programs launched from the facility would be designed to encourage visitors to be better stewards of our environment. Encouraging members of the public to support conservation efforts can ultimately lead to long-term benefits for the environment. We believe that our management actions, including control of invasive plant species, restoring at least a portion of Peverly Brook to stream habitat, managing for native vegetation, and enhancing habitats for rare species such as the Karner blue butterfly and New England cottontail, would have short-term adverse impacts, but enhance long-term productivity of the refuge. Habitat management practices that mimic ecological and sustainable processes optimize the maintenance and enhancement of the biological diversity, integrity, and environmental health of those habitats for the long term.

In summary, we predict that the alternatives would contribute positively in maintaining and enhancing the long-term productivity of the refuge's natural resources with sustainable beneficial cumulative and long term benefits to the environment surrounding the refuge with minimal inconvenience or loss of opportunity for the American public.

Unavoidable Adverse Effects

Unavoidable adverse effects are the effects of those actions that could cause harm to the human 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, any new construction, prescribed burns, or control of invasive species would produce minor, short-term, localized adverse effects. However, none of those effects would rise to a considerable level and would have long-term beneficial impacts. Furthermore, all of those impacts would be mitigated with best management practices, so none of the alternatives would cause significant, unavoidable cumulative impacts.

Some habitat types on the refuge would be adversely affected. Under alternative C, the removal of all impoundment infrastructure, and the restoration to stream habitat, would change the amount of impounded, open water over the long term. However, this change would likely be gradual and would eventually follow natural cycles influenced by beaver.

As we noted previously, many of the habitat and facility construction projects in the alternatives have a certain level of unavoidable adverse effects, especially during the actual construction. Those effects are mitigated to some degree by the use of practices and precautions that safeguard water quality, avoid sensitive or irreplaceable habitats, or time the actions or include features to avoid or minimize impacts on fish and wildlife. The adverse effects generally are short-term and more than offset by the long-term benefits to fish and wildlife, habitats, biological integrity and diversity, and environmental health.

Proposed public uses may have unavoidable adverse effects on vegetation, soils, and wildlife. However, we minimize these impacts to the extent possible by allowing only pedestrian use on designated trails (except during hunting), limiting access to less sensitive areas, and minimizing impacts through best management practices in trail design. Alternatives B and C, in varying degrees, would have adverse impacts to a certain segment of the public that does not desire any change in current habitat management or public use programs. Some of these impacts on certain individuals or neighbors are unavoidable, 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 optimizing wildlife conservation and also providing excellent recreational opportunities to the public.

Potential Irreversible and Irretrievable Commitments of Resources

Irreversible commitments of resources are those which cannot be reversed, except perhaps in the extreme long term or under unpredictable circumstances. An example of an irreversible commitment is an action which contributes to a species' extinction. Once extinct, it can never be replaced. No irreversible commitments of resources are predicted as a result of management activities on Great Bay Refuge.

In comparison, irretrievable commitments of resources are those which can be reversed, given sufficient time and resources, but represent a loss in production or use for a period of time. In our professional judgment there are a few actions proposed that could be considered irretrievable and primarily relate to the construction of administrative and visitor facilities, such as buildings, roads, and trails. They are considered irretrievable because in the future, any facility we construct could potentially be dismantled and the site restored; however, while standing, they represent a loss in habitat productivity.

We identify the resource impacts of constructing these activities earlier in chapter 4. In our professional judgment, the overall local and regional benefits to the human environment far outweigh the loss of productivity. These infrastructures would be located within an area already heavily disturbed and hardened by previous military activity, the new building construction would be more energy efficient and designed to recycle resources to the extent possible, and outreach and communications with the public would be greatly facilitated. In summary, we predict that none of these actions would result in a significant impact on the human environment.

Environmental Justice

President Clinton signed into Executive Order No. 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations" on February 11, 1994, 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 community's access to public information and participation in matters relating to human health or the environment.

The U.S. EPA Office of Environmental Justice defines it as follows:

> Environmental Justice is the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental law, regulations, and policies. EPA has this goal for all communities and persons across this Nation. It will be achieved when everyone enjoys the same degree of protection from environmental and health hazards and equal access to the decisionmaking process to have a healthy environment in which to live, learn, and work (*http://www.epa.gov/environmentaljustice*; accessed August 2011).

We believe, based on our socioeconomic and environmental consequences analysis, that none of our proposed alternatives would place a disproportionately high, adverse environmental, economic, social, or health effects on minority or low-income persons. None of the identified socioeconomic and environmental impacts would be localized nor be placed primarily or unequally on minority and low-income population persons who reside near the refuge. The local town

and county would bear very minor adverse effects and some beneficial effects if the refuge is managed under any of the three proposed alternatives. Adverse impacts, such as anticipated minor increases in traffic and related emissions due to visitation and negligible contributions to local mobile source air emissions from refuge equipment and vehicles, would not disproportionately affect minority and low-income populations compared to other segments of the general population. Beneficial impacts include maintaining natural vegetation that improves air and water quality through filtering, paying refuge revenue sharing payments to the town of Newington to offset property tax loses, and providing enhanced and free public uses under alternative B and C.

Before we make any decisions to make major changes in habitat management or the environment we always inform all of our publics, equally, and our programs and facilities are open to all who are willing to adhere to the established refuge rules and regulations. We do not discriminate in our responses for technical or practical information on conservation issues or when providing technical assistance in managing private lands. Additionally, all refuge uses proposed under the alternatives would be open to all members of the public. The Service is also an equal opportunity employer.

Summary of the Impacts of the Alternatives

The following table 4.2 summarizes the benefits and adverse impacts we described above in chapter 4 for specific resources or programs proposed for Great Bay Refuge under each of the alternatives. For our discussion on cumulative impacts, the relationship between short-term uses of the human environment and enhancement of long-term productivity, unavoidable adverse impacts, potential irreversible and irretrievable commitments of resources, and environmental justice, please refer to the chapter 4 narratives above.

Black duck

Tim Williams

Resources	Management Focus		
	Alternative A– Current Management	**Alternative B– Emphasis on Habitats and Focal Species (Service Preferred)**	**Alternative C– Emphasis on Natural Processes**
Air Quality	We would continue current, and adopt new, energy efficient practices including the use of hybrid vehicles and compact fluorescent lighting. Negligible adverse effects from burning and/or mowing up to 195 acres of grasslands/shrublands each year on the refuge. We would use prescribed fire on approximately 60 out of 169 acres of grasslands each year. We would follow a prescribed burn plan that minimizes smoke impacts on the neighboring airport and addresses other air quality issues. Negligible contribution to regional vehicle emissions from approximately 30,000 refuge visitors each year. Minimal windborne dust from refuge gravel roads. *Karner Blue Butterfly easement:* On average, we would burn 1 to 2 acres annually at the easement. NHFG burns another 60 to 70 acres annually on nearby city of Concord lands. The refuge and its partners follow a prescribed burn plan to minimize smoke impact on neighboring Concord airport and to address other air quality issues. There are no buildings or motorized visitor access on the easement. Overall, negligible regional air quality impact given nearby public road network and adjacent Concord municipal airport.	Similar to A, we would continue energy efficiency practices. The construction of a new energy efficient headquarters/visitor contact station and maintenance facility would provide long-term air quality benefits through use of energy efficient and green technology. Some short-term adverse impacts are likely during the construction phase and/or during demolition of unnecessary facilities, but we would use best management practices to reduce and mitigate this impact. Negligible adverse effects from burning and/or mowing up to 152 acres of grasslands/shrublands each year. Approximately 60 of the 98 grassland acres would be managed annually using prescribed fire, a modest increase compared to alternative A. Similar to alternative A, we would follow prescribed burn plan. Negligible increase in regional vehicle emissions, as compared to regional sources, anticipated from a projected 10 percent increase in visitation. Minimal windborne dust from refuge gravel roads. Slight short-term increase in windborne dust and other particles from demolition of remaining buildings in the Weapons Storage Area and structures at Fabyan Point, removal of Lower Peverly Pond Dam, and restoration of these sites. *Karner Blue Butterfly easement:* Same as alternative A	Similar to B, we would continue energy efficiency practices and construct a new energy efficient headquarters/ visitor contact station and maintenance facility. Long-term air filtration and carbon sequestration would be modestly higher due to an increase in forest cover and reduced grassland and shrubland. Reduction in any adverse impacts from prescribed burning and mowing by eliminating management of grasslands and shrublands at Great Bay. Negligible increase in regional vehicle emissions anticipated from a projected 10 to 12 percent increase in visitation. Slight reduction in windborne dust and other airborne pollutants from vehicles with closure of several management access roads. Slight short-term increase in windborne dust and other particles from demolition of remaining buildings in the Weapons Storage Area and other unnecessary structures, the removal of all impoundment infrastructures, and restoration of these sites. *Karner Blue Butterfly easement:* Same as alternative A
	Impacts that do not vary between the alternatives None of our proposed refuge management activities should adversely affect regional air quality. None would violate EPA standards and each would comply with the Clean Air Act. Management actions and public uses at the refuge would contribute a negligible increase to regional emissions. Under all the alternatives, we would continue to maintain trails for pedestrian, non-motorized and non-wheeled recreational uses only (except for the entrance road and parking lot).		

Resources	Management Focus		
	Alternative A– Current Management	**Alternative B– Emphasis on Habitats and Focal Species (Service Preferred)**	**Alternative C– Emphasis on Natural Processes**
Hydrologic Systems and Water Quality	We would continue to largely rely on partners to restore and maintain water quality within the Great Bay Estuary. We would minimize amount of impervious surface on the refuge by continuing to remove buildings and structures in the former Weapons Storage area and maintaining natural vegetative cover on nearly 1,103 acres. We would continue to maintain all three impoundments and therefore have a limited ability to restore hydrologic function and improve water quality within the Peverly Brook system. Due to lack of staffing, we would have limited ability to routinely monitor sediments and water within the impoundments for contaminants and to implement any remediation or restoration of water resources. The U.S. Air Force would continue long-term monitoring of groundwater wells. *Karner Blue Butterfly easement:* We do not anticipate any water quality or hydrology impacts on the easement due to its topography and that it only supports one small stream.	Under alternative B, we would take a greater role in conserving ecologically significant lands around the Great Bay Estuary in partnership with GBRPP, thus protecting the health of the estuary. We would also have a greater role and opportunity to improve and maintain water quality in the Great Estuary through restoration of oyster reefs and eelgrass beds off-refuge. The removal of the 7-acre Lower Peverly Pond impoundment would restore stream habitat and improved hydrologic function along a portion of Peverly Brook. Upper Peverly and Stubbs Ponds would remain, and therefore there would not be a full restoration of hydrologic function. A protocol would be developed for ongoing assessment of Upper Peverly Pond impoundment. Removal and control of invasive plants (especially brittle waternymph) would improve water quality. Enhanced sediment and water quality sampling in the Peverly Brook system would lead to improved water quality in the long-term and would alert the refuge to potential threats to water quality (e.g., such as from nearby airfield). Similar to alternative A, the U.S. Air Force would continue long-term groundwater monitoring. Some potential risks to water quality from treatment of aquatic invasive plants, mitigated by using only approved herbicides and best management practices and long-term benefits to hydrologic function through removal of invasive plants Development of new trails, a projected 10 percent increase in visitation, and the construction of a new headquarters/visitor contact station and maintenance facility also have the potential to impact water quality. We would use best management practices during the construction and demolition of any public use facilities and buildings to reduce water quality and hydrology impacts. *Karner Blue Butterfly easement:* Same as alternative A	In addition to alternative B, The removal of all three impoundments–Upper Peverly Pond, Lower Peverly Pond, and Stubbs Pond–would offer the best opportunity to restore hydrologic function to the entire Peverly Brook system. Sediment contamination and other water quality issues (such as invasive aquatic plants) would be remediated to the point we do not feel it would jeopardize human and ecological health. There is the greatest potential for contaminants to enter Peverly Brook under this alternative. *Karner Blue Butterfly easement:* Same as alternative A
	Impacts that do not vary between the alternatives None of our proposed refuge management activities should adversely affect regional water quality. None would violate Federal or State standards for contributing pollutants to water sources; each would comply with the Clean Water Act.		

Resources	Management Focus		
	Alternative A– Current Management	**Alternative B– Emphasis on Habitats and Focal Species (Service Preferred)**	**Alternative C– Emphasis on Natural Processes**
Socioeconomic Environment	Given the lack of current staffing at the refuge, we contribute negligibly to the local economy in terms of refuge staff jobs, income, expenditures, and purchases of goods and services for refuge activities. Cost of community services studies show that open space versus development is more cost-effective to towns. *Karner Blue Butterfly easement:* The easement is not owned in fee by the Service so we would not pay refuge revenue sharing payments.	Filling the four refuge staff positions would minimally increase benefits for the local economy in jobs, income, and expenditures. Construction of a new refuge headquarters/ visitor contact station and maintenance facility would provide short-term income to the local economy for labor, materials, and services. Enhancing refuge programs would increase public use by approximately 10 percent each year, thereby increasing their expenditures in the local economy. This increase, however, would remain negligible in the context of the surrounding local communities. We anticipate an increase in biological work and a need for more seasonal technicians and hiring of local contractors or other sources to assist with building demolition, dam removal, and site restoration, providing additional income into the local economy. The proposed hunt expansion may increase hunting-related expenditures in local communities, however the anticipated number of hunting visits to the refuge is small. *Karner Blue Butterfly easement:* In addition to alternative A, enhanced interpretive information and enforcement of unauthorized use would increase the quality of visitor experiences.	In addition to alternative B, We anticipate an increase in visitation by approximately 12 percent a year given the increase in public programs including expanded trail access into parts of the refuge currently closed to protecting breeding grassland and shrubland birds. *Karner Blue Butterfly easement:* Same as alternative B
	Impacts that do not vary between the alternatives Regardless of which alternative we select, we will continue to pay refuge revenue sharing payments each year to the town of Newington.		

Resources	Management Focus		
	Alternative A– Current Management	**Alternative B– Emphasis on Habitats and Focal Species (Service Preferred)**	**Alternative C– Emphasis on Natural Processes**
Soils	Maintaining grasslands and shrublands and controlling invasive plants poses slight risk to soils. Prescribed fire releases nutrients back into the soil. The existing Lower Peverly Pond impoundment infrastructure is failing, eroding, causing downstream sedimentation, and other adverse impacts to soils. Alternative A offers limited ability to address existing sediment contamination in Upper Peverly Pond and elsewhere in the Peverly Brook system. *Karner Blue Butterfly easement:* This is a fire-dependent ecosystem so prescribed fire benefits soils by recycling nutrients. No new trails or changes in allowed uses that would compact soils.	Minimal soil displacement and loss would result from proposed new headquarters/ visitor contact facility and on less than an acre of proposed new trails, and/or during demolition of unnecessary facilities. Soil impacts resulting from building construction partially offset by locating new building in already disturbed area. Removal of unnecessary buildings and other infrastructure would provide long term benefits to soil conditions; this includes potential removal of buildings in the Weapons Storage Area and at Fabyan Point. Restoration of approximately 5 to10 acres of grassland with removal of roads and buildings associated with former Weapons Storage Area. Removal of the Lower Peverly Pond impoundment infrastructure and restoration to stream habitat would improve soil conditions by eliminating the existing soil erosion and sedimentation from the deteriorating dike. Greater ability to address existing and potential sediment contamination in the Peverly Brook system through monitoring and remediation, and dam removal where feasible and greater ability to manage remaining infrastructure to prevent erosion, gulling, and other adverse soil impacts. Maintaining grasslands and shrublands and controlling invasive plants poses slight risk to soils. Prescribed fire releases nutrients back into the soil. Increased annual visitation by 10 percent might result in increased trampling and soil compaction along trails and around visitor facilities. We would design our monitoring, outreach, and education programs to reduce risk. *Karner Blue Butterfly easement:* In addition to alternative A, a shift in emphasis from lupine seedling planting to seeding of lupine would result in less soil disturbance.	Long-term benefits to soils exceeds those of alternatives A and B through removal of all three impoundments and restoration of stream habitat, elimination of grassland and shrubland management, and removal of all remaining structures and unnecessary management access roads and restoring such sites to natural conditions. Similar to alternative B, limited soil displacement and loss would result from proposed new headquarters/visitor contact facility and on less than an acre of proposed new trails. Soil impacts resulting from building construction would be partially offset by locating new building in already disturbed area. As in alternative B, there would still be some localized increase in soil impacts where public access and use occurs. We would design our monitoring, outreach, and education programs to reduce risk. Some risk to soils remains, associated with invasive plant control using herbicides. In the long term, restoring native habitats and natural communities would help restore and maintain soil productivity at these sites. *Karner Blue Butterfly easement:* Same as alternative B.
	Impacts that do not vary between the alternatives Under all the alternatives, the refuge would use IPM to control invasive species, including chemical and mechanical control which have the greatest potential to adversely affect soils. We would only use mechanical control when we determine the potential for soil disturbance is low. When applying herbicides, we would use only herbicides approved by the Regional Contaminants Coordinator and only in accordance with approved rate and timing of application.		

Resources	Management Focus		
	Alternative A– Current Management	**Alternative B– Emphasis on Habitats and Focal Species (Service Preferred)**	**Alternative C– Emphasis on Natural Processes**
Vegetation	Salt marsh vegetation would continue to benefit from resource protection by limiting public access and through invasive plant monitoring and control. Wetland vegetation varies year to year based on water level management. Grass and shrub vegetation continue to be actively managed. Due to a lack of staff, we would have little opportunity to monitor vegetation responses to management regimes. Since there would only be limited, pedestrian only public access into most of the refuge, we only predict minimal impacts to vegetation. *Karner Blue Butterfly easement:* Restoration of pine barrens habitat, including pitch pine and wild lupine, through prescribed fire and other management provides long-term benefit to native vegetation and plant community health.	Benefits to salt marsh vegetation would be slightly higher than alternative A with greater visitor education about sensitivity of salt marsh communities and through enhanced monitoring of sea level rise and baseline conditions of salt marsh health. Grassland and shrubland vegetation would receive the most management attention. Grasslands require active and intensive management to maintain with mowing, burning, and/or clearing of woody vegetation to maintain large openings. Shrubland management would be less intensive as need longer rotational management intervals. Planting of shrubs may require limited seasonal activities. Some riparian vegetation would be restored to Peverly Brook following removal of the Lower Peverly Dam. We would restore approximately 30 acres of the former Weapons Storage Area to native grassland. More active monitoring of vegetation responses to habitat management. A modest expansion of trails and hunting program would have negligible impacts on vegetation. The location of the new visitor contact facility would mostly be in an already disturbed area. *Karner Blue Butterfly easement:* Same as alternative A.	Benefits to salt marsh vegetation will be the highest under alternative C. In addition to the strategies in alternatives A and B, under alternative C, we would restore salt marsh and other estuarine habitat to the former Stubbs Pond once the impoundment infrastructure is removed. Similarly, riparian vegetation would eventually be restored to the Peverly Brook drainage once impoundments are removed. Shrub and grassland plant species would decline, except in areas maintained through natural disturbances. Forest vegetation would benefit the most under this alternative as areas of grass and shrub are allowed to succeed naturally to forest over time. The emphasis would be on maintaining the native forest types based on site capabilities. Similar to B, negligible impacts to vegetation from trails and new building; benefits from closure of many refuge management roads that would no longer be necessary. *Karner Blue Butterfly easement:* Same as alternative A.
	Impacts that do not vary between the alternatives Under all the alternatives we would continue to map, monitor, prioritize, and implement controls for invasive plant species across all habitat types. Control of invasive plant species offers minimal risk of damage to native grass, shrub, and forest vegetation. Herbicides would be used only under strict application regulations and procedures to ensure that only targeted plants are affected.		

Resources	Management Focus		
	Alternative A– Current Management	**Alternative B– Emphasis on Habitats and Focal Species (Service Preferred)**	**Alternative C– Emphasis on Natural Processes**
Migratory Birds	Maintenance of the three existing impoundments would continue to provide habitat for a mix of open water, emergent marsh, and scrub-shrub wetland birds. Grassland and shrubland birds would continue to benefit from the management of these habitats. Burning, mowing, or cutting of these habitats is timed to avoid the nesting season. Maintaining 659 acres of upland forest and 149 acres of forested wetland would benefit forest-dependent species of concern such as scarlet tanager, wood thrush, and Baltimore oriole. *Karner Blue Butterfly easement:* Restoration of pine barrens habitat would benefit a suite of species including common nighthawk, whip-poor-will, eastern towhee, field sparrow, and prairie warbler.	Removal of the Lower Peverly Pond Dam would have limited negative impact on water birds, since few birds use Lower Peverly Pond, compared to Upper Peverly and Stubbs Ponds. A greater focus on the health and status of salt marsh sparrow populations on the refuge and around Great Bay would benefit this species. The amount of grassland habitat would decrease by 71 acres under alternative B. The amount of managed shrubland habitat would increase by 33 acres and be inventoried and monitored to determine the most appropriate management regimes for birds and potentially New England cottontail. The emphasis on invasive removal and maintaining native shrubs would benefit migratory birds. A projected increase in visitation (10 percent) and an expanded hunting program may disturb migratory birds. To minimize this impact hunting zones would be established and all other public use would be restricted to designated trails. *Karner Blue Butterfly easement:* Same as alternative A.	Benefits to grassland and shrub dependent birds would decline as these habitats are not maintained through active management. Forest dependent birds would realize a slight increase in benefits as grassland and shrubland habitats are allowed to succeed naturally over time to forest. With the removal of all the impoundment infrastructure, we anticipate a decline in open water and freshwater marsh birds, such as waterfowl, herons, and rails, and an increase in salt marsh dependent species such as salt marsh sparrow and possibly scrub-shrub (riparian and wetland edge) bird species. As in alternative B, a greater focus on the salt marsh sparrow populations around Great Bay would further benefit this species. A projected increase in visitation (10 to 12 percent and an expanded hunting program may disturb migratory birds. To minimize this impact, all public use, excepting hunting, would be restricted to designated trails. *Karner Blue Butterfly easement:* Same as alternative A.
	Impacts that do not vary between the alternatives We would continue to monitor and control invasive plant species under all alternatives. By removing invasive species and encouraging native vegetation, we would improve the quality of cover and forage for migratory birds. We would continue to prohibit public access to sensitive migratory bird habitat, including 2 acres of rocky shoreline habitat.		

Resources	Management Focus		
	Alternative A– Current Management	**Alternative B– Emphasis on Habitats and Focal Species (Service Preferred)**	**Alternative C– Emphasis on Natural Processes**
Fisheries	Migratory fish, including American eel, and river herring would continue to benefit from the fish passage into Stubbs Pond. American eel would continue to be able to migrate up Peverly Brook to Upper Peverly Pond and use the deep pools in both ponds as cold water refugia in summer. Stubbs Pond would continue to provide habitat for American eel and spawning river herring. *Karner Blue Butterfly easement:* No fisheries resources exist on the easement.	The removal of the Lower Peverly Pond Dam could diminish cold water refugia habitat for American eel. This might be offset by beaver damming parts of Peverly Brook, creating pools of cooler water along the drainage from Upper Peverly Pond to Stubbs Pond. Under alternative B, we would evaluate the effectiveness of the Stubbs Pond fish passage to ensure it maximizes benefits to migratory fish. Long-term benefits to fisheries would result from routine sediment and water quality sampling in the Peverly Brook system with remediation of contaminated sediments implemented where feasible. *Karner Blue Butterfly easement:* Same as alternative A	The removal of all impoundment infrastructures in the Peverly Brook system would provide the maximum benefit to fish passage, although there might be some loss in cold water refugia within the system with the lowering of the water levels. As in alternative B, this might be offset by beaver activity. Removal of Stubbs Pond Dam would result in the loss of spawning habitat for river herring. Removal of impoundment infrastructure would be preceded by sediment, water quality and invasive plant sampling, control and remediation as feasible to improve water quality, offering long-term benefits to fisheries and other aquatic life. Removal of all impoundments could result in the direct discharge of contaminants into Herods Cove and Great Bay. *Karner Blue Butterfly easement:* Same as alternative A
	Impacts that do not vary between the alternatives Under all alternatives, we would continue to work with the Pease International Tradeport to prevent silks that may impair water quality and harm fisheries on the refuge. There would also continue to be fish health concerns due to contaminated sediments with the Peverly Brook System. The refuge would continue to monitor these sediments and water quality.		

Resources	Management Focus		
	Alternative A– Current Management	**Alternative B– Emphasis on Habitats and Focal Species (Service Preferred)**	**Alternative C– Emphasis on Natural Processes**
Threatened and Endangered Species: Karner blue butterfly and New England cottontail	The Karner blue butterfly population would continue to benefit from the Service's support of NHFG's habitat management and Karner blue butterfly monitoring.	Benefits to the Karner blue butterfly population are expected to be significantly greater under alternative B due to increased emphasis on conserving additional pine barrens habitat, more coordinated habitat management, greater support for monitoring and evaluation of the captive rearing and release program, and more onsite outreach and education about Karner blue butterflies and pine barrens ecology. The New England cottontail, a candidate species, would benefit from potential new land conservation and shrub habitat management on the refuge. Also, we would consider using a portion of the refuge as a captive-rearing site for New England cottontail.	The benefits to Karner blue butterflies would be the same as alternative B. New England cottontail would not benefit under this alternative as grassland and shrublands would be allowed to succeed naturally to forest cover.
Biological Integrity, Diversity, and Environmental Health	We would continue to remove former military infrastructure and restore these sites to native vegetative communities. We would continue to rely on partners to restore and manage the biological integrity of intertidal and shallow estuarine zones just offshore of the refuge. We would also continue to maintain all three impoundments, which would provide minimal opportunity to restore environmental health and integrity to the Peverly Brook system. *Karner Blue Butterfly easement:* We would continue to restore and manage the Concord pine barrens ecosystem, benefiting the Karner blue butterfly, rare moths, migratory birds, and pitch pine plant community.	Benefits to intertidal and other estuarine habitats and species in the Great Bay Estuary, including oysters and eelgrass, would increase significantly under alternative B. The refuge would work with partners to protect and restore the health and function of these habitats and to restore populations of oysters and eelgrass. Maintaining shrub and grassland habitats would provide greater habitat diversity, although with some loss of biological integrity since these habitats require active management to maintain. The removal of Lower Peverly Pond Dam would result in partial restoration of the biological integrity of the Peverly Brook system. Bats and New England cottontails would likely benefit under this alternative through active management of a portion of the former Weapons Storage Area. *Karner Blue Butterfly easement:* Same as alternative A.	Similar to alternative B, we anticipate benefits to the intertidal and estuarine habitats in the Great Bay Estuary. Natural communities and rare plants would be a focus under this alternative through restoration of habitats, control of invasive plants, and reliance on natural ecological processes. Restoration of the biological integrity of the entire Peverly Brook system through removal of all impoundment infrastructure and restoration of environmental health through removal of contaminated sediments. We would restore and maintain natural forest conditions, which should provide natural roosting habitats for tree-dwelling bats. *Karner Blue Butterfly easement:* Same as alternative A.
	Impacts that do not vary between the alternatives Under all alternatives, we would protect roosting and nesting bald eagles, restrict public access to sensitive habitats, and protect rare plants and exemplary natural communities. We would also continue to monitor and control invasive plants species. The potential short-term impacts of herbicides for invasive plant treatment would be offset by the long-term habitat and food resource benefits of restoring native vegetation.		

Resources	Management Focus		
	Alternative A– Current Management	**Alternative B– Emphasis on Habitats and Focal Species (Service Preferred)**	**Alternative C– Emphasis on Natural Processes**
Public Uses and Access	Due to lack of staffing under alternative A, the refuge office would remain closed, providing no visitor contact facility. Wildlife observation and photography would continue to be the primary priority public uses. Two pedestrian trails (2 miles and 0.5 miles, respectively) would continue to be maintained. A 2-day deer hunting season would continue to be offered in the fall with support from NHFG. *Karner Blue Butterfly easement:* We expect that the easement would continue to receive only a small number of visitors. Priority public uses include wildlife observation, photography, environmental education, interpretation. Hunting and fishing would not be available.	Under alternatives B, a new refuge office and visitor contact station would be built, with up to four refuge staff, significantly increasing the interaction of visitors with refuge personnel. The two trails would be enhanced with improved observation blinds and wildlife viewing platforms and better signage and interpretive displays, enhancing the experience of refuge visitors. The hiring of a visitor services specialist would significantly increase the environmental education and interpretive offerings both on and off the refuge. We would pursue expansion of hunting opportunities to include wild turkey and fall bow season for deer. *Karner Blue Butterfly easement:* In addition to alternative A, more interpretive information and enforcement of unauthorized use would enhance visitor experiences.	In addition to alternative B, A new spur trail off the Upper Peverly trail that leads out to Woodman Point would provide access to more of the refuge. *Karner Blue Butterfly easement:* Same as alternative B.
	Impacts that do not vary between the alternatives Under all the alternatives we will continue to prohibit fishing, given the uncertainty about contaminated sediments in the Peverly Brook system and the sensitivity of salt marsh and other habitats along the shores of Great Bay. We will work with our partners around Great Bay to steer anglers to more appropriate fishing locations. The refuge would continue to be open to the public from sunrise to sunset.		
Cultural Resources	A lack of staff at the Great Bay Refuge provides limited opportunity to offer interpretive programs or otherwise address cultural resources. *Karner Blue Butterfly easement:* Cultural resources benefit from more detailed inventories and surveys prior to habitat management on the pine barrens in Concord.	Our environmental education and interpretive programs at the Great Bay Refuge would highlight the cultural history of the refuge lands, including historic buildings and uses. We would complete consultation with SHPO on all refuge buildings and determine the management options and/or mitigation measures to implement to insure compliance with section 106 of NHPA. *Karner Blue Butterfly easement:* Same as alternative B.	Same as alternative B *Karner Blue Butterfly easement:* Same as alternative B.
	Impacts that do not vary between the alternatives Under all the alternatives, we would work with the SHPO to assess the range of options for the Margeson Estate, which is on the National Register.. On all projects, including removal of other non-essential structures at Fabyan Point and in the Weapons Storage Area, we would ensure compliance with section 106 of the National Historic Preservation Act and consult with SHPO.		

Chapter 5

USFWS

Public scoping meeting

Consultation and Coordination

- Introduction
- Planning Process
- Contact Information
- Planning Team
- Other Service Program Involvement
- Partners Involved in Refuge Planning

Introduction

This chapter describes how we engaged others in developing this draft CCP/EA. It details our efforts to encourage the involvement of the public and conservation partners, including other Federal and State agencies, county officials, civic groups, non-government conservation and education organizations, and user groups. It also identifies who contributed significantly to the content or writing of the plan.

According to Service policy, we must review and update our final CCP at least once every 15 years. We may need to revise it sooner, either in response to significant new information that would markedly change management direction, or if the Service Director or our Regional Director deem it necessary. If so, we will once again announce our revised planning and encourage your participation.

Planning Process

March 12, 2009	Attended a Great Bay Resource Protection Partnership meeting in New Hampshire along with representatives from New Hampshire Fish and Game, The Nature Conservancy, New Hampshire Audubon, Society for the Protection of New Hampshire Forests, and the US Department of Agriculture–Natural Resource Conservation Service.
March 25, 2009	Attended a Seabrook, New Hampshire Estuary Meeting along with Sue Foote of the Seabrook Conservation Commission and Seabrook Selectmen Theresa Walker.
April 15, 2009	Attended a Pease International Airport Wildlife/ Bird-Air Strike Hazard Meeting along with representatives of New Hampshire Air National Guard, U.S. Department of Agriculture, New Hampshire Fish and Game, and Pease International Tradeport.
April 2009	Conducted a cultural resources site assessment at the Great Bay Refuge in coordination with Regional cultural resource staff.
May 20, 2009	Conducted Congressional outreach visits in Washington, D.C. with Senator Jeanne Shaheen, Senator Judd Gregg, and Congresswomen Carol Shea-Porter.
June 2009	Distributed a Great Bay Refuge CCP issues workbook and planning newsletter to approximately 142 individuals. The workbook was also available at refuge headquarters and at outreach events.
June 11, 2009	Attended a Great Bay Resource Protection Partnership meeting and distributed copies of the Great Bay CCP issue workbook and planning newsletter to meeting's attendees.
June 17, 2009	Published a Notice of Intent in the Federal Register announcing that we have initiated the planning process for the refuge.

June 18, 2009	Held an Open House and Public Scoping meeting at Town Hall in Newington, New Hampshire; 22 people attended.
June 19, 2009	Attended a Mountain View Hiking Club meeting.
June 25, 2009	Attended a Piscataqua Region Estuaries Partnership Meeting in New Hampshire along with representatives from the University of New Hampshire, New Hampshire Fish and Game and many other conservation partners.
July 8, 2009	Held a State and Federal agencies partners meeting at Great Bay Discovery Center, in Stratham, New Hampshire.
April 2009–February 2010	Held six core planning team meetings to discuss goals, objectives, and strategies for each alternative.
March 26, 2010	Held a briefing on the progress of the draft CCP/EA for the Service's Northeast Regional Office Senior Leadership Team.
May 24, 2010	Held a site visit at Great Bay Refuge with State and Federal partners to discuss alternatives for impoundment management on Peverly Brook system.
November 17, 2010	Met with two representatives from the State Historical Preservation Office onsite to look at existing and potentially historic structures.

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Other Service Program Involvement

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Partners Involved in Refuge Planning

Refuge programs received a great deal of support and input from outside the Service during our planning process. Many of these partners help us with biological surveys, enhancing public use and refuge programs, restoring habitat, law enforcement, and protecting land. Our partnerships will continue to expand under the increasing interest in conserving refuge resources. During the development of the draft CCP/EA, the following organizations and people provided input:

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- New Hampshire Fish and Game Department: Steve Fuller, Heidi Holman, Glenn Normandeau, Cheri Patterson, Ed Robinson, Lindsay Webb, Steve Weber
- New Hampshire Coastal Program: Chris Williams
- Piscataqua Region Estuaries Partnership: Jennifer Hunter, Derek Sowers
- The Nature Conservancy: Mark Zankel
- Ibis Wildlife Consulting: Ellen Snyder (Plan Preparer)

Tom Stehn/USFWS

White-tailed deer fawn

Bibliography

Bibliography

Abrams, M.D. 1992. Fire and the development of oak forests. BioScience v42(5):346-353.

Amaral, Michael. 2000. A proposal to translocate Karner blue butterflies (*Lycaeides Melissa samuelis*) from New York to New Hampshire. Prepared for the New York State Department of Environmental Conservation and the U.S. Fish and Wildlife Service Region 5, Endangered Species Office by the Senior Endangered Species Specialist, New England Field Office, Concord, New Hampshire.

American Farmland Trust. 2010. Cost of community services studies. Farmland Information Center Fact Sheet; *http://www.farmland.org/documents/Cost-of-Community-Services-08-2010.pdf*

American Rivers. 2002. The Ecology of Dam Removal: A summary of benefits and impacts. February 2002. pp. 15

Arbuthnot, M. 2008. A landowner's guide to New England cottontail habitat management. Environmental Defense Fund.

Askins, R. A. 1997. History of grasslands in the northeastern United States: implications for bird conservation. Pages 119-136 in P. D. Vickery and P. W. Dunwiddie, editors. Grasslands of northeastern North America: ecology and conservation of native and agricultural landscapes. Massachusetts Audubon Society, Lincoln, Massachusetts.

Askins, R. A. 2000. Restoring North America's birds: lessons from landscape ecology. Yale University Press, New Haven, Connecticut.

Association of Fish and Wildlife Agencies. 2009. Voluntary guidance for States to incorporate climate change into State wildlife action plans & other management plans. Washington, D.C.

Atlantic Flyway Council. 2003. Atlantic Flyway mute swan management plan, 2003-2013.

Auger, P. 1996. Does open space pay? University of New Hampshire Cooperative Extension, Durham, New Hampshire.

Bertness, M. D., P. J. Ewanchuk, and B. R. Silliman. 2002. Anthropogenic modification of New England salt marsh landscapes. Proceedings of the National Academy of Sciences of the United States of America 99: 1395-1398.

Bolster, J., editor. 2002. Cross-grained and wily waters. Peter E. Randall Publisher, Portsmouth, New Hampshire.

Bonnichsen, R., G. L. Jacobson, Jr., R. B. Davis, and H. W. Borns, Jr. 1985. The environmental setting for human colonization of northern New England and adjacent Canada in late Pleistocene time. Pages 151-159 in H. W. Borns,, Jr., P. LaSalle, and W. B. Thompson, editors. Late Pleistocene history of northeastern New England and adjacent Quebec. Geological Society of America Special Paper 197.

Brown, J. 2008. Great Bay National Wildlife Refuge fish survey report. U.S. Fish and Wildlife Service Central New England Fishery Resources Office, Nashua, New Hampshire.

Brown, S., C. Hickey, B. Harrington, and R. Gill, editors. 2001. The U.S. shorebird conservation plan, 2nd edition. Manomet Center for Conservation Sciences, Manomet, Massachusetts.

Capel, C. 2006. Maintaining and restoring grasslands. Chapter 3 in J. D. Oehler, D. F. Covell, S. Capel, and B. Long, editors. Managing grasslands, shrublands, and young forests for wildlife: a guide for the northeast. The Northeast Upland Habitat Technical Committee, Massachusetts Division of Fisheries and Wildlife.

Carver, E., and J. Caudill. 2007. Division of Economics US Fish and Wildlife Service "Banking on Nature 2006; The Economic Benefits to Local Communities of National Wildlife Refuge Visitation" Washington, D.C. Accessed at: *http://www.fws.gov/refuges/about/pdfs/BankingOnNature2006_1123.pdf.*

Chandler, C.C. 2007. Habitat use and survival of Neotropical migrant songbirds during the post-fledging period in the White Mountain National Forest. M.S. Thesis. The University of Massachusetts, Amherst.

Clark, K. E., and L. J. Niles. 2000. Northern Atlantic regional shorebird plan. New Jersey Division of Fish and Wildlife, Woodbine, New Jersey.

Clough, J. S., and E. C. Larson. 2009. Application of the sea-level affecting marshes model (SLAMM 5.0) to Great Bay NWR. Warren Pinnacle Consulting, Inc., Warren, Vermont.

Conover, A.M., C.K. Williams, V.D'Amico. 2010. The impact of non-native plants on bird communities in suburban forest fragments. Poster presented at the 66th Annual Northeast Fish and Wildlife Conference, Newton, MA. MS candidate at University of Delaware. Department of Entomology and Wildlife Ecology.

Cronin, W. 1983. Changes in the land: Indians, colonists, and the ecology of New England. Hill and Wang, New York, New York.

Davis, M. B. 1981. Quaternary history and the stability of forest communities. Pages 133-153 in D.C. West, H.H. Shugart, and D.B. Botkin, editors. Forest succession. Springer-Verlag, New York, New York.

Davis, M.B. 1983. Holocene vegetational history of the United States. Pages 166-181 in H.E. Wright, Jr, editor. Late-Quaternary environments of the United States, Volume 2: The Holocene. University of Minnesota Press, Minneapolis, Minnesota.

DeGraaf, R. M., and M. Yamasaki. 2001. New England wildlife: habitat, natural history, and distribution. University Press of New England, Hanover, New Hampshire.

Department of the Air Force. 2001. Landfill 1—2000 annual report Pease Air Force Base, Portsmouth, New Hampshire. Prepared by Montgomery Watson, Malvern, Pennsylvania.

Dettmers, R. 2003. Status and conservation of shrubland birds in the northeastern US. Forest Ecology and Management 185: 81-93.

Dettmers, R. 2006. A blueprint for the design and delivery of bird conservation in the Atlantic northern forest. U.S. Fish and Wildlife Service, Hadley, Massachusetts.

Dettmers, R., and K. V. Rosenberg. 2000. Partners in Flight landbird conservation plan, physiographic area 9: Southern New England. American Bird Conservancy, Arlington, Virginia.

Dodds, K. J., and R. Cooke. 2006. Forest health assessment Great Bay National Wildlife Refuge. U.S. Forest Service, Forest Health Protection, Durham Field Office, Durham, New Hampshire.

Drury, W. H. 1973. Population changes in New England seabirds. Bird-banding, 44:267-313.

Foss, C. R. 1992. Wildlife in a changing landscape. Pages 14-22 in R. Ober, editor. At what cost? Shaping the land we call New Hampshire. New Hampshire Historical Society and the Society for the Protection of NH Forests, Concord, New Hampshire.

Foster, D. R., and G. Motzkin 2003. Interpreting and conserving the openland habitats of coastal New England: insights from landscape history. Forest Ecology and Management, 185:127-150.

Foster, D.R, G. Motzki, D. Bernardos, and J. Cardoza. 2002. Wildlife dynamics in the changing New England landscape. Journal of Biogeography, 29:1337-1357.

Frick, W.F., J.F. Pollock, A.C. Hicks, K.E. Langwig, D.S. Reynolds, G.G. Taylor, C. M. Butchkoski, and T.H. Kunz. 2010. An emerging disease causes regional collapse of a common North American bat species. Science 329(5992):679-682.

Fuller. S. G. 2008. Population dynamics of the endangered Karner blue butterfly (*Lycaeides Melissa samuelis*) Dissertation, SUNY. Syracuse, New York.

Gies, E. 2009. Conservation: an investment that pays, the economic benefits of open space. The Trust for Public Land, San Francisco, California.

Graham, R. W. 1992. Late Pleistocene faunal changes as a guide to understanding the effects of greenhouse warming on the mammalian fauna of North America. Pages 76-87 in R.L. Peters and T.E. Lovejoy, editors. Global Warming and Biological Diversity. Yale University Press, New Haven, Connecticut.

Greater Portsmouth Chamber of Commerce (GPCC). 2006. Portsmouth is an Established Hub of Global Trade. Portsmouth, New Hampshire. Accessed at: *www.portsmouthchamber.org/globaltrade2006.cfm.*

Greenlaw, J. S., and J. D. Rising. 1994. Sharp-tailed sparrow (*Ammodramus caudacutus*). In The Birds of North America, No. 112 (A. Poole and F. Gill, Eds). Philadelphia: The Academy of Natural Sciences, Washington, D.C.

Hart, D.D., Johnson, T.E., Bushaw-Newton, K.L., Howitz, R.J., Bednarek, A.T., Charles, D.F., Kreeger, D.A., and D.J. Velinsky. 2002. Dam removal: challenges and opportunities for ecological research and river restoration. Bioscience 52(8): 669-681.

Helmbolt, K., and M. Amaral. 1994. Status of the Karner blue butterfly in New Hampshire. Pages 123-128 in D.A. Andow, R.J. Baker, and C.P. Lane, eds. Karner blue butterfly: a symbol of a vanishing landscape. Minnesota Agricultural Experiment Station. St. Paul, Minnesota.

Hodgman, T. P., and K. V. Rosenberg. 2000. Partners in flight bird conservation plan for the Northern New England physiographic area 27.

Holman, H. 2010. Email communication from Heidi Holman, Biologist at NH Fish and Game to Nancy Pau, Wildlife Bioloigst at Parker River NWR, dated 12/6/2010. Email available at Parker River NWR, Newburyport, MA.

Hunt, P. The State of New Hampshire's Birds *prepared by* the Conservation Division, New Hampshire Audubon *for* the Nongame and Endangered Wildlife Program, New Hampshire Fish and Game Department. December 2009. 51 pg.

Joint Sciences Academies' Statement. 2005. *http://www.nationalacademies.org/onpi/06072005.pdf*

Jones, S. H., editor. 2000. A Technical Characterization of Estuarine and Coastal New Hampshire. Jackson Estuarine Laboratory, University of New Hampshire, Durham, USA.

Justice, D., and F. Rubin. 2006. Impervious surface mapping in coastal New Hampshire (2005). A final report to the New Hampshire Estuaries Project by Complex Systems Research Center, University of New Hampshire, Durham, New Hampshire.

Klapproth, Julia C. and James E. Johnson. 2000. Understanding the Science Behind Riparian Forest Buffers: Effects on Water Quality. Virginia Cooperative Extension, College of Natural Resources, Virginia Tech, Blacksburg, VA. Publication Number 420-151. 16pp.

Kovach, A. and L. Fenderson. 2000. Conservation genetics of New England Cottontail: insight from broad-scale (range-wide) and fine-scale (Maine & New Hampshire) Investigations, A report for managers. University of New Hampshire, Durham, NH.

Kushlan, J. A., M. J. Steinkamp, K. C. Parsons, J. Capp, M. A. Cruz, M. Coulter, I. Davidson, L. Dickson, N. Edelson, R. Elliot, R. M. Erwin, S. Hatch, S. Kress, R. Milko, S. Miller, K. Mills, R. Paul, R. Phillips, J. E. Saliva, B. Sydeman, J. Trapp, J. Wheeler, and K. Wohl. 2002. Waterbird conservation for the Americas: the North American waterbird conservation plan, version 1. Waterbird Conservation for the Americas. Washington, DC, U.S.A.

Inkley, D. B., M. G. Anderson, A. R. Blaustein, V. R. Burkett, B. Felzer, B. Griffith, J. Price, and T. L. Root. 2004. Global climate change and wildlife in North America. Wildlife Society Technical Review 04-2. The Wildlife Society, Bethesda, Maryland.

Institute for New Hampshire Studies (INHS). 2009a. New Hampshire Visitor Survey 2007-2008. *Prepared for*: the New Hampshire Division of Travel and Tourism Development. Plymouth State University. Plymouth, New Hampshire. Accessed at: *http://oz.plymouth.edu/inhs/VisitorSurveys/NEW_HAMPSHIRE_VISITOR_SURVEY_2007-08.doc.*

Institute for New Hampshire Studies (INHS). 2009b. Rooms and Meals Taxes Collected. *Prepared for*: the New Hampshire Division of Travel and Tourism Development. Plymouth State University. Plymouth, New Hampshire. Accessed at: *http://oz.plymouth.edu/inhs/EconomicReports/Rooms_&_Meals_Taxes_Collected.doc.*

Lane, O.P., A. Major, K. O'Brien, N.Pau and D.C.Evers. 2008. Methymercury availability in New England estuaries as indicated by saltmarsh sharp-tailed sparrows, 2004-2007. Report BRI 2008-11. BioDiversity Research Institute, Gorham, Maine.

Lenhart, C.F. 2000. The vegetation and hydrology of impoundments after dam removal in southern Wisconsin. Master's Thesis. University of Wisconsin, Madison, WI.

Litvaitis, J. A. 2003. Are pre-Columbian conditions relevant baselines for managed forests in the northeastern United States? Forest Ecology and Management, 185:113-126.

Livaitis, J.A. and J.P. Tash. 2006. Status, habitat features associated with remnant populations, and identification of sites for restoration and translocation of New England cottontails. Final report to the U.S. Fish and Wildlife Service, New England Field Office, Concord, NH.

Lorimer, C. G. 1977. The presettlement forest and natural disturbance cycle of northeastern Maine. Ecology, 58:139-148.

Lorimer, and A.S. White. 2003. Scale and frequency of natural disturbances in the northeastern US: implications for early successional forest habitats and regional age distributions. Forest Ecology and Management, 185:41-64.

Marchand, P. J. 1987. North woods: an inside look at the nature of forests in the Northeast. Appalachian Mountain Club, Boston, Massachusetts.

McKinley, P. and P. Hunt. 2008. Avian use of the Hampton-Seabrook Estuary: 2006-2007. New Hampshire Audubon, Concord, New Hampshire.

Memorandum of Agreement. 1992. Memorandum of Agreement, U.S. Fish and Wildlife Service, Federal Aviation Administration, U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Animal Damage Control, and Pease Development Authority.

Mills, K. 2009. Ecological trends in the Great Bay Estuary. 20 year anniversary report. Great Bay National Estuarine Research Reserve, Durham, New Hampshire

National Invasive Species Council. 2001. Meeting the invasive species challenge: national invasive species management plan. Washington, D.C.

New Hampshire Bird Record. 2009. New Hampshire's Important Bird Area (IBA) Program. Acessed at: *http://www.nhbirdrecords.org/bird-conservation/IBA.htm.*

New Hampshire Economic Conditions. Vol 109 No 2. Accessed at: *http://www.nh.gov/nhes/elmi/pdfzip/econanalys/econcond/EC_0209.pdf.*

New Hampshire Department of Employment Security. 2009. Vital signs 2009 economic and social Indicators for New Hampshire 2004-2007. State of New Hampshire. Economic and Labor Market Information Bureau, www.nh.gov/nhes/elmi/pdfzip/econanalys/vitalsigns/vs2009/VitalSigns2009.pdf.

New Hampshire Department of Environmental Services–Coastal Program (NHDES). 2005a. Life in New Hampshire Salt Marshes: Quick Reference Field Guide. June 2005. Accessed online December 2011 at: *http://des.nh.gov/organization/commissioner/pip/publications/wd/documents/wd-04-19.pdf.*

New Hampshire Department of Environmental Services–Coastal Program (NHDES). 2005a. A Volunteer's Handbook for Monitoring New Hampshire Salt Marshes. September 2005. Accessed online December 2011 at: *http://des.nh.gov/organization/commissioner/pip/publications/wd/documents/wd-04-21.pdf.*

New Hampshire Estuaries Project. 2000. New Hampshire Estuaries Project Management Plan. New Hampshire Estuaries Project, Portsmouth, New Hampshire.

New Hampshire Estuaries Project. 2006. State of the estuaries 2006. New Hampshire Estuaries Project, Durham, New Hampshire.

New Hampshire Estuaries Project. 2007. The impacts of impervious surfaces on water resources. University of New Hampshire, Durham, New Hampshire.

New Hampshire Fish and Game. 2005. New Hampshire Wildlife Action Plan. New Hampshire Fish and Game Department, Concord, New Hampshire.

New Hampshire Fish and Game. 2006. Species Profile: Karner blue butterfly (*Lycaeides Melissa samuelis*). New Hampshire Fish and Game Department, Concord, New Hampshire.

New Hampshire Natural Heritage Bureau. 1990. An ecological inventory of Pease Air Force Base. New Hampshire Natural Heritage Bureau, Concord, New Hampshire.

New Hampshire Natural Heritage Bureau. 2010. Rare Plants, Rare Animals,and Exemplary Natural Communities in New Hampshire Towns. July 2010. Accessed at: *http://www.nhdfl.org/library/pdf/Natural%20Heritage/Townlist.pdf.*

New Hampshire Office of Energy and Planning. 2006. New Hampshire population projections for state and counties 2010 to 2030. Concord, New Hampshire. *www.nh.gov/oep/programs/DataCenter/Population/documents/populationforcountiesbyageandsex.pdf.*

New Hampshire Office of Energy and Planning. 2007. New Hampshire Outdoors 2008-2013–statewide comprehensive outdoor recreation plan. Concord, New Hampshire.

Norment, C. 2002. On grassland bird conservation in the northeast. The Auk, 119:271-279.

Odell, J., A. Eberhardt, D. Burdick, and P. Ingraham. 2006. Great Bay estuary compendium. The Nature Conservancy, Concord, New Hampshire.

Patterson, W. A., III, and K. E. Sassaman. 1988. Indian fires in the prehistory of New England. Pages 107-135 in G.P. Nicholas, editor. Holocene human ecology in northeastern North America. Plenum Press, New York, New York.

Pease Development Authority. 2006. Pease International Tradeport. Portsmouth, New Hampshire. Accessed at: *http://www.peasedev.org/pease/tradeport.asp.*

Peteroy, A.V. 1998. 1998 Karner blue butterfly (*Lycaeides melissa samuelis*) captive rearing results: Concord Pine Barrens, Concord New Hampshire. The Nature Conservancy, Concord, New Hampshire.

Pielou, E. C. 1991. After the ice age: the return of life to glaciated North America. The University of Chicago Press, Chicago, Illinois.

Pimentel, D., L. Lach, R. Zuniga, and D. Morrison. 2000. Environmental and economic costs of nonindigenous species in the United States. BioScience 50:53-65.

Pinkney, A. E., S. K. Krest, L. Eaton-Poole, and D. R. Sutherland. 2005. Investigation of abnormalities in frogs on region 5 National Wildlife Refuges: 2004 yearend report. U. S. Fish and Wildlife Service, Annapolis, Maryland.

Piscataqua Region Estuaries Partnership. 2009. State of the estuaries 2009. Piscataqua Region Estuaries Partnership, University of New Hampshire, Durham, New Hampshire.

Piscataqua Region Estuaries Partnership. 2010. Piscataqua region comprehensive conservation and management plan. Piscataqua Region Estuaries Partnership, University of New Hampshire, Durham, New Hampshire.

Prasad, A. M., L. R. Iverson., S. Matthews., M. Peters. 2007-ongoing. A Climate Change Atlas for 134 Forest Tree Species of the Eastern United States [database]. *http://www.nrs.fs.fed.us/atlas/tree,* Northern Research Station, USDA Forest Service, Delaware, Ohio.

Rodenhouse, N.L., S.N. Matthews, K.P. McFarland, J.D. Lambert, L.R. Iverson, A. Prasad, T.S. Sillett, and R.T. Holmes. 2008. Potential effects of climate change on birds of the Northeast. *Mitigation and Adaptation Strategies for Global Change*. In press.

Rodewald, P.G. and M.C. Brittingham. 2004. Stopover habitats of landbirds during fall: use of edge-dominated and early-successional forests. Auk 121:1040-1055.

Rowe, J. F. 1987. Newington New Hampshire, a heritage of independence since 1630. Phoenix Publishing, Canaan, New Hampshire.

Schmidt, K. A. and Whelan, C. J. (1999), Effects of Exotic *Lonicera* and *Rhamnus* on Songbird Nest Predation. Conservation Biology, 13: 1502–1506

Schroeder, M. J. 1970. Fire weather: a guide for application of meteorological information to forest fire control Operations. U.S. Department of Agriculture, Publication # 360, 229pp

Schultz, C. B., and K. M. Dlugosch. 1999. Nectar and hostplant scarcity limit populations of an endangered Oregon butterfly. Oecologia 119: 231-38.

Short, F. T., P. F. Sale, and J. A. Guy. 1992a. Characterization of estuarine habitats. Pp 25-30 *In*. F. T. Short edited The Ecology of the Great Bay Estuary, New Hampshire and Maine: an estuarine profile and biography. University of New Hampshire, Durham, New Hampshire.

Short, F. T., S. H. Jones, P. F. Sale, and P. Wellenberger. 1992b. Great Bay estuary management issues. Pp 145-164 *In*. F. T. Short edited The Ecology of the Great Bay Estuary, New Hampshire and Maine: an estuarine profile and biography. University of New Hampshire, Durham, New Hampshire.

Smith, B. 2004. What's good for the goose. Wildlife Journal. New Hampshire Fish and Game Department, Concord, New Hampshire.

Sperduto, D. 2000. Vegetation mapping summary for the Great Bay National Wildlife Refuge. New Hampshire Natural Heritage Program, Concord, New Hampshire.

Sperduto, D. 2010. Vegetation mapping summary for the Great Bay National Wildlife Refuge. New Hampshire Natural Heritage Program, Concord, New Hampshire.

Sperduto, D., and William F. Nichols. 2004. Natural Communities of New Hampshire. NH Natural Heritage Bureau, Concord, NH. Pub. UNH Cooperative Extension, Durham, New Hampshire.

Stanley, E.H. and M.W. Doyle. 2003. Trading off: the ecological effects of dam removal. Frontiers in Ecology and the Environment 1(1): 15-22.

Steincamp, M. 2006 (draft). Mid Atlantic/southern New England bird conservation region 30 implementation plan. Atlantic Coast Joint Venture, Laurel, Maryland.

Taylor, J., T. D. Thomas, and L. F. McCarthy. 1996. New Hampshire's living legacy: the biodiversity of the granite state. New Hampshire Fish and Game Department, Concord, New Hampshire.

Tefft, B. C. 2006. Managing shrublands and old fields. Chapter 4 in J. D. Oehler, D. F. Covell, S. Capel, and B. Long, editors. Managing grasslands, shrublands, and young forests for wildlife: a guide for the northeast. The Northeast Upland Habitat Technical Committee, Massachusetts Division of Fisheries and Wildlife.

Thomson, J.R., Hart, D.D., Charles, D.F., Nightengale, T.L, and D. M. Winter. Effects of removal of a small dam on downstream macroinvertebrate and algal assemblages in a Pennsylvania stream. Journal of North American Benthological Society 24(1): 192-207.

Trust for Public Land. 1999. The Economic Benefits of Parks and Open Spaces: how land conservation helps communities grow smart and protect the bottom line. Accessed at: *http://www.tpl.org/tier3_cd.cfm?content_item_id=1195&folder_id=727.*

U.S. Department of Agriculture. 1994. Soil survey of Rockingham County, New Hampshire, Parts 1 and 2. USDA Soil Conservation Service in cooperation with the New Hampshire Experiment Station.

U.S. Department of Commerce (USDOC), Census Bureau. 2007. 2005-2007 American Community Survey. Accessed at: *http://factfinder.census.gov.*

U.S. Department of Transportation, Federal Aviation Administration. 2010. Airport IQ 5010 airport master record and reports: Pease International Tradeport. *http://www.gcr1.com/5010web/airport.cfm?Site=PSM*

U.S. Environmental Protection Agency. 2010. Climate Change: Methane Sources and Emissions. *http://epa.gov/methane/sources.html.*

U.S. Fish and Wildlife Service. 1993. Hunt Plan, Great Bay National Wildlife Refuge, Newington, New Hampshire. U.S. Fish and Wildlife Service.

U.S. Fish and Wildlife Service. 1994. Great Bay National Wildlife Refuge fisheries management plan. U.S. Fish and Wildlife Service, Newington, New Hampshire.

US Fish and Wildlife Service. 1995. Environmental assessment of public hunting of white-tailed deer and waterfowl on Great Bay National Wildlife Refuge. U.S. Fish and Wildlife Service, Newington, New Hampshire.

U.S. Fish and Wildlife Service. 1999. Fulfilling the promise: the national wildlife refuge system. U.S. Fish and Wildlife, Washington, D.C.

U.S. Fish and Wildlife Service. 2003. Final recovery plan for the Karner blue butterfly *(Lycaeides melissa samuelis).* U.S. Fish and Wildlife Service, Fort Snelling, Minnesota.

U.S. Fish and Wildlife Service. 2004. A blueprint for the future of migratory birds: migratory bird program strategic plan 2004-2014. U.S. Fish and Wildlife Service, Washington, D.C.

U.S. Fish and Wildlife Service. 2004. Great Bay National Wildlife Refuge fire management plan.

U.S. Fish and Wildlife Service. 2007. National bald eagle management guidelines. U.S. Fish and Wildlife Service, Arlington, Virginia.

U.S. Fish and Wildlife Service. 2008. Birds of conservation concern 2008. United States Department of the Interior, Division of Migratory Bird Management, Arlington, Virginia.

U.S. Fish and Wildlife Service. 2009. U.S. Fish and Wildlife Service Refuge contaminant assessments website *http://ecos.fws.gov/cap/viewPublicSummaries.do.*

U.S. Fish and Wildlife Service. 2009. Drew Major, Ecological Services, personal communication

U.S. Fish and Wildlife Service. 2009a. Northeast region fisheries program strategic plan: fiscal years 2009-2013.

U.S. Fish and Wildlife Service. 2009b. Rising to the urgent challenge: strategic plan for responding to accelerating climate change.

U.S. Fish and Wildlife Service. 2009c. Great Bay National Wildlife Refuge visitor service's review. U.S. Fish and Wildlife Service, Region 5.

U.S. Fish and Wildlife Service. 2010. *Strategic Plan for Inventories and Monitoring on National Wildlife Refuges: Adapting to Environmental Change.*

U.S. Fish and Wildlife Service and Canadian Wildlife Service. 2004. North American waterfowl management plan.

U.S. Fish and Wildlife Service (USFWS) and U.S. Department of Commerce (USDOC), U.S. Census Bureau. 2002. 2001 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation. Accessed at: *http://www.census.gov/prod/2003pubs/01fhw/fhw01-nh.pdf.*

U.S. Fish and Wildlife Service (USFWS) and U.S. Department of Commerce (USDOC), U.S. Census Bureau. 2007. 2006 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation. Accessed at: *http://www.census.gov/prod/2008pubs/fhw06-nh.pdf.*

U.S. Geological Survey (USGS). 2006. Nesting Ecology and Nesting Habitat Requirements of Ohio's Grassland-nesting Birds: A Literature Review. North Prairie Wildlife Research Center. *http://www.npwrc.usgs.gov/resource/birds/ohionest/sandpipe.htm*

University of Delaware. 2008. The Mummichog (*Fundulus heteroclitus).* Accessed at: *http://www.ceoe.udel.edu/kiosk/mummichog.html.*

Vanasse Hangen Brustlin, Inc. 2005. Sediment investigation Stubbs Pond-Peverly Brook drainage system. Prepared for the New Hampshire Coastal Program.

Vanasse Hangen Brustlin, Inc. 2007. Spaulding turnpike improvements NHS-027-1(37), 11238: final environmental impact statement. Prepared for the New Hampshire Department of Transportation. *http://www.fhitestsite.com/html-studydocs/feis.html*

VanLuven, D. E. 1994. Site conservation plan for the Concord Pine Barrens, Concord New Hampshire. The Nature Conservancy, Concord, New Hampshire.

Vitz, A.C. and A.D. Rodewald. 2006. Can regnerating clearcuts benefit mature-forest songbirds? An examination of post-breeding ecology. Biological Conservation. v127:477-486.

Vitz, A. C. and A.D. Rodewald. 2007. Vegetative and fruit resources as determinants of habitat use by mature-forest birds during the postbreeding period. The Auk. v124(2):494-507.

Vogel, L. 1995. Wintering waterfowl on Great Bay. Technical Report No. 2. Great Bay National Estuarine Research Reserve, Stratham, New Hampshire.

Wake, C, K. Carpenter, J. Cox, J. Souney, P. Sanborn, and M. Rodgers. 2004. Air quality in New England. University of New Hampshire, Durham. Published at: *http://www.airmap.sr.unh.edu/background/airQuality.html.*

Walsh, J. 2009. Patterns of population structure and productivity in saltmarsh sparrows. Masters of Science Thesis. University of New Hampshire, Durham, New Hampshire.

Wigley, T.W. 2004. The science of climate change: global and U.S. perspectives. National Center for Atmospheric Research, Washington, D.C.

Wilcove, D.S., D. Rothstein, J. Dubow, A. Phillips, and E. Losos. 1998. Quantifying threats to imperiled species in the United States. BioScience 48:607-615.

Williams, B.K., R.C. Szaro, C.D. Shapiro. 2007 Adaptive Management: The U.S. Department of the Interior Technical Guide. Adaptive Management Working Group. U.S. Department of the Interior. Washington D.C.

Winne, J. C. 1997. History of vegetation and fire on the Pineo Ridge pine grassland barrens of Washington County, Maine. Pages 25-52 in P. D. Vickery and P. W. Dunwiddie, editors. Grasslands of northeastern North America: ecology and conservation of native and agricultural landscapes. Massachusetts Audubon Society, Lincoln, Massachusetts.

Yates, D. and D. Meattey. 2010. Bat survey on Parker River and Great Bay NWR 2008-09. Biodiversity Research Institute Report, Gorham, Maine.

Yocum, B. A., and W. Machurat. 2001. The Margeson-Hawkridge-Loomis Estate historic structures report. National Park Service, Northeast Region, Northeast Cultural Resources Center, Building Conservation Branch, Lowell, Massachusetts.

Zankel, M., C. Copeland, P. Ingraham, J. Robinson, C. Sinnott, D. Sundquist, T. Walker, and J. Alford. 2006. The Land Conservation Plan for New Hampshire's Coastal Watersheds. The Nature Conservancy, Society for the Protection of New Hampshire Forests, Rockingham Planning Commission, and Strafford Region Planning Commission. Prepared for the New Hampshire Coastal Program and the New Hampshire Estuaries Project, Concord, New Hampshire.

USFWS

New England cottontail

Glossary, Acronyms, and Species Scientific Names

- Glossary
- Acronyms
- List of Species and Their Scientific Names

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

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.

bathymetry the measurement of the depth of bodies of water

best management practice land management practices that produce desired results (usually describing forestry or agricultural practices effective in reducing non-point source pollution.

bioaccumulation an increase in concentration of a chemical in an organism at a higher level than expected.

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.

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.

catadromous refers to fish that migrate from freshwater to saltwater to spawn and reproduce.

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.

conservation easement a legal agreement between a landowner and a land trust or governmental agency that permanently limits some uses of a property to protect its conservation values.

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; 0-15 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.

elver life stage of an eel; young eels

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.

extirpation the localized extinction of a species that is no longer found in a locality or country, but still exists elsewhere in the world.

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.

fee-simple acquisition absolute title to the land, free of any other claims against the title.

fee-title acquisition the acquisition of most or all of the rights to a tract of land; a total transfer of property rights with the formal conveyance of a title.

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

glacial outwash glacial drift deposited by water flowing from a melting glacier.

glacial till a mixture of sand, silt, clay, and rock ground up by a glacier and dropped as it retreats.

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.

limiting factor an environmental limitation that prevents further population growth

microhabitats a small, specific habitat such as under a log or a hole in a tree.

migratory bird a bird species that migrates between wintering and breeding grounds.

millinery trade the use of bird feathers in women's hats and other clothing.

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.

relative abundance an estimate of actual or absolute abundance, usually stated as an index.

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

ACJV	Atlantic Coast Joint Venture
AFWA	Association of Fish and Wildlife Agencies
AHPA	Archaeological and Historic Preservation Act
AHWP	Annual Habitat Work Plan
ARPA	Archaeological Resources Protection Act
BCC	Birds of Conservation Concern
BCR	Bird Conservation Region
BIDEH	Biological integrity, diversity, environmental health
BRI	Biodiversity Research Institute
BTI	*Bacillus thuringiensis*, an insecticide to control mosquitoes
CCDC	Concord Community Development Corporation
CCP	Comprehensive Conservation Plan
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
CWIPP	Coastal Watershed Invasive Plant Partnership
CWS	Canadian Wildlife Service
dbh	diameter at breast height
DDT	a synthetic pesticide, dichlorodiphenyltrichloroethane
DOD	U.S. Department of Defence
EA	Environmental Assessment
EIS	Environmental Impact Statement
EPA	Environmental Protection Agency
ESA	Endangered Species Act
FAA	Federal Aviation Administration
FONSI	Finding of No Significant Impact
GBNERR	Great Bay National Estuarine Research Reserve
GBRPP	Great Bay Resource Protection Partnership
GIS	Geographic Information System
GOMI	Gulf of Maine Institute
HMP	Habitat Management Plan

IBA	Important Bird Area
IMP	Inventory and Monitoring Plan
IPCC	International Panel on Climate Change
IPM	Integrated pest management
LCC	Landscape Conservation Collaborative
LEED	Leadership in Energy and Environmental Design
LMRD	Land Management Research and Demonstration program
LPP	Lower Peverly Pond
LWCF	Land and Water Conservation Fund
MANEM	Mid-Atlantic/New England/Maritimes (Waterbird Conservation Plan)
MPA	Marine Protected Area
MOA	Memorandum of Agreement
MOU	Memorandum of Understanding
NAAMP	North American Amphibian Monitoring Program
NABCI	North American Bird Conservation Initiative
NAWCP	North American Waterbird Conservation Plan
NAWMP	North American Waterfowl Management Plan
NEFO	New England Field Office
NEPA	National Environmental Policy Act
NH	New Hampshire
NHB	New Hampshire Natural Heritage Bureau
NHDES	New Hampshire Department of Environmental Services
NHFG	New Hampshire Fish and Game Department
NHOEP	New Hampshire Office of Energy and Planning
NH WAP	New Hampshire Wildlife Action Plan
NOAA	National Oceanic and Atmospheric Administration
NWPS	National Wilderness Preservation System
NWR	National Wildlife Refuge
NWRS	National Wildlife Refuge System
OMWM	Open Marsh Water Management
PAL	The Public Archaeological Laboratory, Inc

PARC	Partners in Amphibian and Reptile Conservation
PDA	Pease Development Authority
PIF	Partners in Flight
PPP	Preliminary project proposal
PREP	Piscataqua Region Estuaries Partnership
PSNH	Public Service of New Hampshire
RONS	Refuge Operations Needs System
RV	Recreational Vehicle
SAMMS	(USFWS) Service Asset Maintenance Management System
SAV	submerged aquatic vegetation
SCEP	Student Career Experience Program
SEED	Safety Evaluation of Existing Dams report
SET	Sea Elevation Table
SHPO	State Historic Preservation Office
SLAMM	Sea-level affecting marshes model
SPNHF	Society for the Protection of New Hampshire Forests
STEP	Student Temporary Employment Program
SWG	State wildlife grant
TNC	The Nature Conservancy
TPL	Trust for Public Land
UNH	University of New Hampshire
USDA	U.S. Department of Agriculture
USEPA, EPA	U.S. Environmental Protection Agency
USFWS, Service	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
VOC	Volatile organic compound
WIA	Wilderness Inventory Area
WMA	Wildlife Management Area
WMU	Wildlife Management Unit
YCC	Youth Conservation Corps

List of Species and Their Scientific Names

Common Name	Scientific Name
Alder species	*Alnus* spp.
Alewife	*Alosa pseudoharengus*
American beech	*Fagus grandifolia*
American bittersweet	*Celastrus scandens*
American black bear	*Ursus americanus*
American black duck	*Anas rubripes*
American bullfrog	*Lithobates catesbeiana*
American chestnut	*Castanea dentata*
American coot	*Fulica americana*
American crow	*Corvus brachyrhynchos*
American eel	*Anguilla rostrata*
American goldfinch	*Spinus tristis*
American hazelnut	*Corylus americana*
American kestrel	*Falco sparverius*
American redstart	*Setophaga ruticilla*
American robin	*Turdus migratorius*
American shad	*Alosa sapidissima*
American toad	*Anaxyrus americanus*
American wigeon	*Anas americana*
American woodcock	*Scolopax minor*
Amur honeysuckle	*Lonicera maackii*
Arctic tern	*Sterna paradisaea*
Arrowhead	*Sagittaria spp.*
Arrowwood	*Viburnum dentatum*
Asian long-horned beetle	*Anoplophora glabripennis*
Atlantic salmon	*Salmo salar*
Atlantic silverside	*Menidia menidia*
Autumn olive	*Elaeagnus umbellata*
Bald eagle	*Haliaeetus leucocephalus*
Baltimore oriole	*Icterus galbula*
Banded killifish	*Fundulus diaphanus*
Barn swallow	*Hirundo rustica*
Bayberry	*Myrica pennsylvanica*
Beaver	*Castor canadensis*
Beech species	*Fagus* spp.
Big bluestem	*Andropogon gerardii*
Big brown bat	*Eptesicus fuscus*
Birch species	*Betula* spp.
Birdfoot violet	*Viola pedata*
Black and white warbler	*Mniotilta varia*
Black cherry	*Prunus serotina*
Black gum	*Nyssa sylvatica*
Black huckleberry	*Gaylussacia baccata*

Common Name	Scientific Name
Black locust	*Robinia pseudoacacia*
Black oak	*Quercus veluntina*
Black racer	*Coluber constrictor constrictor*
Black sedge	*Scirpus nigra*
Black swallow-wort	*Cynanchum louiseae*
Black throated green warbler	*Setophaga virens*
Black-billed cuckoo	*Coccyzus erythropthalmus*
Black-capped chickadee	*Poecile atricapillus*
Black-grass	*Juncus gerardii*
Blanding's turtle	*Emydoidea blandingii*
Blue jay	*Cyanocitta cristata*
Blue mussels	*Mytilus edulis*
Blueback herring	*Alosa aestivalis*
Blueberry species	*Vaccinium spp.*
Bluefish	*Pomatomus saltatrix*
Blue-spotted salamander	*Ambystoma laterale*
Blue-winged warbler	*Vermivora cyanoptera*
Blunt-leaved milkweed	*Asclepias amplexicaulis*
Bobolink	*Dolichonyx oryzivorus*
Border privet	*Ligustrum obtusifolium*
Brittle waternymph	*Najas minor*
Brook trout	*Salvelinus fontinalis*
Brown bullhead	*Ameiurus nebulosus*
Brown creeper	*Certhia americana*
Brown thrasher	*Toxostoma rufum*
Brown-headed cowbird	*Molothrus ater*
Bufflehead	*Bucephala albeola*
Canada goose	*Branta canadensis*
Canada lynx	*Lynx canadensis*
Canada thistle	*Cirsium arvense*
Caribou	*Rangifer tarandus*
Carolina wren	*Thryothorus ludovicianus*
Cattail species	*Typha* spp.
Cedar waxwing	*Bombycilla cedrorum*
Chain pickerel	*Esox niger*
Chestnut blight	*Cryphonectria parasitica*
Chestnut sided warbler	*Setophaga pensylvanica*
Chimney swift	*Chaetura pelagica*
Chipping sparrow	*Spizella passerina*
Climbing nightshade	*Solanum dulcamara*
Coltsfoot	*Tussilago farfara*
Common barberry	*Berberis vulgaris*
Common buckthorn	*Rhamnus cathartica*
Common gallinule	*Gallinula galeata*

Common Name	Scientific Name
Common garter snake	*Thamnophis sirtalis*
Common grackle	*Quiscalus quiscula*
Common juniper	*Juniperus communis*
Common merganser	*Mergus merganser*
Common mullein	*Verbascum thapsus*
Common nighthawk	*Chordeiles minor*
Common raven	*Corvus corax*
Common tern	*Sterna hirundo*
Common yellowthroat	*Geothlypis trichas*
Coyote	*Canis latrans*
Creeping buttercup	*Ranunculus repens*
Creeping jenny	*Lysimachia nummularia*
Dames rocket	*Hesperis matronalis*
Dickcissel	*Spiza americana*
Dogwood species	*Cornus* spp.
Downy woodpecker	*Picoides pubescens*
Eastern cottontail	*Sylvilagus floridanus*
Eastern hemlock	*Tsuga canadensis*
Eastern kingbird	*Tyrannus tyrannus*
Eastern meadowlark	*Sturnella magna*
Eastern phoebe	*Sayornis phoebe*
Eastern red bat	*Lasiurus borealis*
Eastern red cedar	*Juniperus virginiana*
Eastern small-footed bat	*Myotis leibii*
Eastern towhee	*Pipilo erythrophthalmus*
Eastern wood pewee	*Contopus virens*
Eelgrass	*Zostera marina*
Elderberry species	*Sambucus* spp.
Elk	*Cervus canadensis*
Elm species	*Ulmus* spp.
Emerald ash borer	*Agrilus planipennis*
European privet	*Ligustrum vulgare*
European starling	*Sturnus vulgaris*
Fairy shrimp	*Eubranchipus* spp.
Fern-leaved foxglove	*Aureolaria pedicularia* var. *intercedens*
Field sparrow	*Spizella pusilla*
Fir species	*Abies* spp.
Fisher	*Martes pennanti*
Flowering dogwood	*Cornus florida*
Frosted elfin butterfly	*Callophrys irus*
Glossy buckthorn	*Frangula alnus*
Glossy ibis	*Plegadis falcinellus*
Golden heather	*Hudsonia ericoides*

Common Name	Scientific Name
Golden shiner	*Notemigonus crysoleucas*
Grasshopper sparrow	*Ammodramus savannarum*
Gray catbird	*Dumetella carolinensis*
Gray squirrel	*Sciurus carolinensis*
Gray treefrog	*Hyla versicolor*
Gray wolf	*Canis lupus*
Great auk	*Pinguinus impennis*
Great blue heron	*Ardea herodias*
Great crested flycatcher	*Myiarchus crinitus*
Greater celandine	*Chelidonium majus*
Greater scaup	*Aythya marila*
Green crab	*Carcinus maenas*
Green frog	*Lithobates clamitans*
Green-winged teal	*Anas crecca*
Ground ivy	*Glechoma hederacea*
Hairy bedstraw	*Galium pilosum*
Hairy hudsonia	*Hudsonia tomentosa*
Hairy woodpecker	*Myiarchus crinitus*
Heath hen	*Tympanuchus cupido cupido*
Hemlock wooly adelgid	*Adelges tsugae*
Highbush blueberry	*Vaccinium corymbosum*
Hoary bat	*Lasiurus cinereus*
Hognose snake	*Heterodon platirhinos*
Honeysuckle species	*Lonicera* spp.
Horned lark	*Eremophila alpestris*
Horseshoe crab	*Limulus polyphemus*
Horsetail	*Equisetum sylvaticum*
House finch	*Carpodacus mexicanus*
Indiana bat	*Myotis sodalis*
Indigo bunting	*Passerina cyanea*
Japanese barberry	*Berberis thunbergii*
Japanese honeysuckle	*Lonicera japonica*
Japanese knotweed	*Polygonum cuspidatum*
Japanese wisteria	*Wisteria floribunda*
Karner blue butterfly	*Lycaedes melissa samuelis*
Killdeer	*Charadrius vociferus*
King rail	*Rallus elegans*
Labrador duck	*Camptorhynchus labradorius*
Ladyfern	*Athyrium filix-femina*
Large bur-reed	*Sparganium eurycarpum*
Largemouth bass	*Micropterus salmoides*
Leafy spurge	*Euphorbia esula*
Least bittern	*Ixobrychus exilis*

Common Name	Scientific Name
Lesser scaup	*Aythya affinis*
Little bluestem	*Schizachyrium scoparium*
Little brown bat	*Myotis lucifugus*
Lowbush blueberry	*Vaccinium angustifolium*
Mallard	*Anas platyrhynchos*
Maple species	*Acer* spp.
Marsh marigold	*Caltha palustris*
Marsh wren	*Cistothorus palustris*
Maryland tick-trefoil	*Desmodium marilandicum*
Meadowsweet	*Spiraea alba*
Moose	*Alces alces*
Morrow's honeysuckle	*Lonicera morrowii*
Mountain laurel	*Kalmia latifolia*
Mountain lion	*Puma concolor*
Mourning dove	*Zenaida macroura*
Mullein	*Verbascum thapsus*
Mummichog minnow	*Fundulus heteroclitus*
Musclewood	*Carpinus caroliniana*
Muskrat	*Ondatra zibethicus*
Mute swan	*Cygnus olor*
Narrow-leaf cattail	*Typha angustifolia*
Nelson's sharp-tailed sparrow	*Ammodramus nelsoni*
New England cottontail	*Sylvilagus transitionalis*
New Jersey tea	*Ceanothus americanus*
Nine-spined stickleback	*Pungitius pungitius*
Northern blazing-star	*Liatris borealis*
Northern brown snake	*Storeria dekayi dekayi*
Northern cardinal	*Cardinalis cardinalis*
Northern flicker	*Colaptes auratus*
Northern leopard frog	*Lithobates pipens*
Northern mockingbird	*Mimus polyglottos*
Northern myotis	*Myotis septentrionalis*
Northern red-bellied snake	*Storeria occipitomaculata occipitomaculata*
Northern short-tailed shrew	*Blarina brevicauda*
Oak species	*Quercus* spp.
Oriental bittersweet	*Celastrus orbiculata*
Osprey	*Pandion haliaetus*
Ovenbird	*Seiurus aurocapilla*
Oyster	*Crassostrea virginica*
Oysters	*Crassostrea virginica*
Painted turtle	*Chrysemys picta*
Paper birch	*Betula papyrifera*

Common Name	Scientific Name
Passenger pigeon	*Ectopistes migratorius*
Pennsylvania sedge	*Carex pensylvanica*
Persius duskywing skipper	*Erynnis persius persius*
Phragmites (common reed)	*Phragmites australis*
Pickerel frog	*Lithobates palustris*
Pied-billed grebe	*Podilymbus podiceps*
Pignut hickory	*Carya glabra*
Pileated woodpecker	*Dryocopus pileatus*
Pine species	*Pinus* spp.
Pine warbler	*Setophaga pinus*
Pitch pine	*Pinus rigida*
Prarie warbler	*Setophaga discolor*
Prostrate tick-trefoil	*Desmodium rotundifolium*
Purple loosestrife	*Lythrum salicaria L.*
Purple martin	*Progne subis*
Rainbow smelt	*Osmerus mordax*
Rainbow trout	*Oncorhynchus mykiss*
Raspberry	*Rubus* spp.
Red eyed vireo	*Vireo olivaceus*
Red fox	*Vulpes vulpes*
Red maple	*Acer rubrum*
Red oak	*Quercus rubra*
Red pine	*Pinus resinosa*
Red-backed salamander	*Plethodon cinereus*
Red-winged blackbird	*Agelaius phoeniceus*
Reed canarygrass	*Phalaris arundinacea*
Reflexed sedge	*Carex retroflexa*
Ring-necked duck	*Aythya collaris*
River otter	*Lontra canadensis*
Roseate tern	*Sterna dougallii*
Rose-breasted grosbeak	*Pheucticus ludovicianus*
Ruddy duck	*Oxyura jamaicensis*
Ruffed grouse	*Bonasa umbellus*
Rugosa rose	*Rosa rugosa*
Salt marsh sparrow	*Ammodramus caudacutus*
Salt meadow cordgrass	*Spartina patens*
Sand shrimp	*Crangon septemspinosa*
Savannah sparrow	*Passerculus sandwichensis*
Scarlet tanager	*Piranga olivacea*
Scotch pine	*Pinus sylvestris*
Scrub oak (bear oak)	*Quercus ilicifolia*
Sea mink	*Neovison macrodon*
Seaside goldenrod	*Solidago sempervirens*

Common Name	Scientific Name
Seaside mallow	*Hibiscus moscheutos*
Sedge species	*Scirpus* spp.
Sensitive fern	*Onoclea sensibilis*
Shagbark hickory	*Carya ovata*
Sheep sorrel	*Rumex acetosella*
Shore shrimp	*Paleomonetes vulgaris*
Silky dogwood	*Cornus amomum*
Slender knotweed	*Polygonum tenue*
Smooth alder	*Alnus serrulata*
Smooth cordgrass	*Spartina alterniflora*
Smooth green snake	*Opheodrys vernalis*
Snapping turtle	*Chelydra serpentina*
Softstem bulrush	*Schoenoplectus tabernaemontani*
Song sparrow	*Melospiza melodia*
Sora rail	*Porzana carolina*
Speckled alder	*Alnus rugosa*
Spicebush	*Lindera benzoin*
Spike grass	*Distichlis spicata*
Spotted knapweed	*Centaurea maculosa*
Spotted salamander	*Plethodon cinereus*
Spotted turtle	*Clemmys guttata*
Spreading dogbane	*Apocynum androsaemifolium*
Spring peeper	*Pseudacris crucifer*
Spruce species	*Picea* spp.
Stout bulrush	*Schoenoplectus robustus*
Striped bass	*Morone saxatilis*
Sturgeon	*Acipenser* spp.
Sugar maple	*Acer saccharum*
Sumac speies	*Rhus* spp.
Sunfish	*Lepomis macrochirus*
Sweet goldenrod	*Solidago odora*
Tree swallow	*Tachycineta bicolor*
Tufted titmouse	*Baeolophus bicolor*
Tussock sedge	*Carex stricta*
Upland sandpiper	*Bartramia longicauda*
Veery	*Catharus fuscescens*
Vesper sparrow	*Pooecetes gramineus*
Virginia oppossum	*Didelphis virginiana*
Virginia rail	*Rallus limicola*
Warbling vireo	*Vireo gilvus*
Wasting disease/slime mold	*Labryrinthula zosterae*
Whip-poor-will	*Caprimulgus vociferus*
White ash	*Fraxinus americana*

Common Name	Scientific Name
White fir	*Abies concolor*
White oak	*Quercus alba*
White pine	*Pinus strobus*
White spruce	*Picea glauca*
White-breasted nuthatch	*Sitta carolinensis*
White-nose syndrome fungus	*Geomyces destructans*
White-tailed deer	*Odocoileus virginianus*
Wigeongrass	*Ruppia maritma*
Wild celery	*Apium graveolens*
Wild lupine	*Lupinus perennis*
Wild rice	*Zizania aquatica*
Wild turkey	*Meleagris gallopavo*
Wild turkey	*Meleagris gallopavo*
Willet	*Tringa semipalmata*
Willow flycatcher	*Empidonax traillii*
Winged euonymus	*Euonymus alatus*
Winterberry	*Ilex verticillata*
Wolverine	*Gulo gulo*
Wood duck	*Aix sponsa*
Wood frog	*Lithobates sylvaticus*
Wood thrush	*Hylocichla mustelina*
Yellow perch	*Perca flavescens*
Yellow-rumped warbler	*Setophaga coronata*

Appendix A

Thomas Barnes/USFWS

Bald eagle

Species and Habitats of Concern Known, or Potentially Occurring, on Great Bay Refuge and Karner Blue Butterfly Easement

Table A.1. Species and Habitats of Concern Known, or Potentially Occurring, on Great Bay Refuge

Species	Seasons on Refuge[1]	Federal Threatened & Endangered Species[2]	NH State Threatened & Endangered Species[3]	BCR 30[4]	PIF 9[5]	USFWS Birds of Conservation Concern[6]	Federal Trust Fish Species Trend Data[7]	Species of Regional Conservation Concern[8]	Northern Atlantic Regional Shorebird Plan[9]	North American Waterbird Plan[10]	North American Waterfowl Plan[11]	NH Wildlife Action Plan[12]
WATERBIRDS												
American bittern	M			M		X		X		H		X
Great blue heron	B, M											X
King rail	M			M						H		
Least bittern	B, M		SC	M		X				H		X
Pied-billed grebe	B, M		T			X				H		X
Snowy egret	M			M		X				H		
WATERFOWL												
American black duck	B, M,W			HH	2C						D	X
Atlantic Population Canada goose	B, M			HH							I	
Bufflehead	M			H							I	
Common eider	M			H							D	
Common goldeneye	M			M							NT	
Greater scaup	M			H							NT	
Hooded merganser	B, M			M							I	
Lesser scaup	M			H							D	
Mallard	B			H							NT	
Red-breasted merganser	M			M							I	
Wood duck	B. M			M							I	
SHOREBIRDS												
American woodcock	B, M			HH	1A				5			X
Common snipe	M			M					3			
Common tern	B,M		T	M						L		X
Dunlin	M			H					3			
Greater yellowlegs	M			H					4			
Killdeer	B, M			M					2			
Least sandpiper	M			M					3			

Species	Seasons on Refuge[1]	Federal Threatened & Endangered Species[2]	NH State Threatened & Endangered Species[3]	BCR 30[4]	PIF 9[5]	USFWS Birds of Conservation Concern[6]	Federal Trust Fish Species Trend Data[7]	Species of Regional Conservation Concern[8]	Northern Atlantic Regional Shorebird Plan[9]	North American Waterbird Plan[10]	North American Waterfowl Plan[11]	NH Wildlife Action Plan[12]
Lesser yellowlegs	M			M		X			2			
Red knot	M			HH		X		X	5			
Sanderling	M			HH					4			
Semipalmated plover	M			M					2			
Semipalmated sandpiper	M			H		X			4			X
Short-billed dowitcher	M			H		X			3			
Solitary sandpiper	M			H		X			3			
Spotted sandpiper	B, M			M					3			
Upland sandpiper	B, M		E	M	1B	X		X	4			X
Whimbrel	M			HH		X			5			
White-rumped sandpiper	M			H					3			
Willet	B,M		SC	H					4			X
LANDBIRDS												
American kestrel	B, M		SC									
Bald eagle	W, YR		T	M		X						X
Baltimore oriole	B, M			H	1A							
Black-and-white warbler	B, M			H	2A							
Black-billed cuckoo	B, M				1A							
Black-throated blue warbler	M				1B							
Blue-winged warbler	B, M			HH	1A	X						
Broad-winged hawk	M			H								
Brown thrasher	B, M			H								
Chimney swift	M			H	2A							
Common nighthawk	B,M		E									X
Cooper's hawk	M											X
Eastern kingbird	B, M			H								
Eastern meadowlark	B, M		SC									X
Eastern towhee	B, M			H	2A							X

Species	Seasons on Refuge[1]	Federal Threatened & Endangered Species[2]	NH State Threatened & Endangered Species[3]	BCR 30[4]	PIF 9[5]	USFWS Birds of Conservation Concern[6]	Federal Trust Fish Species Trend Data[7]	Species of Regional Conservation Concern[8]	Northern Atlantic Regional Shorebird Plan[9]	North American Waterbird Plan[10]	North American Waterfowl Plan[11]	NH Wildlife Action Plan[12]
Field sparrow	B, M			H								
Golden-winged warbler	M		SC	M	1B	X						X
Grasshopper sparrow	M		T	M								X
Great-crested flycatcher	B, M			H								
Louisiana waterthrush	M			H	1A			X				
Marsh wren	B, M			H								
Nelson's sparrow	B, M		SC	M	1B	X						X
Northern flicker	B, M			H								
Northern harrier	M		E					X				X
Osprey	B, M		SC									X
Peregrine falcon	M		T		2C	X						X
Prairie warbler	B, M			HH	1A	X						
Purple martin	M		SC									X
Red-shouldered hawk	M											X
Rose-breasted grosbeak	M				2A							
Saltmarsh sparrow	B, M		SC	HH	1A	X		X				X
Scarlet tanager	B, M				1A							
Seaside sparrow	M		SC	HH	1A	X						X
Sedge wren	M		E	M	2C	X		X				X
Short-eared owl	M			M	2C	X						
Veery	M											X
Willow flycatcher	B, M			H								
Wood thrush	B, M			HH	1A	X						X
Yellow-throated vireo	B, M			H								
MAMMALS												
Bobcat												X
Big brown bat												
Eastern red bat			SC					X				X

Species	Seasons on Refuge[1]	Federal Threatened & Endangered Species[2]	NH State Threatened & Endangered Species[3]	BCR 30[4]	PIF 9[5]	USFWS Birds of Conservation Concern[6]	Federal Trust Fish Species Trend Data[7]	Species of Regional Conservation Concern[8]	Northern Atlantic Regional Shorebird Plan[9]	North American Waterbird Plan[10]	North American Waterfowl Plan[11]	NH Wildlife Action Plan[12]
Eastern small-footed bat	B, M		E					X				X
Hoary bat			SC					X				X
Little brown bat	M											
New England cottontail		C	E									X
Northern myotis	B, M		SC									X
Silver-haired bat			SC					X				X
AMPHIBIANS												
Blue-spotted salamander			SC					X				X
Fowler's toad			SC									X
Marbled salamander			E									X
Northern leopard frog			SC					X				X
REPTILES												
Blanding's turtle			E					X				X
Eastern ribbon snake								X				X
Smooth green snake			SC									X
Spotted turtle			T					X				X
Wood turtle			SC					X				X
FISH												
Alewife			SC				D					X
American eel			SC				D					X
American shad			SC				D					X
Atlantic sturgeon							D					X
Blueback herring			SC				D					X
Brindle shiner			T									X
Swamp darter			SC									X
Rainbow smelt			SC									X
PLANTS												
Northern blazing star *(Liatris borealis)*			E									X

Species	Seasons on Refuge[1]	Federal Threatened & Endangered Species[2]	NH State Threatened & Endangered Species[3]	BCR 30[4]	PIF 9[5]	USFWS Birds of Conservation Concern[6]	Federal Trust Fish Species Trend Data[7]	Species of Regional Conservation Concern[8]	Northern Atlantic Regional Shorebird Plan[9]	North American Waterbird Plan[10]	North American Waterfowl Plan[11]	NH Wildlife Action Plan[12]
Large bur-reed *(Spargarium erurycarpum)*			T									X
Seaside mallow *(Hibiscus moscheutos)*			E									X
Goodenough's sedge *(Carex nigra)*			E									X

[1]Seasons on the refuge (Birds): B=Breeding, W=Wintering, M=Migration, YR=Year-round. Sources: (Mirck 1993) and unpublished Great Bay National Wildlife Refuge observations.

[2]Federal List of Threatened and Endangered Species: T=Threatened, E=Endangered, C= Candidate.

[3]New Hampshire State List of Threatened and Endangered Species: T=Threatened, E=Endangered, SC=Special Concern.

[4]New England/Mid-Atlantic Coast Bird Conservation Implementation Plan (Steinkamp 2008): HH=Highest Priority, H=High Priority, M=Moderate Priority.

[5]Partners in Flight Physiographic Area 9 (PIF 9) - Southern New England (Dettmers and Rosenberg 2000): 1A= High Continental Priority–High Regional Responsibility, 1B= High Continental Priority–Low Regional Responsibility, 2A= High Regional Concern, 2B= High Regional Responsibility, 2C=High Regional Threats, 3= Additional Watch List.

[6]U.S. Fish and Wildlife Service - Birds of Conservation Concern 2008 (USFWS 2008): X= Species of Conservation Concern for BCR 30.

[7]Federal Trust Fish Species USFWS Population Trend Data: I=increasing, D=decreasing.

[8]Species of Regional Conservation Concern (NETC 1999):: X= Wildlife species of regional conservation concern in the Northeastern United States.

[9]Northern Atlantic Regional Shorebird Plan (Clark and Niles 2000): 5=Highly Imperiled, 4= Species of High Concern, 3=Species of Moderate Concern, 2=Species of Low Concern, 1=Species Not at Risk. For each species, we list the national priority, except where the Northern Atlantic regional priority is different. In those cases, we list the regional priority instead.

[10]North American Waterbird Plan (Kushlan et al. 2002): H=High Risk, M=Moderate Risk, L=Low Risk.

[11]North American Waterfowl Management Plan (CWS, USFWS, and SEMARNAT 2004): Population Trends: I=Increasing, D=Decreasing, NT=No Trend.

[12] New Hampshire Wildlife Action Plan (NHFG 2005): X= Species of Greatest Conservation Need.

Table A.2. Species and Habitats of Concern Known, or Potentially Occurring, on the Karner Blue Butterfly Easement in Concord New Hampshire

Common Name		Federal Threatened & Endangered Species[1]	NH State Threatened & Endangered Species[2]	BCR 30[3]	NH Wildlife Action Plan[4]
Birds					
Common nighthawk	*Chordeiles minor*		E		X
Eastern towhee	*Pipilo erythrophthalmus*			H	X
Grasshopper sparrow	*Ammodroamus savannarum*		T	M	X
Whip-poor-will	*Caprimulgus vociferous*		SC	H	X
Amphbians					
Fowler's toad	*Bufo woodhousii fowleri*		SC		x
Reptiles					
Black racer	*Coluber constrictor*		T		X
Hognose snake	*Heterodon platirhinos*		E		X
Smooth green snake	*Opheodrys vernalis*		SC		X
Invertebrates					
Barrens xylotype	*Xylotype capax*		SC		x
Broad-lined catopyrrha	*Catopyrrha coloraria*		SC		x
Cora moth	*Cerma cora*		SC		x
Frosted elfin butterfly	*Callophrys irus*		E		x
Karner blue butterfly	*Lycaeides melissa samuelis*	E	E		x
Persius duskywing	*Erynnis persius persius*		E		x
Phyllira tiger moth	*Grammia phyllira*		SC		x
Pine barrens itame	*Itame sp. 1*		SC		x
Pine barrens zanclognatha moth	*Zanclognatha martha*		SC		x
Sleepy duskywing	*Erynnis brizo brizo*		SC		x
PLANTS					
Wild lupine	*Lupinus perennis*	T	T		X

[1]Federal List of Threatened and Endangered Species: T=Threatened, E=Endangered, C= Candidate.

[2]New Hampshire State List of Threatened and Endangered Species: T=Threatened, E=Endangered, SC=Special Concern.

[3]New England/Mid-Atlantic Coast Bird Conservation Implementation Plan (Steinkamp 2008): HH=Highest Priority, H=High Priority, M=Moderate Priority.

[4] New Hampshire Wildlife Action Plan (NHFG 2005): X= Species of Greatest Conservation Need.

Table A.3. Priority Habitat Types and Their Associated Focal Species for Great Bay Refuge.

Priority Habitat Types	Associated Focal Species
Freshwater impoundments	Marsh wren, migrating and wintering waterfowl, nesting marshbirds, alewife, blueback herring, American eel, giant bur-reed
Intertidal Estuarine	Eelgrass beds, oysters, alewife, blueback herring, American eel
Saltmarsh and rocky shoreline	Wintering black duck, wintering bald eagle, foraging marsh and wading birds, migratory shorebirds, saltmarsh sparrow, seaside mallow, American eel
Forested and scrub-shrub wetlands and vernal pools	Willow flycatcher, wood thrush, vernal pool obligate amphibians, foraging woodcock, and native plant communities
Oak-hickory forest	Wood thrush, scarlet tanager, Baltimore oriole, solitary tree bats
Shrubland	Eastern towhee, prairie warbler, blue-winged warbler, American woodcock, black racer, New England cottontail
Grassland	Upland sandpiper, American woodcock, Eastern meadowlark, New England blazing star

LITERATURE CITED

Canadian Wildlife Service, U.S. Fish and Wildlife Service, and Secretariá de Medio Ambiente y Recursos Naturales (CWS, USFWS, and SEMARNAT). 2004. North American Waterfowl Management Plan, Strengthening the Biological Foundation, 2004 Strategic Guidance. Accessed online October 2011 at: *http://www.fws.gov/birdhabitat/NAWMP/files/NAWMP2004.pdf.*

Clark, K.E, and L.J. Niles. 2000. Northern Atlantic Regional Shorebird Plan, Version 1.0. Northern Atlantic Shorebird Habitat Working Group and the New Jersey Division of Fish and Wildlife, Endangered and Nongame Species Program. Woodbine, NJ. 28pp. Accessed online October 2011 at: *http://www.fws.gov/shorebirdplan/RegionalShorebird/downloads/NATLAN4.pdf.*

Dettmers, R. and K.V. Rosenberg. 2000. Partners in Flight Landbird Conservation Plan: Physiographic Area 9: Southern New England, Version 1.0. 52 pp. Accessed online October 2011 at: *http://www.blm.gov/wildlife/plan/pl_09_10.pdf.*

Kushlan, J.A., M.J. Steinkamp, K.C. Parsons, J. Capp, M.A. Cruz, M. Coulter, I. Davidson, L. Dickson, N. Edelson, R. Elliot, R. M. Erwin, S. Hatch, S. Kress, R. Milko, S. Miller, K. Mills, R. Paul, R. Phillips, J. E. Saliva, B. Sydeman, J. Trapp, J. Wheeler, and K. Wohl. 2002. Waterbird Conservation for the Americas: The North American Waterbird Conservation Plan, Version 1. Waterbird Conservation for the Americas. Washington, DC, U.S.A. Accessed online October 2011 at: *http://www.pwrc.usgs.gov/nacwcp/nawcp.html*.

Mirck S., Audubon Society of New Hampshire. 1993. A checklist to the birds of Great Bay. New Hampshire Fish and Game Department. Unpaginated. Jamestown, N.D: Northern Prairie Wildlife Research Center Home Page.

New Hampshire Fish and Game Department. 2005. New Hampshire Wildlife Action Plan. October 1, 2005. Accessed online October 2011 at: *http://www.wildlife.state.nh.us/Wildlife/wildlife_plan.htm.*

Northeast Endangered Species and Wildlife Diversity Technical Committee (NETC). 1999. Wildlife species of regional conservation concern in the northeastern United States. Northeast Wildlife 54: 93-100.

Steincamp, M. 2008. Mid-Atlantic/Southern New England Bird Conservation Region 30 Implementation Plan. Atlantic Coast Joint Venture, Laurel, Maryland. Accessed online October 2011 at: *http://www.acjv.org/BCR_30/BCR30_June_23_2008_final.pdf.*

U.S. Fish and Wildlife Service (USFWS). 2008. Birds of Conservation Concern. 93 pp. Accessed online October 2011 at: *http://library.fws.gov/bird_publications/bcc2008.pdf.*

Appendix B

Bill Thompson/USFWS

Eastern towhee

Process for Establishing Refuge Focal Species and Priority Habitats

- Introduction
- Process Overview
- Literature Citations

Introduction

Biological goals and objectives serve as the foundation for refuge Comprehensive Conservation Plans (CCPs) and Habitat Management Plans (HMPs). These goals and objectives guide all management decisions regarding species and habitats. Prior to drafting biological goals and objectives, each refuge first identifies the species of conservation concern and priority habitats that will be the focus of its management. This appendix details the process the Great Bay National Wildlife Refuge (Great Bay Refuge, refuge) CCP planning team (we) used to identify these priority resources of concern, and ultimately, the refuge focal species and the habitat management priorities to benefit these resources.

Process Overview

We consulted many sources to determine the priority resources of concern for the refuge, including legal mandates, U.S. Fish and Wildlife Service (Service) policies, the refuge's establishing purposes, and a variety of national, regional, State, and local conservation plans. We also considered the refuge's geographic location, local site capabilities, species' relative abundance and distribution, and respective species status in national and regional conservation plans. Additionally, we determined the most important and effective ecological contribution the refuge could make to the Great Bay Estuary, New Hampshire, the Gulf of Maine Ecosystem, and the National Wildlife Refuge System (Refuge System).

Using the factors outlined above, we created a list of priority species and habitats. After grouping the habitats into broad categories, we sorted priority species by habitat type. For each of these broad habitat category types, we also selected a focal species to guide habitat management and for monitoring purposes.

1) Collect Information and Data

1.1) Refuge's Establishing Purposes, Legal Mandates, and U.S. Fish and Wildlife Service Policies

The process for selecting resources of concern was guided by the refuge's establishing purposes, legal mandates for the Refuge System, and Service policies.

Establishing Purposes:

The purposes of Great Bay Refuge were defined in the land transfer that established the refuge in 1992, as follows:

- To encourage the natural diversity of plant, fish, and wildlife species within the refuge, and to provide for their conservation and management.
- To protect species listed as endangered or threatened or identified as candidates pursuant to the Endangered Species Act of 1973.
- To preserve and enhance the water quality of aquatic habitat within the refuge.
- To fulfill the international treaty obligations of the United States relating to fish and wildlife.

The purpose of the Karner Blue Butterfly Conservation Easement in Concord, New Hampshire is the following:

- To protect and manage a small remnant pine barren community in Concord that is habitat for the federally endangered Karner blue butterfly and other rare Lepidoptera.

Legal Mandates:

Chapter 1 of the CCP describes in detail the legal mandates guiding the management of the Refuge System. The following legal mandates relate to the identification of priority resources of concern on a refuge. Various legislative and administrative acts also entrust the conservation and protection of certain species and habitats to the Service, called "Federal trust resources." These include migratory birds, interjurisdicitonal fish, federally listed threatened and endangered species, wetlands, and certain marine mammals.

1. The Emergency Wetlands Resources Act of 1986 (16 U.S.C. § 3901 (b))
   "…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."

2. The Migratory Bird Conservation Act (16 U.S.C. § 715d)
   "…for use as an inviolate sanctuary, or for any other management purpose, for migratory birds."

3. The Endangered Species Act of 1973, as amended (16 U.S.C. § 1531-154)
   "The Secretary of the Interior….is designated as the Management Authority and the Scientific Authority for the purposes of the Convention and the respective functions of each Authority shall be carried out through the United States Fish and Wildlife Service."

   The Act also requires that
   "all Federal departments and agencies shall seek to conserve endangered species and threatened species and shall utilize their authorities in furtherance of the purposes of this Act."

4. Fish and Wildlife Act of 1956 (16 U.S.C. § 742 f(a)(4))
   "…for the development, advancement, management, conservation, and protection of fish and wildlife resources..."

5. Refuge Recreation Act of 1962 (16 U.S.C. § 460k—460k-4)
   "…(2) the protection of natural resources, (3) the conservation of endangered species and threatened species…"

6. Refuge System Improvement Act of 1997 (Section 4(a)(3)
   "(A) each refuge shall be managed to fulfill the Mission of the System, as well as the specific purposes for which that refuge was established..."

   The Improvement Act further states that
   "In administering the System, the Secretary shall...ensure that the biological integrity, diversity, and environmental health of the System are maintained for the benefit of present and future generations of Americans..."

Service Policies:

Policy on Biological Integrity, Diversity and Environmental Health (601 FW 3.3)

This policy provides guidance on maintaining or restoring the biological integrity, diversity, and environmental health of the Refuge System (601 FW 3), including the protection of a broad spectrum of fish, wildlife, and habitat resources in the refuge ecosystems. The policy explains the relationships among refuge purposes, the Refuge System mission, and maintaining biological integrity, diversity, and environmental health as follows:

> *"…each refuge will be managed to fulfill refuge purpose(s) as well as to help fulfill the [Refuge] System mission, and we will accomplish these purpose(s) and our mission by ensuring that the biological integrity, diversity, and environmental health of each refuge are maintained, and where appropriate, restored." (601 FW 3.7B)*

The policy advocates for an integrated and holistic approach to maintaining and restoring biological integrity, diversity, and environmental health. The policy directs refuges to evaluate biological integrity, diversity, and environmental health at both the local scale, such as removing dams to restore historic stream flows, and at the larger landscape scale, such as supporting population and habitats that have declined or been lost at from ecosystem, or at national or international scale. It also highlights the dynamic nature of historical natural processes, and emphasizes managing within a natural range of variability to allow species, genetic strains, and natural communities to evolve with changing conditions. According to the policy, the highest measure of biological integrity, diversity, and environmental health is conserving intact, self-sustaining habitats and wildlife populations that existed during historic conditions.

The policy also provides the following guidance on how to implement it:

1. Identify the refuge purposes, legislative responsibilities, refuge role within the ecosystem, and Refuge System mission.

2. Assess the current status of biological integrity, diversity, and environmental health through baseline vegetation and population surveys, and any other necessary environmental studies.

3. Assess historic conditions and compare them to current conditions. This will provide a benchmark of comparison for the relative intactness of ecosystems' functions and processes. This assessment should include the opportunities and limitations to maintaining and restoring biological integrity, diversity, and environmental health.

4. Consider the refuge's importance to refuge, ecosystem, national, and international landscape scales of biological integrity, diversity, and environmental health. Also, identify the refuge's roles and responsibilities within the Regional and Refuge System administrative levels.

5. Consider the relationships among refuge purposes and biological integrity, diversity, and environmental health, and resolve conflicts among them.

6. Through the comprehensive conservation planning process, interim management planning, or compatibility reviews, determine the appropriate management direction to maintain and, where appropriate, restore, biological integrity, diversity, and environmental health, while achieving refuge purpose(s).

7. Evaluate the effectiveness of our management by comparing results to desired outcomes. If the results of our management strategies are unsatisfactory, assess the causes of failure and adapt our strategies accordingly.

1.2) Matrix of *Potential* Resources of Concern Based on National, Regional, State, and Local Conservation Plans

We generated an overall list of species and plant communities of conservation concern that were either known, or suspected, to occur on Great Bay Refuge using national, regional, State, and local conservation plans (appendix A, table A.1). We also created a similar list for the Karner Blue Butterfly Conservation Easement (appendix A, table A.2). The following is a complete listing of the sources we used to compile the lists of resources of concern:

- Bird Conservation Region (BCR) 30 Plan–New England/Mid-Atlantic Coast
- Partners in Flight (PIF) Physiographic Area 9 (Southern New England) Plan
- North American Waterfowl Management Plan
- U.S. Shorebird Conservation Plan
- North American Waterbird Conservation Plan
- U.S. Fish and Wildlife Service Birds of Conservation Concern–List for BCR 30
- Federal List of Threatened and Endangered Species
- New Hampshire State Comprehensive Wildlife Conservation Plan
- New Hampshire Natural Heritage Bureau (NHB)–State List of Threatened and Endangered Species
- Natural Communities of New Hampshire
- New Hampshire Natural Heritage Inventory
- Piscataqua Region Comprehensive Conservation and Management Plan (2010)
- Northeast States Nongame Technical Committee List of Species of Special Concern

1.3) Identify Elements of Biological Integrity, Diversity, and Environmental Health

To identify the elements of biological integrity, diversity, and environmental health for Great Bay Refuge, we reviewed the historical conditions, site capability, current regional landscape conditions, and biological diversity for the refuge. The major sources we consulted included the following:

- Soils Map–U.S. Department of Agriculture Natural Resources Conservation Service Soil Types National Ecological Land Units Map
- Kuchler's Potential Natural Vegetation Map
- Current Vegetation Map for Great Bay Refuge–National Vegetation Classification System
- Historical and Current Wetlands Inventory Map
- Historical topographic and hydrological maps
- Historical aerial photography
- Record of land management under Pease Airport (documented habitat alterations)
- NHB Natural Communities distribution maps
- New Hampshire State Comprehensive Wildlife Conservation Plan
- Consultation with The Nature Conservancy
- Consultation of NHB natural community expert
- Targeted field investigations (e.g., tree coring of various pine groves to ascertain origin and history)

We developed the following table (B.1) to help assess the biological integrity, diversity, and environmental health elements for the existing habitats at Great Bay Refuge.

Table B.1. Biological Integrity, Diversity, and Environmental Health Elements for Great Bay Refuge

Plant Community	Population/Habitat Attributes (Soils, Structure, Species Composition)	Natural Processes/Limiting Factor
Dry Appalachian oak-hickory forest	Oaks (*Quercus velutina, Q. coccinea, Q. alba, Q. prinus, Q. ruba*), hickories (*Carya ovata, C. ovalis, C. glabra*), and white pine (*Pinus strobus*) dominated canopy. Shrub layer dominated by flowering dogwood (*Cornus florida*), mountain laurel (*Kalmia latifolia*) and American hazelnut (*Corylus americana*). Oak sedge (*Carex pensylvanica*) may form extensive "lawns." High diversity of herbaceous species, including numerous State rare species: common goldenrod (*Solidago odora*), birdfoot violet (*Viola pedata*), hairy bedstraw (*Galium pilosum*), fernleaf yellow false foxglove (*Aureolaria pedicularia*), reflexed sedge (*Carex retroflexa*), peatleaf knotweed (*Polygonum tenue*), *Tephrosia virginiana*, smooth small-leaf ticktrefoil (*Desmodium marilandicum*), prostrate ticktrefoil (*Desmodium rotundifolium*). Occurs on middle and upper slopes with acidic, low-nutrient, well-drained soils.	Successional forest—May transition to beech forest without disturbance. May stay oak-hickory with climate change with northward range shift and increasing fire frequency.
Dry-mesic Appalachian oak-hickory forest	Dry-mesic—see below. Occurs on well-drained fine sandy loam soil. Beech, paper birch, and dry-site herbs more abundant.	Successional forest—Need fire or logging to maintain. Transition to sugar maple/beech forests without disturbance. May stay oak-hickory with climate change with northward range shift and increasing fire frequency.

Plant Community	Population/Habitat Attributes (Soils, Structure, Species Composition)	Natural Processes/Limiting Factor
Mesic Appalachian oak-hickory forest	Mesic and dry-mesic sites dominated by oaks (*Q. rubra, Q. velutina*), hickories (*C. ovata*), white pine, and transitional hardwoods (*Betula lenta, Prunus serotina, Fraxinus americana, Betula papyrifera, Fagus grandifolia,* and *Tsuga canadensis*). Shrub (*Viburnum acerifolium, Corylus cornuta, Hamamelis virginiana, Toxicodendron radicans, Mitchella repens, Gaultheria procumbens, Lycopodium*) and herb (*Aralia nudicaulis, Maianthemum canadense*) layer sparse to moderate. Silt loam soils with high moisture capacity or at slope-bases	Successional forest—Need fire or logging to maintain. Transition to sugar maple/beech forests without disturbance. May stay oak-hickory with climate change.
Dry to wet field mosaic	The wet meadows tend to occur on poorly drained silt or sand soils with a mixture of wetland and upland grasses, forbs, and occasional shrubs. For example, little bluestem (*S. scoparium*), sedges (*Carex spp.*), goldenrods (*Solidago spp.*), ferns (*O. sensibilis, A. filix-femina*), raspberries (*Rubus spp.*), arrowleaf (*Polygonum sagittatum*),and alder (*Alnus spp.*). The drier portions of these mosaics tend to occur on well-drained fine sandy loams and loam soils. The vegetative composition is dominated mainly by forbs and common pasture grasses (e.g., *Agrostis spp., Festuca spp. Poa spp.*). Some of the forbs and woody shrubs include milkweeds (*Asclepias spp.*), meadowsweet, steeple bush (*Spirea spp.*), goldenrods (*Solidago spp.*), and *Rubus* species.	The wet meadows are likely to succeed into red maple swamps/wet forest (e.g., red maple–sensitive fern forest or red maple–elm–lady fern forest). Dry-mesic fields will most likely succeed to oak–hickory forest without active management (e.g., fire and mowing). Also, both communities need monitoring for exotics as these sites are very susceptible to invasion due to disturbance from management actions. For example, reed canary grass is the dominant species in the wet portion of the field and leafy spurge and autumn olive is common in dry areas.
Dry shrubland mosaic	Often contain many of the same grasses and forbs of dry field communities but have a higher abundance of young trees and shrubs. Species will vary with local seed sources but tree saplings often include birch (Betula spp.), aspen (*Populus spp.*), pine (*Pinus spp.*), and cherry (*Prunus spp.*). Shrub species include sweet fern (*Comptonia peregrina*), bayberry (*Morella pensylvanica*), blueberry (*Vaccinium spp.*), and raspberries (*Rubus spp.*).	On well-drained sandy loams and loam soils with a water table well below the ground surface. Often succeeding from dry fields, these communities tend to be susceptible to invasive species like autumn olive and honeysuckle. May succeed to oak-hickory forest without management (e.g., mowing, burning).
Mesic Shrubland mosaic	Shrubs species of these communities are dogwoods (*Cornus spp.*), blueberries (*Vaccinium spp.*), raspberries (*Rubus spp.*), birches (*Betula spp.*), fruit species (*Malus spp., Pyrus spp.*), alders (*Alnus spp.*) eastern red cedar (*Juniperus virginiana*), and buckthorns (*Ramnus spp.*). The groundcover is composed of grasses (e.g., *Agrostis spp., Festuca spp. Poa spp.*) and forbs such as goldenrods (*Solidago spp.*), asters (*Aster spp.*), and vetches (*Vicia spp.*). The mesic soil conditions of these shurblands are well-drained silt loam and fine sandy loam soils. However, the silt of these soils will have greater moisture retention compared to coarser soils.	These soil conditions tend to have seasonally high water tables compared to the dry-mesic fields and are very susceptible to invasion by exotics such as, buckthorn, and honeysuckle. A high abundance of invasive species may impede regeneration of native trees, but this community will likely succeed to mesic Appalachian oak-hickory forest if left unmanaged.

Plant Community	Population/Habitat Attributes (Soils, Structure, Species Composition)	Natural Processes/Limiting Factor
Low red maple-elm/musclewood/ lady fern silt forest	Red maple (*Acer rubrum*) is the dominant tree with American elm (*Ulmus americana*), white pine (*Pinus strobus*), white ash (*Fraxinus americana*), and swamp white oak (*Quercus bicolor*) present. The understory is commonly composed of musclewood (*Carpinus caroliniana*), climbing poison-ivy (*Toxicodendren radicans*), winterberry holly (*Ilex verticillata*), and northern arrowwood (*Viburnum dentatum*), with a well-developed herb layer dominated by lady fern (*Athyrium filix-femina*) . Other species include sensitive fern (*Onoclea sensibilis*), violets (*Viola spp.*), spotted touch-me-not (*Impatiens capensis*), and high bush blueberry (*Vaccinium corymbosum*).	Occurs at intermediate zones between uplands and wetlands. Established on poorly drained silt loams with seasonally high water table. However, are not regularly flooded. Great Bay site threatened by invasive species including; buckthorn, honeysuckle, multiflora rose, and barberries.
Black gum-red maple basin swamp	Dominated by black gum (*Nyssa sylvatica*) and red maple (*Acer rubrum*) as tree canopy, highbush blueberry (*Vaccinium corymbosum*) and winterberry (*Ilex verticillata*) as the primary shrub layer, and cinnamon fern (*Osmunda cinnamonea*) and sphagnum moss as the herbaceous layer. Well-developed hummocks.	S1S2Typically found in perched upland till basins, acidic, nutrient-poor, poorly drained peat or mucky soils. Dependent on precipitation.
Seasonally saturated red maple swamp	Common red maple swamp associated with stream drainages. Soils are typically alluvial or shallow muck/peat over alluvial minerals. Red maple (*Acer rubrum*) is the primary tree species, with shrub layer absent or moderately dense. Clonal graminoids such as upright sedge (*Carex stricta*) and blue joint (*Calamagrostis canadensis*) are frequent dominants.	S4S5—Differ from floodplain forests by seasonal rather than temporarily flooded water regime. Low-energy environment allows for development of organic soils. Commonly successional from wet meadows to shallow emergent marshes and have either woodland or forest canopy structure.
Red maple/ sensitive fern-tussock sedge basin/seepage	Saturated or seasonally saturated soils with diverse assemblage of herbaceous species and relatively little sphagnum moss (less than five percent). Typically occupying headwater basins, where seepage or non-channelized upland runoff is water source. Dominated by red maple, with lesser quantities of elm (*Ulmus americana)* and other hardwood. Sensitive fern (*Onoclea sensibilis*) is a good indicator. Diverse shrub layer dominated by winterberry (*Ilex verticillata*), with assembledges of northern highbush blueberry (*V. corymbosum),* southern arrowwood (*V. dentatum),* speckled alder (*Alnus incana),* and meadowsweet (*Spiraea alba*). Other dominant herbaceous layers include sedges (*Carex stricata* and *C. bromoides*). Jewelweed (*Impatiens capensis),* blueflag (*Iris versicolor),* earth loosestrife (*Lysimachia terrestris),* fringed sedge (*Carex crinita*), royal fern (*Osmunda regalis*), and bluejoint (*Calamagrostis canadensis*) may be present.	Often found with other swamp communities in larger mosaic. The largest complex at Great Bay is 65 acres in size. Circumnetral seepage swamp (s1?)—Found at Pease Tradeport.

Plant Community	Population/Habitat Attributes (Soils, Structure, Species Composition)	Natural Processes/Limiting Factor
Speckled alder basin/seepage shrub thicket	Dominated by speckled alder (*Alnus incana*) with lower abundance of red osier dogwood (*Cornus sericea*), mountain holly (*Nemopanthus mucronatus*), mountain fly honeysuckle (*Lonicera villosa*), meadowsweet (*Spiraea alba*), steeplebush (*S. tomentosa*), possumhaw (*Viburnum nudum*), and currant (*Ribes spp.*). Herbaceous cover include sedges (*C. triperma*, *C. canescens*, *C. echinata*) and ferns (*Dryopteris cristata*, *D. carthusiana*, *Gymnocarpium dryopteris*).	Occurs in open headwater basin, in somewhat seepy subacidic fens and along small low-energy streams.
Graminoid-forb-sensitive fern seepage marsh	Sensitive fern (*O. sensibilis*) tends to be most dominant within these systems along with other indicative species composed of sedges (*C. lacustris*, *C. scabrata*), ferns (*O. regalis*, *T. palustris*), skunk cabbage (*Symplocarpus foetidus*), and saxifrage spp. (*S. pensylvanica*, *C. americanum*). Species in lower abundance include spotted touch-me-not (*I. capensis*), field mint (*Mentha arvensis*), and poison sumac (*Toxicodendron vernix*). Soils are shallow fibric peats or silty muck/sands with pH ranging from 5.5 to 6.3.	Associated with groundwater discharge zones with little canopy cover (e.g., upland borders of various wetlands and along stream drainages). Under certain conditions may succeed into speckled alder wooded fen.
Tall graminoid emergent marsh	Shallow emergent marsh dominated by "tall" graminoids, typically blue-joint (*Calamagrostis canadensis*), rattlesnake manna-grass (*Glyceria canadensis*), whitegrass (*Leersia virginica*) or oryzoides, reed canarygrass (*Phalaris arundinaceae*), threeway sedge (*Dulichium arundinaceum*), upright sedge (*Carex stricta*), *C. lacustris*, woolgrass (*Scirpus cyperinus*), and Canadian rush (*Juncus canadensis*). A broad diversity of herbaceous plants is often present, but not dominant. Community with high species diversity.	Seasonally flooded communities on fine mineral to organic substrates along low-energy streams or open basins. Dominant species form rhizomatous and colonial mats, and is influenced by hydrologic regime and propagule availability. May succeed to scrub-shrub or forested swamps or deepwater marshes depending on hydrology.
Open-basin cattail marsh	Contain mucky organic soils that are seasonally to semi-permanently flooded. Soils remain saturated throughout the year with water levels near or above the ground surface. Well-developed clonal stands often have a thick mat of thatch from previous year's growth. Although dominated by common cattail (*Typha latifolia*), other species present include knotweed (*Polygonum spp.*), *Bidens spp.*, and *Scirpus* species.	Found in open basins associated the backwaters of ponds, lakes, or stream drainageways. May be susceptible to common reed (*Phragmites australis*) invasion.
Short graminoid-forb emergent marsh/mudflat	Mudflats composed of short herbaceous vegetation that is seasonally flooded or intermittently exposed. Dominated by cut-grasses (*Leersia spp.*) and manna-grass (*Glyceria spp.*)	Narrow border on edge of Peverly Pond, probably dependent upon seasonal dry spells.

Plant Community	Population/Habitat Attributes (Soils, Structure, Species Composition)	Natural Processes/Limiting Factor
Red pine forest/ woodland	Occurring on sand plains and other well drained soils or pockets of cold-air drainages. Red pine (*Pinus resinosa*) is the main canopy species with a few white pines (*Pinus strobus*), oaks (*Q. rubra, Q. alba*), and shagbark hickories (*Carya ovata*). The understory contains blueberries (*Vaccinium spp.*).	Occurs on sand plains and other well-drained soils or cold-air drainage. Fire interval of 175 to 200 years. Refuge population is about150 yrs old, but younger stand of red pine regenerating (about 10 to 20 years old).
Pine plantations	Four separate plantations, each with different species of trees. 1. White fir (*Abies concolor*) approximately 25 years old. 2. Blue Spruce (*Picea pungens*). 3. White pine (*Pinus strobus*) approximately 25 years old. 4. White spruce (*Picea glauca*), trees approximately 30-feet tall.	Naturally reverting to oak-hickory forest; planted pines dying from disease. Monitor for invasives (e.g., common buckthorn and autumn olive).
Low salt marsh	Dominated by smooth cord-grass (*Spartina alterniflora*) with soils of organic materials atop sandy or silty materials. Pannes and pools can be found within the low salt marsh and some vascular halophytes that may occur in low-abundance include common glasswort (*Salicornia europaea*), orach (*A. hastate, A. glabriuscula*), sea blites (*Suaeda spp.*), and macroalgae (e.g., *Ascophyllum nodosum* and *Fucus spp.*).	Occurring along coastal shorelines that are protected from high-energy wave action. The Low marsh in found between the mean sea level and mean high tide resulting in daily flooding with soil water salinity levels between 18 to 30 parts per thousand (ppt).
High salt marsh	Soils are generally organic materials (greater than 50 inches) on top of sand, silt, or bedrock. Salt-meadow cord-grass (*Spartina patens*) is the dominant vegetation but other common plants include short form smooth cord-grass *(S. alterniflora*), spike-grass (*Distichlis spicata*), and salt marsh rush (*Juncus gerardii*). The greatest species richness is found along the upper landward edge of the marsh and includes seaside goldenrod (*Solidago sempervirens*) and a variety of grasses (e.g., *Panicum virgatum, Hierochloe odorata, Festuca rubra, Elytrigia repens, Elymus virginicus*). Pannes and pools occur within the high salt marsh.	Found adjacent to the low salt marsh and occurring landward of the mean high tide mark stretching to the upper reaches of spring tides. These systems are irregularly flooded (less than daily) and have soil water salinity levels between 18 to 30 ppt.
Brackish marsh	Soils are likely sulfihemist with low surface salt content. These support a variety of species that are tolerant of the brackish conditions. The most abundant species is narrow-leaved cattail (*Typha angustifolia*), but other species found in this system include rushes (*Scirpus robustus, S. pungens*), seaside goldenrod (*Solidago sempervirens*), fresh-water cordgrass (*Spartina pectinata*), broadleaf cattail (*Typha latifolia*), and halberd-leaved orach (*Atriplex hastata*).	Along upper edges of high salt marshes where fresh water runoff or groundwater discharge flows onto the marsh surface. Only flooded by salt water during spring tides and storm surges resulting in soil water salinity ranging from greater than 0.5 to less than 18 ppt.

Plant Community	Population/Habitat Attributes (Soils, Structure, Species Composition)	Natural Processes/Limiting Factor
Low/high salt marsh complex	Combination of low and high salt marsh communities (see above). However, rather than moving on a gradient from shore to upland, the high marsh is sporadically intermixed with the low marsh due to small-scale changes in surface elevation.	Elevation changes may be due to ice scouring, erosion, and/or soil/sod deposition from ice rafts.
Coastal Rocky Headland	Occurring on bedrock with thin, acidic soil along exposed rocky points in close proximity to salt spray. Dominated by stunted eastern red cedar (*Juniperus virginiana*) with lesser amounts of black oak (*Quercus velutina*) and pines (*Pinus strobes, P. resinosa*). The understory is composed of blueberries (*Vaccinium spp.*), northern bayberry (*Myrica pensylvanica*), and creeping juniper (*Juniperus communis*).	Exposed to salt spray and maritime climate. Potential risk to invasion by established European barberry.
Coastal Shoreline Strand/Swale	Sparsely vegetated (often less than 25 percent) upper intertidal region of fine to coarse soils. Covered with wrack composed of driftwood, S. alterniflora detritus, and macroalgae. Sea-rocket (*Cakile edentula*) is the dominant vegetation. Other species present include poison-ivy (*Toxicodendron radicans*) and seaside goldenrod (*Solidago sempervirens*).	Located in protected estuarine shorelines or backdune depressions that are flooded less than daily.
Intertidal Rocky Shore	Estuarine rivers, streams, or partially enclosed shoreline composed of coarse soils, rubble, and bedrock substrates. Vegetation is mainly macroalgae (*A. nodosum, F. vesiculosus*).	Flooded daily by tides but protected from strong currents and high-energy wave action.
Forest On Fill	Approximately 20-year old forest on sandy, silty fill of udorhents soil. Tree species include: trembling aspen (*Populus tremuloides*), birches (*Betula populifolia, B. papyrifera*), red maple (*Acer rubrum*), white pine (*Pinus strobus*), and white ash (*Fraxinus americana*). Understory species include blackberry (*Rubus spp.*) and dogwood (*Cornus spp.*).	Invasives (buckthorns and multi-flora rose) established in understory.

2) Identify Priority Resources of Concern

To guide the determination of which resources of concern should be a management priority, the planning team consulted the previously mentioned bird conservation plans, partner prioritization lists, the refuge's purposes, and the Service's Biological Integrity, Diversity, and Environmental Health Policy. We also used survey data for the refuge and surrounding area, and analyzed current and potential natural vegetation and desired future conditions.

As previously mentioned, the refuge needs to consider multiple geographic scales when determining its greatest contribution to species and habitat conservation. This type of analysis ensures the refuge's goals are compatible, significant, and relevant to the resource at various scales. It is also necessary to understand the scale in which other conservation partners are operating within the larger regional planning area, local planning area, State, or bird conservation region. Refuges are often unique within cooperative regional conservation planning efforts because they are part of the larger Refuge System; they are one of the few conservation entities that need to consider their role at the continental scale. While it may seem counterintuitive, incorporating large-scale

perspectives can assist in narrowing the focus in deciding management priorities within certain management units (Knopf 1994). In fact, a refuge's highest priority may be decided based on its contribution to priority resources at the continental scale.

2.1) Regional Plan Ranking

Various Service programs and partner agencies and organizations have developed regional "prioritization rankings" for various resources of concern. These represent the best science and professional judgment of the larger conservation community. We used this as a "first filter" to identify priority resources of concern. Table B.2 below identifies the lists and rankings that were used.

Table B.2. Regional Plans and Lists and their Respective Rankings

Regional Plans and Lists	Rankings selected for Priority Species
Federal List of Threatened and Endangered Species	Threatened, endangered, and candidate species supported by refuge habitats
U.S. Fish and Wildlife Service - Birds of Conservation Concern (BCC)	All species supported by refuge habitats on the BCC list for BCR 30
U.S. Fish and Wildlife Service - Birds of Management Concern	All species supported by refuge habitats
BCR 30 Priority Species List	Species supported by refuge habitats with priorities of "highest high" or "high"
PIF 9 Priority Species List	Species supported by refuge habitat with priorities of 1A, 2A, 2B, or 2C
U.S. Shorebird Conservation Plan–Atlantic Flyway	All species supported by refuge habitats that also have BCR 30 priorities of either "highest high" or "high"
North American Waterbird Conservation Plan	All species supported by refuge habitats that also have BCR 30 priorities of either "highest high" or "high"
North American Waterfowl Management Plan	All species supported by refuge habitats that also have BCR 30 priorities of either "highest high" or "high"
U.S. Fish and Wildlife Service–List of Fish Trust Species	Declining species in Gulf of Maine ecoregion supported by refuge habitats
Priority Marine Mammals	All species supported by refuge habitats (none identified)
NHNHB Rare Species Distribution and Occurrence Maps	All threatened and endangered plants and invertebrates, and regionally rare birds supported by refuge habitats
New Hampshire Comprehensive Wildlife Conservation Plan Priorities	All non-bird species with Species Action Plan supported by refuge habitats
NHNHB Natural Communities of New Hampshire	Exemplary or underrepresented communities in the State (G1-3; S1-2)

Supporting Discussion:

Partners In Flight (PIF) and Bird Conservation Regions (BCRs) have incorporated both the regional and continental scales into their species ranks, providing a starting point for selecting priority bird species for a refuge. PIF (landbirds) and BCR (all birds) plans use Breeding Bird Survey and Breeding Bird Atlas data to

identify species that are of high conservation priority for defined geographic regions. The priorities are based on long-term declines and threats to long-term viability, as well as the ability of conservation actions in a particular geographic region to contribute to long-term population stability based on relative abundance of the species population.

The PIF/BCR tiering helps prioritize landbird conservation efforts at different scales. The role of refuges is to address the habitats of species of high continental concern and species that have a high proportion of their population in a particular BCR. This will allow an individual refuge to have the greatest impact nationally and regionally, while contributing to BCR goals. By first looking at the habitats of selected species, we maximize the efforts of the Refuge System by managing for the habitats with the highest ranking species, which typically represent the habitats unique to that portion of the continent.

For non-bird species, where regional and national scale prioritizations are not available, we relied on New Hampshire Natural Heritage and Piscataqua Regional Estuaries Partnership priorities and reports.

2.2) Review of Baseline Wildlife Surveys

We did a comprehensive review of baseline wildlife surveys conducted to date to assist with determining species presence and abundance on the refuge. Additional surveys were conducted during the CCP process as budget and staffing allowed. We selected species prioritized in regional plans and were consistently found on the refuge in good abundance for the Priority List. Rare species that occur in small numbers, had historical distribution on the refuge, or had potential for reintroduction and recolonization also were selected for the Priority List. The list of surveys and their results are described in detail in chapter 2.

2.3) Reviewed Habitat Requirements and Current Distribution

For species that were not already documented on the refuge through survey data, we reviewed species habitat requirements and current species distribution to determine the likelihood of the species to be on the refuge and the potential for the refuge to contribute significantly to the State, regional, or national population. Our main sources included Birds of North American Online (Cornell University) and species profiles from the New Hampshire State Wildlife Action Plan.

2.4) Gather Expert Opinion

Partner Meeting
We met with various State and Federal agencies to discuss Great Bay Refuge's greatest contribution to the Great Bay Estuary region, the State, and the Northeast.

Site Visit with Community Ecologist
In 1999, NHB conducted sites visits to develop habitat community maps for the Great Bay Refuge. Dan Sperduto, author of the "Natural Communities of New Hampshire" did the initial mapping. Afterwards, he revisited the refuge to work with the refuge biologist to identify exemplary communities and site capacities of altered habitats.

Consultation with Other Experts
For certain species with little to no survey data, such as bats, amphibians, and reptile use on refuge, we consulted with local and regional experts, including Dave Yates from Biodiversity Research Institute and Kim Babbitt from University of New Hampshire.

3) Select Focal Species by Refuge Habitat Types

3.1) Associating Priority Resources of Concern to Refuge Habitat Types

While vegetative communities are mainly dictated by soils, hydrology, and plant communities, many wildlife species use more than one vegetative community. In fact, the juxtaposition of different vegetative communities in the landscape provides the various habitat requirements for specific species. For example, many amphibians and reptiles breed in seasonal wetlands, called vernal pools, but spend the majority of their life cycle in adjacent upland habitat. Table 2.9 (in chapter 2) sorts the mapped vegetative communities into broad habitat

categories that are more meaningful from a wildlife management standpoint. All goals, objectives, and strategies in the CCP are developed for these broader habitat categories. We then assigned the priority resources of concern to these habitat categories. As most refuge management activities are focused on habitat manipulation or restoration, this association ties the species priorities into tangible management objectives.

3.2) Incorporating Biological Integrity, Diversity, and Environmental Health Elements

In selecting priority resources of concern and focal species, we used the biological integrity, diversity, and environmental health elements table (Table B.1) to identify the refuge's capability and greatest contribution. Filters used include site capabilities, limiting factors, response to management or restoration, as well as, ability to maintain or restore aspects of ecological or ecosystem processes within the refuge and surrounding landscape. A few examples of these filters are highlighted below.

Site Capability/Limiting Factors. Under alternative A (Current Management), the refuge would manage for many small grassland units. Baseline surveys indicate that most of these small grasslands do not provide benefits to priority grassland nesting birds. Additionally, soil maps and additional soil surveys confirm that the soils mainly support forested habitat (oak-hickory forest or maple/beech forests). The annual mowing of these numerous small tracts also increases management burden. During the CCP process, we reevaluated grassland management and proposed under alternative B to focus on maintaining and restoring two to three large grassland units, with dry and sandy soils that would be more appropriate to maintain as a grassland. These areas also had historic records of upland sandpipers, a priority species for the State.

Response to Management or Restoration. Although currently not present at Great Bay Refuge, we are proposing to restore and manage habitat for New England cottontail under alternative B. This species is a candidate species for the Federal List of Threatened and Endangered Species. It is currently persisting in small (less than 10 to 20 acres), fragmented, shrub habitats in a fraction of its historical range. There is a significant extant population just across Great Bay that the refuge is working with partners to protect. One of the major threats to this species is that lack of habitat management on conserved lands to provide the early successional (dense shrub) habitat it requires. Refuges have the expertise, equipment, and a mandate to manage for this species, thus providing a unique opportunity to expand the existing population and restore new populations. Unlike other habitats (like grassland or forest) which require larger contiguous tracts, managing for 10 to 20 acre shrub habitat would significantly contribute to the recovery of this species.

Restoring Ecological Integrity and Ecosystem Process. As described in chapter 2, New England has the longest land use history in the United States. As such, it's difficult to find areas where natural ecological processes are fully intact. However, one can often find areas where these processes are mostly intact, such as the oak-hickory community (including forested and shrub wetlands) on Great Bay Refuge. Alternative B proposes small changes to restore ecological integrity, such as minimizing edge habitat from trails and forest openings, and restoring hydrological flow in the lower Peverly Book. Under alternative C, we would maximize restoration of ecosystem process by eliminating management of shrub, grassland, and impoundment habitats, and removing excess roads that create edge habitats.

3.3) Selecting Focal Resources

For each of these broad habitat categories types, we then selected focal resources for management and monitoring purposes. Focal resources are highly associated with conditions that represent the needs of larger groups of species or communities that have similar requirements (e.g., habitats, ecological and/or ecosystem processes) and respond to management similarly. When wildlife are selected as focal resources, they may be selected because they reflect the distribution and abundance of species with similar requirements (focal species), their protection covers a wide range of co-existing species in the same habitat (umbrella species), a species whose status provides information on the overall condition of the ecosystem and of other species in that ecosystem (indicator species), or species that have an effect on many other species in an ecosystem disproportionate to their abundance or biomass (keystone species). By managing for focal resources, important components of functional, healthy ecosystems will be addressed. Also, through our management for focal resources, we hope to conserve our priority species and habitats. The following table identifies refuge habitat types and associated focal species.

Table B.3. Priority Habitat Types and Their Associated Focal Species for Great Bay Refuge

Priority Habitat Types	Associated Focal Species
Freshwater impoundments	Marsh wren, migrating and wintering waterfowl, nesting marshbirds, alewife, blueback herring, American eel, large bur-reed
Intertidal Estuarine*	Eelgrass beds, oysters, alewife, blueback herring , American eel
Salt marsh and rocky shoreline	Wintering black duck, wintering bald eagle, foraging marsh and wading birds, migratory shorebirds, salt marsh sparrow, seaside mallow, American eel
Forested and scrub-shrub wetlands and vernal pools	Willow flycatcher, wood thrush, vernal pool obligate amphibians, foraging woodcock, and native plant communities
Oak-hickory forest	Wood thrush, scarlet tanager, Baltimore oriole, solitary tree bats
Shrubland	Eastern towhee, prairie warbler, blue-winged warbler, American woodcock, black racer, New England cottontail
Grassland	Upland sandpiper, American woodcock, Eastern meadowlark, New England blazing star

* *This habitat type does not occur on the refuge, but is an important priority habitat in the Great Bay Estuary*

Literature Citations

Dettmers, Randy. 2006. Draft: Blueprint for the Design and Delivery of Bird Conservation in the Atlantic Northern Forest. U.S. Fish and Wildlife Service, Hadley, MA. 352 p.

Dunn, Erica H.; D.J.T. Hussell, and D.A. Welsh. 1998. Priority-Setting Tool Applied to Canada's Landbirds Based on Concern and Responsibility for Species. Conservation Biology. Vol. 13 No. 6 pgs 1404-1415.

Ford, Robert P., and M.C. Roedel. 2004. Bird conservation planning in the interior low plateaus. In: Bonney, Rick; D. N. Pashley; R.J. Cooper; L. Niles, eds. 2000. Strategies for bird conservation: The Partners In Flight planning process; Proceedings of the 3rd Partners in Flight Workshop; 1995 October 1-5; Cape May, NJ. Proceedings RMRS-P16. Ogden, UT: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station.

Freemark, Kathryn E.; J.R. Probst; J.B. Dunning and S.J. Hejl. 1993. Adding a Landscape Ecology Perspective to Conservation and Management Planning. In, Finch, Deborah M. and P.W. Stangel, eds. Status and Management of Neotropical Migratory Birds; 1992 September 21-25; Estes Park, Co. Gen. Tech. Rep. RM-229. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 422 p.

Knopf, Fritz L. and F.B. Samson. 1994. Scale Perspectives on Avian Diversity in Western Riparian Ecosystems. Conservation Biology, Vol. 8, No. 3. pages 669-676.

McWilliams, William H.; B. Butler; L Caldwell; D. Griffith; M. Hoppus; K. Laustsen; A. Lister; T. Lister; J. Metzler; R. Morin; S. Sader; L. Stewart; J. Steinman; J. Westfall; D. Williams; A. Whitman; and C. Woodall. 2004. The Forests of Maine: 2003. Resource Bulletin NE-164 September 2005. U.S. Department of Agriculture, Forest Service. Northeastern Research Station, Newtown Square, PA. 195p.

Mueller, Allen J.: D.J. Twedt and C.R. Loesch. 2000. Development of Management Objectives forBreeding Birds in the Mississippi Alluvial Valley. In: Bonney, Rick; D. N. Pashley; R.J. Cooper; L. Niles, eds. 2000. Strategies for bird conservation: The Partners In Flight planning process; Proceedings of the 3rd Partners in Flight Workshop; 1995 October 1-5; Cape May, NJ. Proceedings RMRS-P16. Ogden, UT: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station.

Nazaire, Mare. 2005. A Study of the Vegetation and Floristic Diversity of Two Peatland Complexes of Post-Settlement Origin in Lake Umbagog National Wildlife Refuge, Coos County, New Hampshire. Master of Science Thesis, University of New Hampshire. 192 p.

Panjabi, Arvind. 2001. The Partners In Flight Handbook on Species Assessment & Prioritization. Version 1.1 December 2001. Rocky Mountain Bird Observatory.

Probst, John R. and F.R. Thompson, III. 1996. A multiscale assessment of the geographic and ecological distributins of Midwestern Neotropical migratory birds. Pages 22-40 in Thompson, F.R., III (ed.), Managing Midwestern landscapes for the conservation of neotropical migratory birds. Gen. Tech, Rep. NC-187. USDA Forest Service.

Ralph, C. John and T.D. Rich, eds. Bird Conservation Implementation and Integration in the Americas: Proceedings of the Third International Partners in Flight Conference. 2002 March 20-24; Asilomar, CA, Volume 1. Gen. Tech. Rep. PSW-GTR-191. Albany, CA: Pacific Southwest Research Station, Forest Service, U.S. Department of Agriculture. 651 p.

Rich, T.D.; C.J. Beardmore; H. Berlanga; P.J. Blancher; M.S. Bradstreet; G. S. Butcher; D.W. Demarest; E.H. Dunn; W.C. Hunter; E.E. Inigo-Elias; J.A. Kennedy; A.M. Martell; A.O. Panjabi; D.N. Pashley; K.V. Rosenberg; C.M. Rustay; J.S. Wendt; and T.C. Will. 2004. Partners in Flight North American Landbird Conservation Plan. Cornell Lab of Ornithology. Ithaca, NY.

Rosenberg, Kenneth V. and T.P. Hodgman. 2000. Partners In Flight Landbird Conservation Plan: Physiographic Area 28: Eastern Spruce-Hardwood Forest. Draft 1.0. American Bird Conservancy. p48.

Rosenberg, Kenneth V. and J.V. Wells. 2000. Global perspectives on neotropical migratory bird conservation in the Northeast: Long-term responsibility versus immediate concern. In: Bonney, Rick; D. N. Pashley; R.J. Cooper; L. Niles, eds. 2000. Strategies for bird conservation: The Partners In Flight planning process; Proceedings of the 3rd Partners in Flight Workshop; 1995 October 1-5; Cape May, NJ. Proceedings RMRS-P16. Ogden, UT: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station.

Rosenberg, Kenneth V. and J.V. Wells. 1995. Importance of geographic areas to Neotropical migrant birds in the Northeast. Final report to U.S. Fish and Wildlife Service, Region-5, Hadley, MA.

Sauer, John R. 2004. Combining information from monitoring programs: complications associated with indices and geographic scale. In: Bonney, Rick; D. N. Pashley; R.J. Cooper; L. Niles, eds. 2000. Strategies for bird conservation: The Partners In Flight planning process; Proceedings of the 3rd Partners in Flight Workshop; 1995 October 1-5; Cape May, NJ. Proceedings RMRS-P16. Ogden, UT: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station.

Sauer, John R.; J.K. Casey; H. Laskowski; J.D. Taylor and J. Fallon. 2005. Use of Survey Data to Define Regional and Local Priorities for Management on National Wildlife Refuges. In: Ralph, John C. and T.D. Rich, eds. Bird Conservation Implementation and Integration in the Americas: Proceedings of the Third International Partners in Flight Conference. 2002 March 20-24; Asilomar, CA, Volume 2. Gen. Tech. Rep. PSW-GTR-191. Albany, CA: Pacific Southwest Research Station, Forest Service, U.S. Department of Agriculture; Pgs 1224-1231.

Schroeder, Richard L.; J. Holler and J. P. Taylor. 2004. Managing National Wildlife Refuges for Historic or Non-Historic Conditions: Determining the Role of the Refuge in the Ecosystem. In: Managing Biological Integrity, Diversity, and Environmental Health in the National Wildlife Refuges. Natural Resources Journal. Fall 2004. Vol. 44, No. 4. Pgs.1041-1066.

Scott, J. Michael; T. Loveland; K. Gergely; J. Strittholt and N. Staus. National Wildlife Refuge System: Ecological Context and Integrity. In: Managing Biological Integrity, Diversity, and Environmental Health in the National Wildlife Refuges. Natural Resources Journal. Fall 2004. Vol. 44, No. 4. Pgs.1041-1066.

Schneider, K.J., and D.M. Pence, eds. 1992. Migratory nongame birds of management concern in the Northeast. U.S. Dep. Inter., Fish and Wildlife Service, Hadley, MA. 400p.

Sportza, Lucy M. 1999. Regional approaches to planning for protected areas and conservation. Environments, 29(3): 1-14.

U.S. Fish and Wildlife Service. 1991. Final Environmental Assessment Proposal to Protect Wildlife Habitat, Lake Umbagog, Coos County, New Hampshire, Oxford County, Maine. June 1991. Hadley MA. 49 p.

Appendix C

John J. Mosseso–NBII

Wood turtle

Findings of Appropriateness and Compatibility Determinations

Findings of Appropriateness and Compatibility Determinations

Finding of Appropriateness—Berry Picking, Mushroom Collecting, and Flower Picking C-1

Finding of Appropriateness—Bicycling off Public Entrance Road C-3

Finding of Appropriateness—Camping C-5

Finding of Appropriateness—Dog Walking C-7

Finding of Appropriateness—Geocaching C-9

Finding of Appropriateness—Horseback Riding C-11

Finding of Appropriateness—Jogging C-13

Finding of Appropriateness—Commercial Wildlife and Nature Photography C-15

Compatibility Determination—Commercial Wildlife and Nature Photography C-17

Finding of Appropriateness—Research by Non-Service Personnel C-23

Compatibility Determination—Research Conducted by Non-Service Personnel C-25

Finding of Appropriateness—Walking, Hiking, Cross Country Skiing, and Snowshoeing C-37

Compatibility Determination—Walking, Hiking, Cross Country Skiing, and Snowshoeing C-39

Compatibility Determination—Wildlife Observation and Photography, Environmental Education, and Interpretation . C-45

Compatibility Determination—Hunting C-51

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Exhibit 1

FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Great Bay National Wildlife Refuge

Use: Berry Picking, Mushroom Collecting, and Flower Picking

This exhibit is not required for wildlife-dependent recreational uses, forms of take regulated by the State, or uses already described in a refuge CCP or step-down management plan approved after October 9, 1997.

Decision criteria:	**YES**	**NO**
(a) Do we have jurisdiction over the use?	✔	
(b) Does the use comply with applicable laws and regulations (Federal, State, Tribal, and local)?		✔
(c) Is the use consistent with applicable Executive orders and Department and Service policies?		✔
(d) Is the use consistent with public safety?		✔
(e) Is the use consistent with goals and objectives in an approved management plan or other document?		✔
(f) Has an earlier documented analysis not denied the use or is this the first time the use has been proposed?		✔
(g) Is the use manageable within available budget and staff?		✔
(h) Will this be manageable in the future within existing resources?		✔
(i) Does the use contribute to the public's understanding and appreciation of the refuge's natural or cultural resources, or is the use beneficial to the refuge's natural or cultural resources?		✔
(j) Can the use be accommodated without impairing existing wildlife-dependent recreational uses or reducing the potential to provide quality (see section 1.6D. for description), compatible, wildlife-dependent recreation into the future?		✔

Where we do not have jurisdiction over the use ("no" to [a]), there is no need to evaluate it further as we cannot control the use. Uses that are illegal, inconsistent with existing policy, or unsafe ("no" to [b], [c], or [d]) may not be found appropriate. If the answer is "no" to any of the other questions above, we will generally not allow the use.

If indicated, the refuge manager has consulted with State fish and wildlife agencies. Yes ___✔___ No ___ .

When the refuge manager finds the use appropriate based on sound professional judgment, the refuge manager must justify the use in writing on an attached sheet and obtain the refuge supervisor's concurrence.

Based on an overall assessment of these factors, my summary conclusion is that the proposed use is:

Not Appropriate ___✔___ **Appropriate** _____

Refuge Manager: _____ Date: _____

If found to be **Not Appropriate**, the refuge supervisor does not need to sign concurrence if the use is a new use.

If an existing use is found **Not Appropriate** outside the CCP process, the refuge supervisor must sign concurrence.

If found to be **Appropriate**, the refuge supervisor must sign concurrence:

Refuge Supervisor: _____ Date: _____

A compatibility determination is required before the use may be allowed.

603 FW 1
Exhibit 1
Page 2

JUSTIFICATION FOR A FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Great Bay National Wildlife Refuge

Use: Berry Picking, Mushroom Collecting, and Flower Picking

NARRATIVE:

To comply with 2006 U.S. Fish and Wildlife Service (Service) policy on appropriateness, we are evaluating all non-priority public uses for Great Bay National Wildlife Refuge (Great Bay Refuge, the refuge). Berry picking, mushroom collecting, and flower picking are not identified as a priority public uses of the National Wildlife Refuge System under the National Wildlife Refuge System Administration Act of 1966 (16 U.S.C. § 668dd-668ee), as amended by the National Wildlife Refuge System Improvement Act of 1997. These uses will not be allowed on the refuge for several reasons.

Impacts such as trampling vegetation and wildlife disturbance would occur. Visitors walking off established public use trails may impact plants indirectly by compacting soils, increasing erosion, and walking on young plants, reducing survival and regeneration. Berries, mushrooms, and flowers can be important sources of food for various wildlife species and the removal of these can have adverse effects. Also, collecting of natural materials is prohibited on refuge lands by 50 C.F.R. 27.51, except by special use permit.

After evaluating these uses under Service policies, we conclude that we will not allow these activities. Berry picking, mushroom collecting, and flower picking do not support a refuge purpose, goal, or objective and would not benefit the resources within the refuge. Therefore, we find these, and similar activities, to not be appropriate for the Great Bay Refuge.

603 FW 1
Exhibit 1

FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Great Bay National Wildlife Refuge

Use: Bicycling off Public Entrance Road

This exhibit is not required for wildlife-dependent recreational uses, forms of take regulated by the State, or uses already described in a refuge CCP or step-down management plan approved after October 9, 1997.

Decision criteria:	**YES**	**NO**
(a) Do we have jurisdiction over the use?	✔	
(b) Does the use comply with applicable laws and regulations (Federal, State, Tribal, and local)?	✔	
(c) Is the use consistent with applicable Executive orders and Department and Service policies?	✔	
(d) Is the use consistent with public safety?	✔	
(e) Is the use consistent with goals and objectives in an approved management plan or other document?		✔
(f) Has an earlier documented analysis not denied the use or is this the first time the use has been proposed?		✔
(g) Is the use manageable within available budget and staff?		✔
(h) Will this be manageable in the future within existing resources?		✔
(i) Does the use contribute to the public's understanding and appreciation of the refuge's natural or cultural resources, or is the use beneficial to the refuge's natural or cultural resources?	✔	
(j) Can the use be accommodated without impairing existing wildlife-dependent recreational uses or reducing the potential to provide quality (see section 1.6D. for description), compatible, wildlife-dependent recreation into the future?		✔

Where we do not have jurisdiction over the use ("no" to [a]), there is no need to evaluate it further as we cannot control the use. Uses that are illegal, inconsistent with existing policy, or unsafe ("no" to [b], [c], or [d]) may not be found appropriate. If the answer is "no" to any of the other questions above, we will generally not allow the use.

If indicated, the refuge manager has consulted with State fish and wildlife agencies. Yes _____ No ___✔___.

When the refuge manager finds the use appropriate based on sound professional judgment, the refuge manager must justify the use in writing on an attached sheet and obtain the refuge supervisor's concurrence.

Based on an overall assessment of these factors, my summary conclusion is that the proposed use is:

Not Appropriate ___✔___ **Appropriate** _____

Refuge Manager: _____ Date: _____

If found to be **Not Appropriate**, the refuge supervisor does not need to sign concurrence if the use is a new use.

If an existing use is found **Not Appropriate** outside the CCP process, the refuge supervisor must sign concurrence.

If found to be **Appropriate**, the refuge supervisor must sign concurrence:

Refuge Supervisor: _____ Date: _____

A compatibility determination is required before the use may be allowed.

603 FW 1
Exhibit 1
Page 2

JUSTIFICATION FOR A FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Great Bay National Wildlife Refuge

Use: Bicycling off Public Entrance Road

NARRATIVE:

To comply with 2006 U.S. Fish and Wildlife Service (Service) policy on appropriateness, we are evaluating all non-priority public uses for Great Bay National Wildlife Refuge (Great Bay Refuge, the refuge). Bicycling is not a priority public use of the National Wildlife Refuge System under the National Wildlife Refuge System Administration Act of 1966 (16 U.S.C. § 668dd-668ee), as amended by the National Wildlife Refuge System Improvement Act of 1997 (Public Law 105-57). Bicycling will not be allowed on the trails or anywhere else on the refuge.

Bicycling may degrade the trails and cause further erosion. Although foot travel is allowed on established trails so that visitors may experience the priority public uses of wildlife observation, photography and environmental education, biking is not required to experience these uses. Biking may degrade the trail, cause further erosion, and cause safety hazards to other visitors.

After evaluating bicycling under Service policies, current conditions, required maintenance, and demand, we conclude that we will not allow this activity. Prohibiting bicycling may positively impact soils and wildlife; if only by reducing the amount of erosion and soil compaction that might occur on trails and the frequency and extent of wildlife disturbance. Biking is not a wildlife dependent public use, nor is it necessary to support a priority public use, and it may decrease the enjoyment of the refuge for other visitors.

However, bicycling does provide a means for many area residents and visitors to get to the refuge, and this finding does not restrict that use. The refuge does allow bicycling on the entrance road and has bike rack available at the trail parking area. There are also many other sites throughout the surrounding area that provide opportunities for bicycling.

603 FW 1
Exhibit 1

FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Great Bay National Wildlife Refuge

Use: Camping

This exhibit is not required for wildlife-dependent recreational uses, forms of take regulated by the State, or uses already described in a refuge CCP or step-down management plan approved after October 9, 1997.

Decision criteria:	**YES**	**NO**
(a) Do we have jurisdiction over the use?	✔	
(b) Does the use comply with applicable laws and regulations (Federal, State, Tribal, and local)?	✔	
(c) Is the use consistent with applicable Executive orders and Department and Service policies?	✔	
(d) Is the use consistent with public safety?	✔	
(e) Is the use consistent with goals and objectives in an approved management plan or other document?		✔
(f) Has an earlier documented analysis not denied the use or is this the first time the use has been proposed?	✔	
(g) Is the use manageable within available budget and staff?		✔
(h) Will this be manageable in the future within existing resources?		✔
(i) Does the use contribute to the public's understanding and appreciation of the refuge's natural or cultural resources, or is the use beneficial to the refuge's natural or cultural resources?	✔	
(j) Can the use be accommodated without impairing existing wildlife-dependent recreational uses or reducing the potential to provide quality (see section 1.6D. for description), compatible, wildlife-dependent recreation into the future?	✔	

Where we do not have jurisdiction over the use ("no" to [a]), there is no need to evaluate it further as we cannot control the use. Uses that are illegal, inconsistent with existing policy, or unsafe ("no" to [b], [c], or [d]) may not be found appropriate. If the answer is "no" to any of the other questions above, we will generally not allow the use.

If indicated, the refuge manager has consulted with State fish and wildlife agencies. Yes _____ No ___✔___.

When the refuge manager finds the use appropriate based on sound professional judgment, the refuge manager must justify the use in writing on an attached sheet and obtain the refuge supervisor's concurrence.

Based on an overall assessment of these factors, my summary conclusion is that the proposed use is:

Not Appropriate ___✔___ **Appropriate** _____

Refuge Manager: _____ Date: _____

If found to be **Not Appropriate**, the refuge supervisor does not need to sign concurrence if the use is a new use.

If an existing use is found **Not Appropriate** outside the CCP process, the refuge supervisor must sign concurrence.

If found to be **Appropriate**, the refuge supervisor must sign concurrence:

Refuge Supervisor: _____ Date: _____

A compatibility determination is required before the use may be allowed.

603 FW 1
Exhibit 1
Page 2

JUSTIFICATION FOR A FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Great Bay National Wildlife Refuge

Use: Camping

NARRATIVE:

To comply with 2006 U.S. Fish and Wildlife Service (Service) policy on appropriateness, we are evaluating all non-priority public uses for Great Bay National Wildlife Refuge (Great Bay Refuge, the refuge). Camping is not identified as a priority public use of the National Wildlife Refuge System under the National Wildlife Refuge System Administration Act of 1966 (16 U.S.C. § 668dd-668ee), as amended by the National Wildlife Refuge System Improvement Act of 1997. Camping will not be allowed on the refuge for several reasons.

If we allow camping on the refuge, visitors may wander off-trail to find suitable sites and consequently cause increased soil and vegetation compaction and disturbance to wildlife. Camping encourages visitors to stay overnight and leave behind trash, food, and human waste which are ecological and aesthetic problems. Law enforcement and safety may also become greater concerns if campers are not responsible or do not exercise caution.

After evaluating camping under Service policies, we conclude that we will not allow this activity. Since we have never permitted camping on the refuge, we do not expect that prohibiting this activity will significantly impact current or future visitors. However, prohibiting camping may positively impact wildlife and wildlife habitat by reducing

- the amount trash, food, and human waste left behind;
- soil compaction and vegetation trampling; and
- the frequency and extent of wildlife disturbance.

603 FW 1
Exhibit 1

FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Great Bay National Wildlife Refuge

Use: Dog Walking

This exhibit is not required for wildlife-dependent recreational uses, forms of take regulated by the State, or uses already described in a refuge CCP or step-down management plan approved after October 9, 1997.

Decision criteria:	**YES**	**NO**
(a) Do we have jurisdiction over the use?	✔	
(b) Does the use comply with applicable laws and regulations (Federal, State, Tribal, and local)?	✔	
(c) Is the use consistent with applicable Executive orders and Department and Service policies?	✔	
(d) Is the use consistent with public safety?	✔	
(e) Is the use consistent with goals and objectives in an approved management plan or other document?		✔
(f) Has an earlier documented analysis not denied the use or is this the first time the use has been proposed?		✔
(g) Is the use manageable within available budget and staff?	✔	
(h) Will this be manageable in the future within existing resources?	✔	
(i) Does the use contribute to the public's understanding and appreciation of the refuge's natural or cultural resources, or is the use beneficial to the refuge's natural or cultural resources?		✔
(j) Can the use be accommodated without impairing existing wildlife-dependent recreational uses or reducing the potential to provide quality (see section 1.6D. for description), compatible, wildlife-dependent recreation into the future?		✔

Where we do not have jurisdiction over the use ("no" to [a]), there is no need to evaluate it further as we cannot control the use. Uses that are illegal, inconsistent with existing policy, or unsafe ("no" to [b], [c], or [d]) may not be found appropriate. If the answer is "no" to any of the other questions above, we will generally not allow the use.

If indicated, the refuge manager has consulted with State fish and wildlife agencies. Yes _____ No ___✔___.

When the refuge manager finds the use appropriate based on sound professional judgment, the refuge manager must justify the use in writing on an attached sheet and obtain the refuge supervisor's concurrence.

Based on an overall assessment of these factors, my summary conclusion is that the proposed use is:

Not Appropriate ___✔___ **Appropriate** _____

Refuge Manager: _____ Date: _____

If found to be **Not Appropriate**, the refuge supervisor does not need to sign concurrence if the use is a new use.

If an existing use is found **Not Appropriate** outside the CCP process, the refuge supervisor must sign concurrence.

If found to be **Appropriate**, the refuge supervisor must sign concurrence:

Refuge Supervisor: _____ Date: _____

A compatibility determination is required before the use may be allowed.

603 FW 1
Exhibit 1
Page 2

JUSTIFICATION FOR A FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Great Bay National Wildlife Refuge

Use: Dog Walking

NARRATIVE:

To comply with 2006 U.S. Fish and Wildlife Service (Service) policy on appropriateness, we are evaluating all non-priority public uses for Great Bay National Wildlife Refuge (Great Bay Refuge, the refuge). Dog-walking is not identified as a priority public use of the National Wildlife Refuge System under the National Wildlife Refuge System Administration Act of 1966 (16 U.S.C. § 668dd-668ee), as amended by the National Wildlife Refuge System Improvement Act of 1997. Dog walking will not be allowed on the refuge for several reasons.

Many wildlife species perceive dogs as natural predators, which causes them to react to the presence (visual/scent) of dogs. Common reactions include vacating and avoiding areas disturbed by dogs (Lima and Bednekoff 1999, Lenth et al. 2006). Domestic dogs can also depredate native wildlife (Gill 1994).

Researchers have found that dogs displace native migratory bird species from their native habitats (Banks and Bryan 2007). Studies have also indicated that the presence of dogs on trails can decrease wildlife use within 330 feet (100 meters) of the trail (Lenth et al. 2006). Since the presence of dogs disturbs native wildlife, permitting dog walking on may decrease the ability of refuge visitors to engage in wildlife observation, a priority public use of the refuge.

After evaluating dog walking under Service policies, we conclude that we will not allow this activity. We will maintain and enhance existing signage indicating dogs are not permitted to improve compliance. There are also many sites throughout the surrounding area that provide opportunities for dog owners to take their pets.

LITERATURE CITED:

Banks, P.B. and J.V. Bryant. 2007. Four-legged friend or foe? Dog walking displaces native birds from natural areas. Animal Behavior 3: 611-613.

Gill, M. 1994. Bird flushing by dogs at proposed Eastshore State Park: Can they all just get along? *In* Contemporary Topics in Environmental Sciences. D. Sloan, E. Edlund, M. Christensen, K. Taylor, eds. U.C. Berkeley, Berkeley, Ca.

Lenth, B., M. Brennan, R. L. Knight. February 2006. The Effects of Dogs on Wildlife Communities. Final research report submitted to Boulder County Open Space and Mountain Parks.

Lima, S.L. and P.A. Bednekoff. 1999. Temporal variation in danger drives anti-predator behavior: the predation risk allocation hypothesis. American Naturalist 153:649-659.

603 FW 1
Exhibit 1

FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Great Bay National Wildlife Refuge

Use: Geocaching

This exhibit is not required for wildlife-dependent recreational uses, forms of take regulated by the State, or uses already described in a refuge CCP or step-down management plan approved after October 9, 1997.

Decision criteria:	**YES**	**NO**
(a) Do we have jurisdiction over the use?	✔	
(b) Does the use comply with applicable laws and regulations (Federal, State, Tribal, and local)?		✔
(c) Is the use consistent with applicable Executive orders and Department and Service policies?		✔
(d) Is the use consistent with public safety?	✔	
(e) Is the use consistent with goals and objectives in an approved management plan or other document?		✔
(f) Has an earlier documented analysis not denied the use or is this the first time the use has been proposed?	✔	
(g) Is the use manageable within available budget and staff?		✔
(h) Will this be manageable in the future within existing resources?		✔
(i) Does the use contribute to the public's understanding and appreciation of the refuge's natural or cultural resources, or is the use beneficial to the refuge's natural or cultural resources?		✔
(j) Can the use be accommodated without impairing existing wildlife-dependent recreational uses or reducing the potential to provide quality (see section 1.6D. for description), compatible, wildlife-dependent recreation into the future?		✔

Where we do not have jurisdiction over the use ("no" to [a]), there is no need to evaluate it further as we cannot control the use. Uses that are illegal, inconsistent with existing policy, or unsafe ("no" to [b], [c], or [d]) may not be found appropriate. If the answer is "no" to any of the other questions above, we will generally not allow the use.

If indicated, the refuge manager has consulted with State fish and wildlife agencies. Yes _____ No ___✔___.

When the refuge manager finds the use appropriate based on sound professional judgment, the refuge manager must justify the use in writing on an attached sheet and obtain the refuge supervisor's concurrence.

Based on an overall assessment of these factors, my summary conclusion is that the proposed use is:

Not Appropriate ___✔___ **Appropriate** _____

Refuge Manager: _____ Date: _____

If found to be **Not Appropriate**, the refuge supervisor does not need to sign concurrence if the use is a new use.

If an existing use is found **Not Appropriate** outside the CCP process, the refuge supervisor must sign concurrence.

If found to be **Appropriate**, the refuge supervisor must sign concurrence:

Refuge Supervisor: _____ Date: _____

A compatibility determination is required before the use may be allowed.

603 FW 1
Exhibit 1
Page 2

JUSTIFICATION FOR A FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Great Bay National Wildlife Refuge

Use: Geocaching

NARRATIVE:

To comply with 2006 U.S. Fish and Wildlife Service (Service) policy on appropriateness, we are evaluating all non-priority public uses for Great Bay National Wildlife Refuge (Great Bay Refuge, the refuge). Geocaching is not identified as a priority public use of the National Wildlife Refuge System under the National Wildlife Refuge System Administration Act of 1966 (16 U.S.C. § 668dd-668ee), as amended by the National Wildlife Refuge System Improvement Act of 1997. This use will not be allowed on the refuge for several reasons.

This activity involves the placement of items in a hidden location where other people subsequently search for the hidden items. The placement of these hidden items encourages visitors to leave designated public use trails and enter into closed areas where public use is restricted. Impacts include habitat damage from the trampling of vegetation and disturbance to wildlife.

Geocaching does not support a refuge purpose, goal or objective and would not benefit the resources within the refuge. After evaluating geocaching under Service policies, we conclude that we will not allow this activity.

603 FW 1
Exhibit 1

FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Great Bay National Wildlife Refuge

Use: Horseback Riding

This exhibit is not required for wildlife-dependent recreational uses, forms of take regulated by the State, or uses already described in a refuge CCP or step-down management plan approved after October 9, 1997.

Decision criteria:	**YES**	**NO**
(a) Do we have jurisdiction over the use?	✔	
(b) Does the use comply with applicable laws and regulations (Federal, State, Tribal, and local)?	✔	
(c) Is the use consistent with applicable Executive orders and Department and Service policies?	✔	
(d) Is the use consistent with public safety?	✔	
(e) Is the use consistent with goals and objectives in an approved management plan or other document?		✔
(f) Has an earlier documented analysis not denied the use or is this the first time the use has been proposed?	✔	
(g) Is the use manageable within available budget and staff?		✔
(h) Will this be manageable in the future within existing resources?		✔
(i) Does the use contribute to the public's understanding and appreciation of the refuge's natural or cultural resources, or is the use beneficial to the refuge's natural or cultural resources?		✔
(j) Can the use be accommodated without impairing existing wildlife-dependent recreational uses or reducing the potential to provide quality (see section 1.6D. for description), compatible, wildlife-dependent recreation into the future?		✔

Where we do not have jurisdiction over the use ("no" to [a]), there is no need to evaluate it further as we cannot control the use. Uses that are illegal, inconsistent with existing policy, or unsafe ("no" to [b], [c], or [d]) may not be found appropriate. If the answer is "no" to any of the other questions above, we will generally not allow the use.

If indicated, the refuge manager has consulted with State fish and wildlife agencies. Yes _____ No ___✔___.

When the refuge manager finds the use appropriate based on sound professional judgment, the refuge manager must justify the use in writing on an attached sheet and obtain the refuge supervisor's concurrence.

Based on an overall assessment of these factors, my summary conclusion is that the proposed use is:

Not Appropriate ___✔___ **Appropriate** _____

Refuge Manager: _____ Date: _____

If found to be **Not Appropriate**, the refuge supervisor does not need to sign concurrence if the use is a new use.

If an existing use is found **Not Appropriate** outside the CCP process, the refuge supervisor must sign concurrence.

If found to be **Appropriate**, the refuge supervisor must sign concurrence:

Refuge Supervisor: _____ Date: _____

A compatibility determination is required before the use may be allowed.

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Page 2

JUSTIFICATION FOR A FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Great Bay National Wildlife Refuge

Use: Horseback Riding

NARRATIVE:

To comply with 2006 U.S. Fish and Wildlife Service (Service) policy on appropriateness, we are evaluating all non-priority public uses for Great Bay National Wildlife Refuge (Great Bay Refuge, the refuge). Horseback riding is not identified as a priority public use of the National Wildlife Refuge System under the National Wildlife Refuge System Administration Act of 1966 (16 U.S.C. § 668dd-668ee), as amended by the National Wildlife Refuge System Improvement Act of 1997. Horseback riding will not be allowed on the refuge for several reasons.

Horseback riding may impact soils and native vegetation through trampling and soil compaction (Kuss 1986). Horses may also leave piles of manure along the trail, degrading the enjoyment of the refuge for other visitors. Additionally, horse manure may contain viable seeds from invasive plants (Wells and Lauenroth 2007) which could become a management problem for the refuge.

Although foot travel is allowed on established trails so that visitors may experience the priority public uses of wildlife observation, photography, and environmental education, horseback riding is not required to experience these uses. Horseback riding may degrade the trail, cause further erosion on steeper areas of trails, and cause safety hazards to other visitors (Deluca et al. 1998).

After evaluating horseback riding under Service policies, deed restrictions, current conditions, aesthetic and ecological implications, required maintenance, and demand, we conclude that we will not allow this activity. Prohibiting horseback riding may positively impact soils and wildlife; if only by reducing the amount of erosion and soil compaction that might occur on trails, the frequency and extent of wildlife disturbance, and preventing a potential vector of invasive plants. Horseback riding is not a wildlife dependent public use, nor is it necessary to support a priority public use, and it may decrease the enjoyment of the refuge for other visitors.

LITERATURE CITED:

Deluca, T.H., W.A. Patterson, W.A. Friedmund, and D.N. Cole. 1998. Influence of llamas, horses, and hikers on soil erosion from established recreation trails in western Montana, USA. Environmental Management 22(2): 255-262.

Kuss, F.R. 1996. A review of the major factors influencing plant responses to recreation impacts. Environmental Management 10: 638-650.

Wells F.H., and W. K. Lauenroth. 2007. The Potential for Horses to Disperse Alien Plants Along Recreational Trails. Rangeland Ecology & Management: Vol. 60, No. 6 pp. 574–577.

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Exhibit 1

FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Great Bay National Wildlife Refuge

Use: Jogging

This exhibit is not required for wildlife-dependent recreational uses, forms of take regulated by the State, or uses already described in a refuge CCP or step-down management plan approved after October 9, 1997.

Decision criteria:	**YES**	**NO**
(a) Do we have jurisdiction over the use?	✔	
(b) Does the use comply with applicable laws and regulations (Federal, State, Tribal, and local)?	✔	
(c) Is the use consistent with applicable Executive orders and Department and Service policies?	✔	
(d) Is the use consistent with public safety?	✔	
(e) Is the use consistent with goals and objectives in an approved management plan or other document?		✔
(f) Has an earlier documented analysis not denied the use or is this the first time the use has been proposed?	✔	
(g) Is the use manageable within available budget and staff?		✔
(h) Will this be manageable in the future within existing resources?		✔
(i) Does the use contribute to the public's understanding and appreciation of the refuge's natural or cultural resources, or is the use beneficial to the refuge's natural or cultural resources?	✔	
(j) Can the use be accommodated without impairing existing wildlife-dependent recreational uses or reducing the potential to provide quality (see section 1.6D. for description), compatible, wildlife-dependent recreation into the future?		✔

Where we do not have jurisdiction over the use ("no" to [a]), there is no need to evaluate it further as we cannot control the use. Uses that are illegal, inconsistent with existing policy, or unsafe ("no" to [b], [c], or [d]) may not be found appropriate. If the answer is "no" to any of the other questions above, we will generally not allow the use.

If indicated, the refuge manager has consulted with State fish and wildlife agencies. Yes _____ No ___✔___.

When the refuge manager finds the use appropriate based on sound professional judgment, the refuge manager must justify the use in writing on an attached sheet and obtain the refuge supervisor's concurrence.

Based on an overall assessment of these factors, my summary conclusion is that the proposed use is:

Not Appropriate ___✔___ **Appropriate** _____

Refuge Manager: _____ Date: _____

If found to be **Not Appropriate**, the refuge supervisor does not need to sign concurrence if the use is a new use.

If an existing use is found **Not Appropriate** outside the CCP process, the refuge supervisor must sign concurrence.

If found to be **Appropriate**, the refuge supervisor must sign concurrence:

Refuge Supervisor: _____ Date: _____

A compatibility determination is required before the use may be allowed.

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JUSTIFICATION FOR A FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Great Bay National Wildlife Refuge

Use: Jogging

NARRATIVE:

To comply with 2006 U.S. Fish and Wildlife Service (Service) policy on appropriateness, we are reevaluating all non-priority public uses for Great Bay National Wildlife Refuge (Great Bay Refuge, the refuge). Jogging is not identified as a priority public use of the National Wildlife Refuge System under the National Wildlife Refuge System Administration Act of 1966 (16 U.S.C. § 668dd-668ee), as amended by the National Wildlife Refuge System Improvement Act of 1997. Jogging, although permitted in the past, will no longer be allowed on the refuge for several reasons.

The presence of people jogging could result in some disturbance to wildlife located in habitats adjacent to the trail system. Recreational trail use has been shown to cause disturbance to wildlife up to 330 feet (100 meters) from trails (Taylor and Knight 2003). The established trails were developed so that visitors may engage in the priority public uses of wildlife observation, photography, and environmental education; jogging is not required to experience these uses. Further, the fact that it would result in incremental disturbance to wildlife additive to the priority public uses we are trying to accommodate, and may negatively affect the experience of visitors who are bird watching, suggests there is no compelling reason to allow it.

After evaluating jogging under Service policies, we conclude that we will not allow this activity. Jogging is not a wildlife-dependent public use, nor is it necessary to support a priority public use, and it may decrease the enjoyment of the refuge for other visitors engaged in priority wildlife-dependent activities.

LITERATURE CITED:

Taylor, A. R., and R. L. Knight. 2003. Wildlife Responses to Recreation and Associated Visitor Perceptions. Ecological Applications, 13 (4), 2003, pp. 951-963.

603 FW 1
Exhibit 1

FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Great Bay National Wildlife Refuge

Use: Commercial Wildlife and Nature Photography

This exhibit is not required for wildlife-dependent recreational uses, forms of take regulated by the State, or uses already described in a refuge CCP or step-down management plan approved after October 9, 1997.

Decision criteria:	**YES**	**NO**
(a) Do we have jurisdiction over the use?	✔	
(b) Does the use comply with applicable laws and regulations (Federal, State, Tribal, and local)?	✔	
(c) Is the use consistent with applicable Executive orders and Department and Service policies?	✔	
(d) Is the use consistent with public safety?	✔	
(e) Is the use consistent with goals and objectives in an approved management plan or other document?	✔	
(f) Has an earlier documented analysis not denied the use or is this the first time the use has been proposed?	✔	
(g) Is the use manageable within available budget and staff?	✔	
(h) Will this be manageable in the future within existing resources?	✔	
(i) Does the use contribute to the public's understanding and appreciation of the refuge's natural or cultural resources, or is the use beneficial to the refuge's natural or cultural resources?	✔	
(j) Can the use be accommodated without impairing existing wildlife-dependent recreational uses or reducing the potential to provide quality (see section 1.6D. for description), compatible, wildlife-dependent recreation into the future?	✔	

Where we do not have jurisdiction over the use ("no" to [a]), there is no need to evaluate it further as we cannot control the use. Uses that are illegal, inconsistent with existing policy, or unsafe ("no" to [b], [c], or [d]) may not be found appropriate. If the answer is "no" to any of the other questions above, we will generally not allow the use.

If indicated, the refuge manager has consulted with State fish and wildlife agencies. Yes _____ No ___✔___.

When the refuge manager finds the use appropriate based on sound professional judgment, the refuge manager must justify the use in writing on an attached sheet and obtain the refuge supervisor's concurrence.

Based on an overall assessment of these factors, my summary conclusion is that the proposed use is:

Not Appropriate _____ **Appropriate** ___✔___

Refuge Manager: _____ Date: _____

If found to be **Not Appropriate**, the refuge supervisor does not need to sign concurrence if the use is a new use.

If an existing use is found **Not Appropriate** outside the CCP process, the refuge supervisor must sign concurrence.

If found to be **Appropriate**, the refuge supervisor must sign concurrence:

Refuge Supervisor: _____ Date: _____

A compatibility determination is required before the use may be allowed.

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JUSTIFICATION FOR A FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Great Bay National Wildlife Refuge

Use: Commercial Wildlife and Nature Photography

NARRATIVE:

To comply with 2006 U.S. Fish and Wildlife Service (Service) policy on appropriateness, we are evaluating all non-priority public uses for Great Bay National Wildlife Refuge (Great Bay Refuge, the refuge). Commercial photography is not identified as a priority public use of the National Wildlife Refuge System under the National Wildlife Refuge System Administration Act of 1966 (16 U.S.C. § 668dd-668ee), as amended by the National Wildlife Refuge System Improvement Act of 1997. However, non-commercial wildlife photography is a priority public use.

Visitors engaged in commercial photography could trample vegetation along refuge trails and disturb wildlife disturbance. Recreational trail use has been shown to cause disturbance to wildlife up to 330 feet (100 meters) from trails (Taylor and Knight 2003). Wildlife disturbance would be minimized through the mandatory use of temporary and portable blinds by permittees. Because the use would only be allowed when it supports conservation, the products could potentially offset short-term impacts by enhancing public awareness of the natural resources. Some commercial photography would occur along established refuge trails and could impact plants indirectly by compacting soils, increasing erosion, and walking on young plants, reducing survival and regeneration.

After evaluating commercial photography under Service policies, we conclude that we will allow this activity. Commercial wildlife and nature photography would support refuge purposes, goals or objectives and would benefit the resources within the refuge. Therefore, this activity has been found to be appropriate for the Great Bay Refuge.

LITERATURE CITED:

Taylor, A. R., and R. L. Knight. 2003. Wildlife Responses to Recreation and Associated Visitor Perceptions. Ecological Applications, 13 (4), 2003, pp. 951-963.

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Exhibit 1

COMPATIBILITY DETERMINATION

USE:

Commercial Wildlife and Nature Photography

REFUGE NAME:

Great Bay National Wildlife Refuge

ESTABLISHING AND ACQUISITION AUTHORITY(IES):

Public Law 102-154, Section 319(d) Department of the Interior and Related Agencies Appropriations Bill, 1992.

REFUGE PURPOSE(S):

Great Bay National Wildlife Refuge (Great Bay Refuge, the refuge) was established to

- encourage the natural diversity of plant, fish, and wildlife species within the refuge, and to provide for their conservation and management;
- protect species listed as endangered or threatened or identified as candidates pursuant to the Endangered Species Act of 1973;
- preserve and enhance the water quality of aquatic habitat within the refuge; and
- To fulfill the international treaty obligations of the United States relating to fish and wildlife.

NATIONAL WILDLIFE REFUGE SYSTEM MISSION:

"The mission of the 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 of 1997 (Public Law 105–57; 111 Stat. 1282)

DESCRIPTION OF USE:

(a) What is the use? Is the use a priority public use?
The use is commercial photography, either still or motion pictures, of wildlife or nature scenes for conservation uses. This is not a priority public use, but would be contributing to priority public uses.

(b) Where would the use be conducted?
This use would occur in areas of the refuge specified in the special use permit. The use will generally take place in areas that are open to visitors including the refuge road, parking lot, and trails. Visitors engaged in commercial photography would be required to use temporary or portable blinds to minimize disturbance to wildlife.

(c) When would the use be conducted?
The use may occur during daylight hours during the year.

(d) How would be use be conducted?
Requests must be submitted in writing to the refuge manager no less than 21 days prior to the requested date(s). Each request will be reviewed on a case by case basis and will require a special use permit.

(e) Why is this use being proposed?
The refuge has received requests every 2 to 3 years to film or photograph habitats and/or wildlife. These requests would contribute to enhancing awareness of conservation and recreational opportunities at the refuge.

AVAILABILITY OF RESOURCES:

Great Bay Refuge is an unstaffed satellite administered by Parker River Refuge. Staff time from Parker River Refuge would be required to review and oversee permits and should be available to do so.

Visitor Services Specialist (GS-12) (review requests)—1 day/year = **$475**

ANTICIPATED IMPACTS OF THE USE:

Public uses, such as commercial photography, can produce short-term, negative direct or indirect impacts on wildlife or habitats. However, we believe the long-term benefits from the conservation nature of the products could be greater. Projects will be conducted at the appropriate time of year and conditions to minimize disturbances and incorporate other best management practices.

Direct Effects

Direct impacts are those where the activity has an immediate effect on wildlife and /or habitats.

Trail use may lead to trampling of vegetation adjacent to the trail or compaction of soil and leaf litter. These impacts are generally localized to areas adjacent to trails or areas of frequent off-trail use. Impacts of off-trail use can include a reduction in the density of plants near trails, soil compaction, increased erosion, and damage or killing of plants (Colorado State Parks 1998). To reduce the potential for these types of disturbance, markers and refuge boundary signs encourage trail users to stay on the trail to minimize effects on surrounding vegetation.

The presence of humans walking along trails can directly disturb migratory birds and other wildlife species. Wildlife often respond to human presence by departing from the disturbed site (Owen 1973, Burger 1981, Kaiser and Fritzell 1984, Korschen et al. 1985, Henson and Grant 1991, Kahl 1991, Klein 1993), using of sub-optimal habitat or non-preferred habitat (Erwin 1980, Williams and Forbes 1980), altering their behavior (Burger 1981, Korschen et al. 1985, Morton et al. 1989, Ward and Stehn 1989, Havera et al. 1992, Klein 1993), and increasing their energy expenditure (Morton et al. 1989, Belanger and Bedard 1990). Human disturbances can also decrease reproductive success by causing nest abandonment, decline in parental care, altering feeding schedules, and other stresses (Colorado State Parks 1998). It can cause shifts in habitat use, lead to abandonment of habitat, and increase energy demands in affected wildlife (Knight and Cole 1991). Hammitt and Cole (1998) conclude that the frequent presence of humans in natural areas can dramatically change the behavior of some wildlife species.

Wildlife responses to human disturbance vary by species, and by the type, level, frequency, duration, and time of year of the human use. For example generalist species, which thrive in disturbed areas, are often more abundant along trails than specialist species that are more sensitive to human disturbance (Colorado State Parks 1998). Adverse impacts also tend to increase as user groups increase in size (Beale and Monaghan 2004).

The impact of walking along trails can have impacts even outside of the immediate trail corridor (Miller et al. 2001). 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. They also found that nest predation was greater near trails (Miller et. al 1998).

Overall, direct effects should be minor with the use of blinds and other techniques to minimize disturbance.

Indirect Effects
We do not anticipate any indirect, negative impacts from this use.

Cumulative Effects
Cumulative effects are effects that are minor when considered separately but may be important when considered collectively. The principal concerns are repeated disturbances of birds that are nesting, foraging, or resting.

We anticipate that this use will support refuge purposes, the National Wildlife Refuge System mission, and priority public uses, including environmental education and interpretation. It has the potential to have a very positive cumulative impact on the refuge's natural resources.

PUBLIC REVIEW AND COMMENT:

As part of the comprehensive conservation planning process for Great Bay Refuge, this compatibility determination will undergo extensive public review, including a comment period of at least 30 days following the release of the draft Comprehensive Conservation Plan and Environmental Assessment.

DETERMINATION (CHECK ONE BELOW):

____ Use is not compatible

__X__ Use is compatible with the following stipulations

STIPULATIONS NECESSARY TO ENSURE COMPATIBILITY:

- Sites for photo shoots will be submitted in advance and approved by the refuge manager.
- Blinds will be required for all areas that are not open to the public.
- No sound making or lighting devices permitted.
- Only commercial photography in support of conservation, refuge purposes, the National Wildlife Refuge System Mission, and/or for educational and interpretive purposes will be permitted.
- A special use permit is required.

JUSTIFICATION:

This program as described is determined to be compatible. Any potential negative impacts of commercial wildlife and nature photography activities on refuge resources will be minimized by the restrictions included in the conditions of the special use permit. In addition, the activities associated with commercial photography will be regulated and monitored by refuge staff.

The Service permits commercial photography where it would further outreach, education, or public understanding of the natural environment, refuge resources and management, or the Refuge System and Service's missions. No approvals for a permit would occur until the refuge manager can insure those benefits would result.

As such, all approved commercial wildlife and nature photography will contribute to the goals of the refuge and Refuge System, and 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 RE-EVALUATION DATE: _____

LITERATURE CITED:

Beale, C. M., and P. Monaghan. 2004. Human disturbance: people as predation-free predators? Journal of Applied Ecology 41:335-343.

Belanger, L., and J. Bedard. 1990. Energetic cost of man-induced disturbance to staging snow geese. Journal of Wildlife Management. 54:36-41.

Burger, J. 1981. Effect of human activity on birds at a coastal bay. Biological Conservation 21:231-241.

Colorado State Parks. 1998. Planning trails with wildlife in mind: a handbook for trail planners prepared by Trails and Wildlife Task Force and Hellmund Associates. 51 pp. Accessed online at: *http://www.fs.fed.us/outdoors/naturewatch/start/planning/Trails-for-Wildlife-Handbk.pdf.*

Erwin, R. M. 1980. Breeding habitat by colonially nesting water birds in 2 Mid-Atlantic U.S. regions under different regimes of human disturbance. Biological Conservation. 18:39-51.

Hammitt, W. E. and D.N. Cole. 1998. Wildland Recreation. John Wiley & Sons, New York, 361pp.

Henson, P. T., and A. Grant. 1991. The effects of human disturbance on trumpeter swan breeding behavior. Wildlife Society Bulletin 19:248-257.

Havera, S. P., L. R. Boens, M. M. Georgi, and R. T. Shealy. 1992. Human disturbance of waterfowl on Keokuk Pool, Mississippi River. Wildlife Society Bulletin 20:290-298.

Kaiser, M.S. & Fritzell, E.K. 1984. Effects of river recreationists on green-backed heron behavior. Journal of Wildlife Management 48, 561-567.

Kahl, R. 1991. Boating disturbance of canvasbacks during migration at Lake Poygan, Wisconsin. Wildlife Society Bulletin 19:242-248.

Knight, R.L. and D. N. Cole. 1991. Effects of recreational activity on wildlife in wildlands. Trans. 56th N.A. Wildl. & Nat. Res. Conf. Pages 238-247.

Korschen, C. E., L. S. George, and W. L. Green. 1985. Disturbance of diving ducks by boaters on a migrational staging area. Wildlife Society Bulletin 13:290-296.

Miller, S.G., R.L. Knight, and C.K. Miller. 1998. Influence of recreational trails on breeding bird communities. Ecological Applications 8:162-169.

Miller, S.G., R.L. Knight, and C.K. Miller. 2001. Wildlife responses to pedestrians and dogs.

Wildlife Society Bulletin 29(1): 124-132.

Morton, J. M., A. C. Fowler, and R. L. Kirkpatrick. 1989. Time and energy budgets of American black ducks in winter. Journal of Wildlife Management 53:401-410(also see corrigendum in J. Wildl. Manage. 54:683).

Owen, M. 1973. The management of grassland areas for wintering geese. Wildfowl. 24:123-130.

Ward, D. H., and R. A. Stehn. 1989. Response of brant and other geese to aircraft disturbance at Izembek Lagoon, Alaska. U.S. Fish and Wildlife Service, Alaska Fish and Wildlife Research Center. Final report to the Minerals Management Service. Anchorage, Alaska. 193 pp.

Williams, G. J., and E. Forbes. 1980. The habitat and dietary preferences of dark-bellied brant geese and widgeon in relation to agricultural management. Wildfowl. 31:151-157.

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Exhibit 1

FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Great Bay National Wildlife Refuge

Use: Research by Non-Service Personnel

This exhibit is not required for wildlife-dependent recreational uses, forms of take regulated by the State, or uses already described in a refuge CCP or step-down management plan approved after October 9, 1997.

Decision criteria:	**YES**	**NO**
(a) Do we have jurisdiction over the use?	✔	
(b) Does the use comply with applicable laws and regulations (Federal, State, Tribal, and local)?	✔	
(c) Is the use consistent with applicable Executive orders and Department and Service policies?	✔	
(d) Is the use consistent with public safety?	✔	
(e) Is the use consistent with goals and objectives in an approved management plan or other document?	✔	
(f) Has an earlier documented analysis not denied the use or is this the first time the use has been proposed?	✔	
(g) Is the use manageable within available budget and staff?	✔	
(h) Will this be manageable in the future within existing resources?	✔	
(i) Does the use contribute to the public's understanding and appreciation of the refuge's natural or cultural resources, or is the use beneficial to the refuge's natural or cultural resources?	✔	
(j) Can the use be accommodated without impairing existing wildlife-dependent recreational uses or reducing the potential to provide quality (see section 1.6D. for description), compatible, wildlife-dependent recreation into the future?	✔	

Where we do not have jurisdiction over the use ("no" to [a]), there is no need to evaluate it further as we cannot control the use. Uses that are illegal, inconsistent with existing policy, or unsafe ("no" to [b], [c], or [d]) may not be found appropriate. If the answer is "no" to any of the other questions above, we will generally not allow the use.

If indicated, the refuge manager has consulted with State fish and wildlife agencies. Yes _____ No ___✔___.

When the refuge manager finds the use appropriate based on sound professional judgment, the refuge manager must justify the use in writing on an attached sheet and obtain the refuge supervisor's concurrence.

Based on an overall assessment of these factors, my summary conclusion is that the proposed use is:

Not Appropriate _____ **Appropriate** ___✔___

Refuge Manager: _____ Date: _____

If found to be **Not Appropriate**, the refuge supervisor does not need to sign concurrence if the use is a new use.

If an existing use is found **Not Appropriate** outside the CCP process, the refuge supervisor must sign concurrence.

If found to be **Appropriate**, the refuge supervisor must sign concurrence:

Refuge Supervisor: _____ Date: _____

A compatibility determination is required before the use may be allowed.

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JUSTIFICATION FOR A FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Great Bay National Wildlife Refuge

Use: Research by Non-Service Personnel

NARRATIVE:

Research conducted by non-U.S. Fish and Wildlife Service (Service) personnel is not identified as a priority public use of the National Wildlife Refuge System under the National Wildlife Refuge System Administration Act of 1966 (16 U.S.C. § 668dd-668ee), as amended by the National Wildlife Refuge System Improvement Act of 1997. This use is not a priority public use of the National Wildlife Refuge System (Refuge System). However, research by non-Service personnel is often conducted by colleges and universities; Federal, State, and local agencies; nongovernmental organizations; and qualified members of the general public. Research on Great Bay National Wildlife Refuge (Great Bay Refuge, the refuge) would further the understanding of the natural environment and could be applied to management of the refuge's wildlife. Research by others outside of the Service adds greatly to the information base for refuge managers to make informed decisions.

All research proposals are evaluated for their benefits to the refuge and the Refuge System mission. The refuge manager will issue a special use permit for all approved research projects. All research projects require the principal investigator to provide summary reports of findings and acknowledge the refuge for their participation.

Great Bay Refuge is an unstaffed satellite refuge administered by Parker River Refuge. No additional equipment, facilities, or improvements will be necessary to allow research by non-Service personnel. Staff time would be required to review research proposals and oversee permitted projects. We expect that conducting these activities will require less than 10 percent of a work-year for one staff member.

Disturbance to wildlife and vegetation by researchers could occur through observation, mist-netting, banding, and accessing the study area by foot. It is possible that direct mortality could result as a by-product of research activities. Mist-netting for example, can cause stress, especially when birds are captured, banded, and weighed. There have been occasional mortalities to these birds, namely when predators, such as raccoons and cats, reach the netted birds before researchers do.

Minimal impact will occur when research projects which are previously approved are carried out according to the stipulations stated in the special use permit issued for each project. Overall, however, allowing well-designed and properly reviewed research to be conducted by non-Service personnel is likely to have very little impact on refuge wildlife populations. If the research project is conducted with professionalism and integrity, potential adverse impacts are likely to be outweighed by the knowledge gained about a species, habitat, or public use.

After evaluating research by non-Service personnel under Service policies, we conclude that the activity is appropriate as it contributes to and supports refuge management, purposes, and goals, and the mission of the Refuge System.

COMPATIBILITY DETERMINATION

USE:

Research Conducted by Non-Service Personnel

REFUGE NAME:

Great Bay National Wildlife Refuge

ESTABLISHING AND ACQUISITION AUTHORITY(IES):

Public Law 102-154, Section 319(d) Department of the Interior and Related Agencies Appropriations Bill, 1992.

REFUGE PURPOSE(S):

Great Bay National Wildlife Refuge (Great Bay Refuge, the refuge) was established to

- encourage the natural diversity of plant, fish, and wildlife species within the refuge, and to provide for their conservation and management;
- protect species listed as endangered or threatened or identified as candidates pursuant to the Endangered Species Act of 1973;
- preserve and enhance the water quality of aquatic habitat within the refuge; and
- fulfill the international treaty obligations of the United States relating to fish and wildlife.

NATIONAL WILDLIFE REFUGE SYSTEM MISSION:

"The mission of the 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 of 1997 (Public Law 105–57; 111 Stat. 1282)

DESCRIPTION OF USE:

(a) What is the use? Is the use a priority public use?
The use is research conducted by non-Service personnel. It is not identified as a priority public use of the National Wildlife Refuge System under the National Wildlife Refuge System Administration Act of 1966 (16 U.S.C. § 668dd-668ee), as amended by the National Wildlife Refuge System Improvement Act of 1997. This use is not a priority public use of the Refuge System.

There is much that can be learned from field research within the refuge. Baseline information in biological, geophysical, hydrological, and other fields is still in need of being collected. There are many opportunities for consultants, colleges and universities, and other agencies to obtain permission to conduct critical and noteworthy research on the refuge.

Two provisions of the National Wildlife Refuge Improvement Act are to "maintain biological integrity, diversity, and environmental health" and to conduct "inventory and monitoring." Monitoring and research

are an integral part of refuge management. Plans and actions based on thorough research and consistent monitoring provide an informed approach to management effects on wildlife and habitat.

Currently, research applicants are required to submit a proposal that outlines

(1) objectives of the study;

(2) justification for the study;

(3) detailed methodology and schedule;

(4) potential impacts on refuge wildlife or habitat, including disturbance (short- and long-term), injury, or mortality (this includes a description of measures the researcher will take to reduce disturbance or impacts);

(5) research personnel required;

(6) costs to refuge, if any; and

(7) progress reports and end products (i.e., reports, thesis, dissertations, and publications).

Research proposals are reviewed by refuge staff and conservation partners, as appropriate, for approval. Evaluation criteria currently include, but are not limited to, the following:

- Research that will contribute to specific refuge management issues will be given higher priority over other research requests.
- Research that will conflict with other ongoing research, monitoring, or management programs will not be permitted.
- Research projects that can be accomplished off-refuge are less likely to be approved.
- Research that causes undue disturbance or is intrusive will likely not be permitted. Level and type of disturbance will be carefully evaluated when considering a request.
- Refuge evaluation will determine if any effort has been made to minimize disturbance through study design, including considering adjusting location, timing, scope, number of permittees, study methods, number of study sites, etc.
- If staffing or logistics make it impossible for the refuge to monitor researcher activity in a sensitive area, the research request may be denied, depending on the specific circumstances.
- The length of the project will be considered and agreed upon before approval. Projects will be reviewed annually.

(b) Where would the use be conducted?
The location of the research will vary depending on the individual research project that is being conducted. The entire refuge is available for scientific research. An individual research project is usually limited to a particular habitat type, plant species, or wildlife species. On occasion research projects will encompass an assemblage of habitat types, plants or wildlife. The research location will be limited to those areas of the refuge that are absolutely necessary to conduct the research project and that do not create a significant negative impact to refuge operations and wildlife use.

(c) When would the use be conducted?
The timing of the research will depend entirely on the individual research project's approved design. Scientific research would be allowed to occur on the refuge throughout the year as long as that use does not present a significant negative impact to wildlife use and management operations. 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 hunt, special precautions will be required and enforced to ensure public health and safety.

(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 and objectives of each research project will be scrutinized well before it will be allowed to occur on the refuge. We will not permit a research project that lacks an approved study plan and protocol, compromises public health and safety, or presents a significant negative impact to wildlife resources within the refuge. This permitted research use must be regulated and governed by the conditions and other terms of a refuge special use permit. The special use permit will provide any needed protection to individual refuge policies, mission, wildlife populations, and natural habitats. In addition, all research projects require the primary investigator to submit written summary reports of all findings, and acknowledge the refuge staff's participation.

(e) Why is this use being proposed?
Research by non-Service personnel is conducted by colleges and universities; Federal, State, and local agencies; nongovernmental organizations; and qualified members of the public. Such studies further our understanding of the refuge's natural environment. Research is therefore an important part of the adaptive management process that often results in improved management of refuge habitats and wildlife populations. Much of the information that research generates can be applied to management practices both on, and adjacent to, the refuge.

The Service encourages and supports research and management studies on refuge lands that will improve and strengthen decisions for managing natural resources. The refuge manager encourages and seeks research that clearly relates to approved refuge objectives, improves habitat management, and promotes adaptive management. Priority research addresses information on better managing the Nation's biological resources that are important to agencies of the Department of Interior, the Refuge System, and state fish and wildlife agencies, and that address important management issues or demonstrate techniques for managing species or habitats.
The refuge manager will also consider research for other purposes that may not relate directly to refuge-specific objectives, but contribute to the broader enhancement, protection, use, preservation, or management of native populations of fish, wildlife and plants, and their natural diversity in the Northeast Region and/or the Atlantic Flyway. All proposals must comply with Service policy on compatibility.

AVAILABILITY OF RESOURCES:

Great Bay Refuge is an unstaffed satellite refuge administered by Parker River Refuge. No additional equipment, facilities, or improvements will be necessary to allow research by non-Service personnel. Staff from Parker River Refuge would be required to review research proposals and oversee permitted projects. We expect that conducting these activities will require less than 10 percent of a work-year for one staff member.

Anticipated costs are:

Senior Refuge Biologist (GS-12) (review request)—4 days/year = **$1,900**

Refuge Manager (GS-13) (review and approval)—1 day/year = **$500**

Law Enforcement Officer (GS-9) (enforcement patrols) —1 day/year = **$400**

ANTICIPATED IMPACTS OF THE USE:

The Service encourages approved research to further the understanding of the natural resources. Research by other than Service personnel adds greatly to the information base for refuge managers to make proper decisions. Disturbance to wildlife and vegetation by researchers could occur through observation, mist-netting, banding, and accessing the study area by foot. It is possible that direct mortality could result as a by-product of research activities. For example, mist-netting can cause stress, especially when birds are captured, banded, and weighed. There have been occasional mortalities to these birds, namely when predators, such as raccoons and cats, reach the netted birds before researchers do.

Minimal impact will occur when research projects which are previously approved are carried out according to the stipulations stated in the special use permit issued for each project. Overall, however, allowing well designed and properly reviewed research to be conducted by non-Service personnel is likely to have very little impact on refuge wildlife populations. If the research project is conducted with professionalism and integrity, potential adverse impacts are likely to be outweighed by the knowledge gained about an entire species, habitat, or public use.

PUBLIC REVIEW AND COMMENT:

As part of the comprehensive conservation planning process for Great Bay refuge, this compatibility determination will undergo extensive public review, including a comment period of at least 30 days following the release of the draft Comprehensive Conservation Plan and Environmental Assessment.

DETERMINATION (CHECK ONE BELOW):

____ Use is not compatible

__X__ Use is compatible with the following stipulations

STIPULATIONS NECESSARY TO ENSURE COMPATIBILITY:

The criteria for evaluating a research proposal, outlined in the "Description of Use" section above, will be used when determining whether a proposed study will be approved on the refuge. If proposed research methods are evaluated and determined to have potential adverse impacts on refuge wildlife or habitat, then the refuge would determine the utility and need of such research to conservation and management of refuge wildlife and habitat. If the need was demonstrated by the research permittee and accepted by the refuge, then measures to minimize potential impacts (e.g., reduce the numbers of researchers entering an area, restrict research in specified areas) would be developed and included as part of the study design and on the special use permit. Special use permits will contain specific terms and conditions that the researcher(s) must follow relative to activity, location, duration, seasonality, etc., to ensure continued compatibility. All refuge rules and regulations must be followed unless alternatives are otherwise accepted in writing by refuge management.

We will require all researchers to submit a detailed research proposal that follows Great Bay Refuge study proposal guidelines (see attachment I) and Service Policy (FWS Refuge Manual Chapter 4, Section 6). Researchers must give us at least 45 days to review proposals before the research begins. If the research involves the collection of wildlife, the refuge must be given 60 days to review the proposal. Researchers must obtain all necessary scientific collecting or other permits before starting the research. We will prioritize and approve proposals based on the need, benefit, compatibility, and funding required for the research.

Extremely sensitive wildlife habitat areas would be avoided unless sufficient protection from research activities (i.e., disturbance, collection, capture, and handling) is implemented to limit the area and/or wildlife potentially impacted by the proposed research. Where appropriate, some areas may be temporarily or seasonally closed so that research would be permitted when impacts to wildlife and habitat are less of a concern. Research activities will be modified to avoid harm to sensitive wildlife and habitat when unforeseen impacts arise.

Refuge staff will monitor researcher activities for potential impacts to the refuge and for compliance with conditions on the special use permit. The refuge manager may determine that previously approved research and special use permits be terminated due to observed impacts. The refuge manager will also have the ability to cancel a special use permit if the researcher is not in compliance with the stated conditions.

Proposals

We will expect researchers to submit a final report to the refuge on completing their work. For long-term studies, we may also require interim progress reports. We also expect that research will be published in peer-reviewed publications. All reports, presentations, posters, articles or other publications will acknowledge the Refuge System and Great Bay Refuge as partners in the research. We have this requirement to ensure that the research community, partners, and the public understand that the research could not have been conducted without the refuge having been established, its operational support, and that of the Refuge System.

We will issue special use permit for all research conducted by non-Service personnel. The special use permit will list all conditions necessary to ensure compatibility. The special use permit will also identify a schedule for annual progress reports and the submission of a final report or scientific paper.

We may ask our regional refuge biologists, other Service divisions, State agencies, or academic experts to review and comment on proposals. We will require all researchers to obtain appropriate State and Federal permits.

JUSTIFICATION:

This program as described is determined to be compatible. Any potential negative impacts of research activities on the resources of the refuge will be minimized by the restrictions included in the special use permit special conditions. In addition, the research study design and researcher activities will be regulated and monitored by refuge staff.

The Service encourages approved research to further our understanding of refuge natural resources and management. Research by non- Service personnel adds greatly to the information base for refuge managers to make proper decisions. Research conducted by non-Service personnel will contribute to the goals of the refuge and Refuge System, and 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 RE-EVALUATION DATE: _____

LITERATURE CITED:

U.S. Fish and Wildlife Service. 1985. Refuge Manual. Washington, D.C.: U.S. Government Printing Office.

ATTACHMENT I.

Great Bay National Wildlife Refuge Study Proposal Guidelines

A study proposal is a justification and description of the work to be done, and includes cost and time requirements. The proposals must be specific enough to serve as blueprints for the investigation. They must spell out in advance systematic plans for the investigation at a level of detail commensurate with the cost and scope of the project and the needs of management. Please submit proposals electronically as a Microsoft® Word® document or hard copy to the refuge manager.

The following list provides a general outline of first-order headings/sections for study proposals.

- Cover Page
- Table of Contents (for longer proposals)
- Abstract
- Statement of Issue
- Literature Summary
- Objectives/Hypotheses
- Study Area
- Methods and Procedures
- Quality Assurance/Quality Control
- Specimen Collections
- Deliverables
- Special Requirements, Concerns, Necessary Permits
- Literature Cited
- Peer Review
- Budget
- Personnel and Qualifications

Cover Page

The cover page must contain the following information.

- Title of proposal
- Current date
- Investigator(s)—name, title, organizational affiliation, address, telephone and fax numbers and e-mail address of all investigators or cooperators
- Proposed starting date
- Estimated completion date
- Total funding support fequested from the U.S. Fish and Wildlife Service
- Signatures of principal investigator(s) and other appropriate institutional officials

Abstract

The abstract should contain a short summary description of the proposed study, including reference to major points in the sections “Statement of Issue,” “Objectives,” and “Methods and Procedures.”

Statement of Issue

Provide a clear precise summary of the problem to be addressed and the need for its solution. This section should include statements of the importance, justification, relevance, timeliness, generality, and contribution of the study. Describe how any products will be used, including any anticipated commercial use. What is the estimated probability of success of accomplishing the objective(s) within the proposed timeframe?

Literature Summary

This section should include a thorough but concise literature review of current and past research that pertains to the proposed research, especially any pertinent research conducted at the Great Bay National Wildlife Refuge. A discussion of relevant legislation, policies, and refuge planning and management history, goals, and objectives should also be included.

Objectives/Hypotheses
A very specific indication of the proposed outcomes of the project should be stated as objectives or hypotheses to be tested. Project objectives should be measurable. Provide a brief summary of what information will be provided at the end of the study and how it will be used in relation to the problem. These statements should flow logically from the statement of issue and directly address the management problem.

Establish data quality objectives in terms of precision, accuracy, representativeness, completeness, and comparability as a means of describing how good the data need to be to meet the project's objectives.

Study Area
Provide a detailed description of the geographic area(s) to be studied and include a clear map delineating the proposed study area(s) and showing specific locations where work will occur.

Methods and Procedures
This section should describe as precisely as possible, how the objectives will be met or how the hypotheses will be tested. Include detailed descriptions and justifications of the field and laboratory methodology, protocols, and instrumentation. Explain how each variable to be measured directly addresses the research objective/hypothesis. Describe the experimental design, population, sample size, and sampling approach (including procedures for sub-sampling). Summarize the statistical and other data analysis procedures to be used. List the response variables and tentative independent variables or covariates. Describe the experimental unit(s) for statistical analysis. Also include a detailed project time schedule that includes start, fieldwork, analysis, reporting, and completion dates.

Quality Assurance/Quality Control
Adequate quality assurance/quality control procedures help ensure that data and results are

- credible and not an artifact of sampling or recording errors;
- of known quality;
- able to stand up to external scientific scrutiny; and
- accompanied by detailed method documentation.

Describe the procedures to be used to ensure that data meet defined standards of quality and program requirements, errors are controlled in the field, laboratory, and office, and data are properly handled, documented, and archived. Describe the various steps (e.g., personnel training, calibration of equipment, data verification and validation) that will be used to identify and eliminate errors introduced during data collection (including observer bias), handling, and computer entry. Identify the percentage of data that will be checked at each step.

Specimen Collections
Clearly describe the kind (species), numbers, sizes, and locations of animals, plants, rocks, minerals, or other natural objects to be sampled, captured, or collected. Identify the reasons for collecting, the intended use of all the specimens to be collected, and the proposed disposition of collected specimens. For those specimens to be retained permanently as voucher specimens, identify the parties responsible for cataloging, preservation, and storage, as well as the proposed repository.

Deliverables
The proposal must indicate the number and specific format of hard and/or electronic media copies to be submitted for each deliverable. The number and format will reflect the needs of the refuge and the refuge manager. Indicate how many months after the project is initiated (or the actual anticipated date) that each deliverable will be submitted. Deliverables are to be submitted or presented to the refuge manager.

Deliverables that are required are as follows.

Reports and Publications
Describe what reports will be prepared and the timing of reports. Types of reports required in fulfillment of natural and social science study contracts or agreements include:

(1) Progress report(s) (usually quarterly, semiannually, or annually; may be required)

(2) Draft final and final report(s) (always required)

A final report must be submitted in addition to a thesis or dissertation (if applicable) and all other identified deliverables. Final and draft final reports should follow refuge guidelines (attachment I).

In addition, investigators are encouraged to publish the findings of their investigations in refereed professional, scientific publications and present findings at conferences and symposia. The refuge manager appreciates opportunities to review manuscripts in advance of their publication.

Data Files

Provide descriptions of any spatial (Geographic Information Systems [GIS]) and non-spatial data files that will be generated and submitted as part of the research. Non-spatial data must be entered onto CD-ROMs in Microsoft Access or Microsoft Excel. Spatial data, which includes Global Positioning System (GPS)-generated files, must be in a format compatible with the refuge's GIS system (ArcGIS 8 or 9, Arcview 3.3, or e00 format). All GIS data must be in UTM 19, NAD 83. A condition of the permit will be that the Service has access to and may utilize in future mapping and management all GIS information generated.

Metadata

For all non-spatial and spatial data sets or information products, documentation of information (metadata) describing the extent of data coverage and scale, the history of where, when, and why the data were collected, who collected the data, the methods used to collect, process, or modify/ transform the data, and a complete data dictionary must also be provided as final deliverables. Spatial metadata must conform to Service (FGDC) metadata standards.

Oral Presentations

Three types of oral briefings should be included: pre-study, annual, and closeout. These briefings will be presented to refuge staff and other appropriate individuals and cooperators. In addition, investigators should conduct periodic informal briefings with refuge staff throughout the study whenever an opportunity arises. During each refuge visit, researchers should provide verbal updates on project progress. Frequent dialogue between researchers and refuge staff is an essential element of a successful research project.

Specimens and Associated Project Documentation

A report on collection activities, specimen disposition, and the data derived from collections must be submitted to the refuge following refuge guidelines.

Other:

Researchers must provide the refuge manager with all of the following:

(1) Copies of field notes/notebooks/datasheets
(2) Copies of raw data (in digital format), including GIS data, as well as analyzed data
(3) Copies of all photos (digital photos preferred), slides, videos, and films
(4) Copies of any reports, theses, dissertations, publications or other material (such as news articles) resulting from studies conducted on refuge
(5) Detailed protocols used in study
(6) Aerial photographs
(7) Maps/GIS data
(8) Interpretive brochures and exhibits
(9) Training sessions (where appropriate)

(10) Survey forms

(11) Value-added software, software developed, and models

Additional deliverables may be required of specific studies.

Special Requirements, Permits, and Concerns

Provide information on the following topics where applicable. Attach copies of any supporting documentation that will facilitate processing of your application.

Refuge Assistance

Describe any refuge assistance needed to complete the proposed study, such as use of equipment or facilities or assistance from refuge staff. It is important that all equipment, facilities, services, and logistical assistance expected to be provided by the Service be specifically identified in this section so all parties are in clear agreement before the study begins.

Ground Disturbance

Describe the type, location, area, depth, number, and distribution of expected ground-disturbing activities, such as soil pits, cores, or stakes. Describe plans for site restoration of significantly affected areas.

Proposals that entail ground disturbance may require an archaeological survey and special clearance prior to approval of the study. You can help reduce the extra time that may be required to process such a proposal by including identification of each ground disturbance area on a U.S. Geological Survey 7.5-minute topographic map.

Site Marking and/or Animal Marking

Identify the type, amount, color, size, and placement of any flagging, tags, or other markers needed for site or individual resource (e.g., trees) identification and location. Identify the length of time it is needed and who will be responsible for removing it. Identify the type, color, and placement of any tags placed on animals (see special use permit for stipulations on marking and handling of animals).

Access to Study Sites

Describe the proposed method and frequency of travel to and within the study site(s). Explain any need to enter restricted areas. Describe the duration, location, and number of participants, and approximate dates of site visits.

Use of Mechanized and Other Equipment

Describe any vehicles, boats, field equipment, markers, or supply caches by type, number, and location. You should explain the need to use these materials and how long they are to be left in the field.

Safety

Describe any known potentially hazardous activities, such as electro-fishing, scuba diving, whitewater boating, aircraft use, wilderness travel, and wildlife capture, handling, or immobilization.

Chemical Use

Identify chemicals and hazardous materials that you propose using within the refuge. Indicate the purpose, method of application, and amount to be used. Describe plans for storage, transfer, and disposal of these materials and describe steps to remediate accidental releases into the environment. Attach copies of Material Safety Data Sheets (MSDS).

Animal Welfare

If the study involves vertebrate animals, describe your protocol for any capture, holding, marking, tagging, tissue sampling, or other handling of these animals (including the training and qualifications of personnel relevant to animal handling and care). If your institutional animal welfare committee has

reviewed your proposal, please include a photocopy of their recommendations. Describe alternatives considered, and outline procedures to be used to alleviate pain or distress. Include contingency plans to be implemented in the event of accidental injury to or death of the animal. Include State and Federal permits. Where appropriate, coordinate with and inform State natural resource agencies.

Literature Cited
List all reports and publications cited in the proposal.

Peer Review
Provide the names, titles, addresses, and telephone numbers of individuals with subject-area expertise who have reviewed the research proposal. If the reviewers are associated with the investigator's research institution or if the proposal was not reviewed, please provide the names, titles, addresses, and telephone numbers of three to five potential subject-area reviewers who are not associated with the investigator's institution. These individuals will be asked to provide reviews of the proposal, progress reports, and the draft final report.

Budget
The budget must reflect both funding and assistance that will be requested from the Service and the cooperator's contributions on an identified periodic (usually annual) basis.

Personnel Costs
Identify salary charges for principal investigator(s), research assistant(s), technician(s), clerical support, and others. Indicate period of involvement (hours or months) and pay rate charged for services. Be sure to include adequate time for data analysis and report writing and editing.

Fringe Benefits
Itemize fringe benefit rates and costs.

Travel
Provide separate estimates for fieldwork and meetings. Indicate number of trips, destinations, estimated miles of travel, mileage rate, air fares, days on travel, and daily lodging and meals charges. Vehicle mileage rate cannot exceed standard government mileage rates if Federal funds are to be used. Charges for lodging and meals are not to exceed the maximum daily rates set for the locality by the Federal Government (contact Great Bay Refuge for appropriate rates).

Equipment
Itemize all equipment to be purchased or rented and provide a brief justification for each item costing more than $1,000. Be sure to include any computer-related costs. For proposals funded under a Service agreement or contract, the refuge reserves the right to transfer the title of purchased equipment with unit cost of $1,000 or more to the Federal Government following completion of the study. These items should be included as deliverables.

Supplies and Materials
Purchases and rentals under $1,000 should be itemized as much as is reasonable.

Subcontract or Consultant Charges
All such work must be supported by a subcontractor's proposal also in accordance with these guidelines.

Specimen Collections
Identify funding requirements for the cataloging, preservation, storage, and analyses of any collected specimens that will be permanently retained.

Printing and Copying
Include costs for preparing and printing the required number of copies of progress reports, the draft final report, and the final report. In general, a minimum of two copies of progress reports (usually due quarterly, semiannually, or as specified in agreement), the draft final report, and the final report are required.

Indirect Charges
Identify the indirect cost (overhead) rate and charges and the budget items to which the rate is applicable.

Cooperator's Contributions
Show any contributing share of direct or indirect costs, facilities, and equipment by the cooperating research institution.

Outside Funding
List any outside funding sources and amounts.

Personnel and Qualifications
List the personnel who will work on the project and indicate their qualifications, experience, and pertinent publications. Identify the responsibilities of each individual and the amount of time each will devote. A full vita or resume for each principal investigator and any consultants should be included here.

Interim Final Report Guidelines
Draft final and final reports should follow Journal of Wildlife Management format, and should include the following sections.

- Title Page
- Abstract
- Introduction/Problem Statement
- Study Area
- Methods (including statistical analyses)
- Results
- Discussion
- Management Implications
- Management Recommendations
- Literature Cited

603 FW 1
Exhibit 1

FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Great Bay National Wildlife Refuge

Use: Walking, Hiking, Cross Country Skiing, and Snowshoeing

This exhibit is not required for wildlife-dependent recreational uses, forms of take regulated by the State, or uses already described in a refuge CCP or step-down management plan approved after October 9, 1997.

Decision criteria:	**YES**	**NO**
(a) Do we have jurisdiction over the use?	✔	
(b) Does the use comply with applicable laws and regulations (Federal, State, Tribal, and local)?	✔	
(c) Is the use consistent with applicable Executive orders and Department and Service policies?	✔	
(d) Is the use consistent with public safety?	✔	
(e) Is the use consistent with goals and objectives in an approved management plan or other document?	✔	
(f) Has an earlier documented analysis not denied the use or is this the first time the use has been proposed?	✔	
(g) Is the use manageable within available budget and staff?	✔	
(h) Will this be manageable in the future within existing resources?	✔	
(i) Does the use contribute to the public's understanding and appreciation of the refuge's natural or cultural resources, or is the use beneficial to the refuge's natural or cultural resources?	✔	
(j) Can the use be accommodated without impairing existing wildlife-dependent recreational uses or reducing the potential to provide quality (see section 1.6D. for description), compatible, wildlife-dependent recreation into the future?	✔	

Where we do not have jurisdiction over the use ("no" to [a]), there is no need to evaluate it further as we cannot control the use. Uses that are illegal, inconsistent with existing policy, or unsafe ("no" to [b], [c], or [d]) may not be found appropriate. If the answer is "no" to any of the other questions above, we will generally not allow the use.

If indicated, the refuge manager has consulted with State fish and wildlife agencies. Yes _____ No ___✔___.

When the refuge manager finds the use appropriate based on sound professional judgment, the refuge manager must justify the use in writing on an attached sheet and obtain the refuge supervisor's concurrence.

Based on an overall assessment of these factors, my summary conclusion is that the proposed use is:

Not Appropriate _____ **Appropriate** ___✔___

Refuge Manager: _____ Date: _____

If found to be **Not Appropriate**, the refuge supervisor does not need to sign concurrence if the use is a new use.

If an existing use is found **Not Appropriate** outside the CCP process, the refuge supervisor must sign concurrence.

If found to be **Appropriate**, the refuge supervisor must sign concurrence:

Refuge Supervisor: _____ Date: _____

A compatibility determination is required before the use may be allowed.

603 FW 1
Exhibit 1
Page 2

JUSTIFICATION FOR A FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Great Bay National Wildlife Refuge

Use: Walking, Hiking, Cross Country Skiing, and Snowshoeing

NARRATIVE:

To comply with 2006 U.S. Fish and Wildlife Service (Service) policy on appropriateness, we are evaluating all non-priority public uses for Great Bay National Wildlife Refuge (Great Bay Refuge, the refuge). Walking, hiking, cross-country skiing, and snowshoeing are not explicitly identified as a priority public uses of the National Wildlife Refuge System under the National Wildlife Refuge System Administration Act of 1966 (16 U.S.C. § 668dd-668ee), as amended by the National Wildlife Refuge System Improvement Act of 1997. However, we consider this uses appropriate as they allow refuge visitors the least impacting mode of transportation to participate in wildlife observation, photography, and environmental education, which are priority public uses.

The presence of people walking, hiking, skiing, and snowshoeing could result in some disturbance to wildlife located in habitats adjacent to the trail system. Recreational trail use has been shown to cause disturbance to wildlife up to 330 feet (100 meters) from trails (Taylor and Knight 2003). The use of the trails could lead to soil compaction causing some tree roots to be exposed if they are close to the ground surface. The boardwalk and refuge signs encourage visitors to stay on the trail to minimize disturbance to wildlife and surrounding vegetation. Other impacts in violation of refuge regulations such as littering, picking/collecting vegetation or illegal take of wildlife could occur. Refuge staff believe that with the proper management, walking, hiking, skiing, and snowshoeing will not result in any short- or long-term impacts that will adversely affect the purpose of the refuge or the mission of the National Wildlife Refuge System.

To minimize wildlife disturbance and environmental damage, refuge visitors are required to remain on the designated trails. Trails are monitored and maintained by the refuge volunteers and refuge staff. One trail is almost entirely boardwalked and is wheelchair accessible. The other trail is predominantly of earth and some gravel. The trail surfaces are maintained each year as necessary.

One of the goals of the National Wildlife Refuge System is to provide high-quality wildlife viewing opportunities for the public. Allowing the use of the trail system by persons engaging in walking, hiking, cross country skiing, and snowshoeing will provide visitors the chance to view wildlife. This activity promotes an appreciation for the continued conservation and protection of wildlife and habitat. Walking, hiking, cross country skiing, and snowshoeing would not materially interfere with or detract from the mission of the National Wildlife Refuge System or the purposes for which the refuge was established.

LITERATURE CITED:

Taylor, A. R., and R. L. Knight. 2003. Wildlife Responses to Recreation and Associated Visitor Perceptions. Ecological Applications, 13 (4), 2003, pp. 951-963.

COMPATIBILITY DETERMINATION

USE:

Walking, Hiking, Cross Country Skiing, and Snowshoeing

REFUGE NAME:

Great Bay National Wildlife Refuge

ESTABLISHING AND ACQUISITION AUTHORITY(IES):

Public Law 102-154, Section 319(d) Department of the Interior and Related Agencies Appropriations Bill, 1992.

REFUGE PURPOSE(S):

Great Bay National Wildlife Refuge (Great Bay Refuge, the refuge) was established:

- To encourage the natural diversity of plant, fish, and wildlife species within the refuge, and to provide for their conservation and management
- To protect species listed as endangered or threatened or identified as candidates pursuant to the Endangered Species Act of 1973
- To preserve and enhance the water quality of aquatic habitat within the refuge
- To fulfill the international treaty obligations of the United States relating to fish and wildlife.

NATIONAL WILDLIFE REFUGE SYSTEM MISSION:

"The mission of the 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 of 1997 (Public Law 105–57; 111 Stat. 1282)

DESCRIPTION OF USE:

(a) What is the use? Is the use a priority public use?
The uses are walking/hiking, cross country skiing, and snowshoeing. These are not priority public uses of the National Wildlife Refuge System under the National Wildlife Refuge System Administration Act of 1966 (16 U.S.C. § 668dd-668ee), and the National Wildlife Refuge System Improvement Act of 1997 (Public Law 105-57). However, refuge staff believe by allowing these activities, that the participants will be positively exposed to the refuge and the Refuge System. This exposure may lead to a better understanding of the importance of the Refuge System to the American people. The aforementioned activities have occurred on the refuge for many years.

(b) Where would the use be conducted?
These uses would primarily be conducted along the two public use trails (Ferry Way Trail and Upper Peverly Trail). Occasional refuge-organized programs or events may also occur in portions of the refuge normally closed to the public.

(c) When would the use be conducted?
We will allow these uses daily, year-round, from sunrise to sunset, unless a conflict with a trail maintenance activity or an extenuating circumstance necessitates our deviating from normal operating hours. Such circumstances include, but are not limited to, the 2-day controlled deer hunt, and closures for snow and ice storms or other events affecting human safety.

(d) How would the use be conducted?
We will allow these uses on the 2-mile Ferry Way Trail and the 0.5-mile Upper Peverly Trail. These uses afford pedestrian access for wildlife observation and other priority pubic uses, as noted below in section (e). To support these activities, there is currently a map at the information kiosk at the public parking area where both trails originate, as well a general information brochure that include a map showing the trails. This information is also available on the refuge Web site.

Visitors are required to remain on the designated trail system to minimize environmental damage and prevent accidents. Collecting of any kind is not allowed, nor is disturbing or feeding wildlife. Trails are monitored and maintained by refuge volunteers to provide a safe and quality visitor experience. The trail surfaces are maintained each year, as necessary.

Refuge visitors may use bicycles to access the refuge, but bicycles are not allowed on any of the refuge trails. Similarly, jogging is also not allowed on refuge trails, as indicated in the finding of appropriateness for jogging.

(e) Why is this use being proposed?
These uses support wildlife observation and other priority public uses on Great Bay and most national wildlife refuges. Refuge staff believe, by allowing these activities, that the participants will be positively exposed to the refuge and the Refuge System. This exposure may lead to a better understanding of the importance of the Refuge System to the American people and to their support for refuge acquisition and management.

AVAILABILITY OF RESOURCES:

The resources necessary to provide and administer this use are available within current and anticipated refuge budgets. Trail maintenance is provided by refuge volunteers.

Visitor Services Specialist (GS-12)—5 days/year = **$2,375**

Outdoor Recreation Planner (GS-9)—10 days/year = **$4,000**

Law Enforcement (GS-9)—5 days/year = **$2,000**

Anticipated Impacts of the Use:
The presence of people walking, hiking, skiing, and snowshoeing could result in some disturbance to wildlife located in habitats adjacent to the trail system.

Direct Effects
Direct impacts are those where the activity has an immediate effect on wildlife and /or habitats.

Trail use may lead to trampling of vegetation adjacent to the trail or compaction of soil and leaf litter. These impacts are generally localized to areas adjacent to trails or areas of frequent off-trail use. Impacts of off-trail use can include a reduction in the density of plants near trails, soil compaction and increased erosion, and damage or killing of plants (Colorado State Parks 1998). To reduce the potential forhese types of disturbance, markers and refuge boundary signs encourage trail users to stay on the trail to minimize effects on surrounding vegetation.

The presence of humans walking along trails can directly disturb migratory birds and other wildlife species. Wildlife often respond to human presence by departing from the disturbed site (Owen 1973, Burger 1981, Kaiser and Fritzell 1984, Korschen et al. 1985, Henson and Grant 1991, Kahl 1991, Klein 1993), using of sub-optimal habitat or non-preferred habitat (Erwin 1980, Williams and Forbes 1980), altering their behavior

(Burger 1981, Korschen et al. 1985, Morton et al. 1989, Ward and Stehn 1989, Havera et al. 1992, Klein 1993), and increasing their energy expenditure (Morton et al. 1989, Belanger and Bedard 1990). Human disturbances can also decrease reproductive success by causing nest abandonment, decline in parental care, altering feeding schedules, and other stresses (Colorado State Parks 1998). It can cause shifts in habitat use, lead to abandonment of habitat, and increase energy demands in affected wildlife (Knight and Cole 1991). Hammitt and Cole (1998) conclude that the frequent presence of humans in natural areas can dramatically change the behavior of some wildlife species.

Wildlife responses to human disturbance vary by species, and by the type, level, frequency, duration, and time of year of the human use. For example generalist species, which thrive in disturbed areas, are often more abundant along trails than specialist species that are more sensitive to human disturbance (Colorado State Parks 1998). Adverse impacts also tend to increase as user groups increase in size (Beale and Monaghan 2004).

The impact of walking along trails can have impacts even outside of the immediate trail corridor (Miller et al. 2001). 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. They also found that nest predation was also greater near trails (Miller et. al 1998).

Indirect Effects

When people move from one area to another, they can be vectors for the seeds or other propagules of invasive plants. Once established, invasive plants can outcompete native plants, thereby altering habitats and indirectly impacting wildlife. The threat of invasive plants establishing themselves will always be an issue that requires monitoring.

Cumulative Effects

Effects that are minor when we consider them separately but may be important when we consider them collectively are cumulative effects. The principal concerns are repeated disturbances of birds that are nesting, foraging, or resting. Opening refuge land to public use can often result in litter, vandalism, or other illegal activities.

Our observations and knowledge of the areas involved provide no evidence that, cumulatively, these proposed wildlife-dependent uses will have an unacceptable effect on the wildlife resource. Although we do not expect a substantial increase in the cumulative effects of public use in the near term, it will be important for refuge staff to monitor public use and respond, if necessary, to conserve the high-quality wildlife resources on the refuge.

We expect no additional effects from wildlife observation, wildlife photography, environmental education or interpretation. Refuge staff will monitor and evaluate the effects of public use in collaboration with volunteers to discern and respond to unacceptable impacts on wildlife or habitats.

PUBLIC REVIEW AND COMMENT:

As part of the comprehensive conservation planning process for Great Bay refuge, this compatibility determination will undergo extensive public review, including a comment period of at least 30 days following the release of the draft Comprehensive Conservation Plan and Environmental Assessment.

DETERMINATION (CHECK ONE BELOW):

____ Use is not compatible

__X__ Use is compatible with the following stipulations

STIPULATIONS NECESSARY TO ENSURE COMPATIBILITY:

- To minimize or avoid negative impacts to wildlife and habitat
- Harassment, baiting, playback tapes, or electronic calls are not allowable methods to attract wildlife for observation or photography (this does not necessarily apply to management activities, e.g., approved research or surveys, which are evaluated on a case-by-case basis).
- Collecting of any kind is prohibited (his does not necessarily apply to management activities, e.g., approved research or surveys, which are evaluated on a case-by-case basis)
- Stay on trails unless authorized with permit or attending a refuge program

JUSTIFICATION:

The Service and the National Wildlife Refuge System maintain goals of providing opportunities to view wildlife. Allowing the use of the trail system by persons engaging in walking, hiking, cross country skiing, and snowshoeing will provide visitors the chance to view wildlife. This activity promotes an appreciation for the continued conservation and protection of wildlife and habitat. Walking, hiking, cross country skiing, and snowshoeing would not materially interfere with or detract from the mission of the National Wildlife Refuge System or the purposes for which the refuge was established.

SIGNATURE:

Refuge Manager: _____ _____
(Signature) (Date)

CONCURRENCE:

Regional Chief: _____ _____
(Signature) (Date)

MANDATORY 10 YEAR RE-EVALUATION DATE: _____

LITERATURE CITED:

Beale, C. M., and P. Monaghan. 2004. Human disturbance: people as predation-free predators? Journal of Applied Ecology 41:335-343.

Belanger, L., and J. Bedard. 1990. Energetic cost of man-induced disturbance to staging snow geese. Journal of Wildlife Management. 54:36-41.

Burger, J. 1981. Effect of human activity on birds at a coastal bay. Biological Conservation 21:231-241.

Colorado State Parks. 1998. Planning trails with wildlife in mind: a handbook for trail planners prepared by Trails and Wildlife Task Force and Hellmund Associates. 51 pp. Accessed online at: *http://www.fs.fed.us/outdoors/naturewatch/start/planning/Trails-for-Wildlife-Handbk.pdf.*

Erwin, R. M. 1980. Breeding habitat by colonially nesting water birds in 2 Mid-Atlantic U.S. regions under different regimes of human disturbance. Biological Conservation. 18:39-51.

Hammitt, W. E. and D.N. Cole. 1998. Wildland Recreation. John Wiley & Sons, New York, 361pp.

Henson, P. T., and A. Grant. 1991. The effects of human disturbance on trumpeter swan breeding behavior. Wildlife Society Bulletin 19:248-257.

Havera, S. P., L. R. Boens, M. M. Georgi, and R. T. Shealy. 1992. Human disturbance of waterfowl on Keokuk Pool, Mississippi River. Wildlife Society Bulletin 20:290-298.

Kaiser, M.S. & Fritzell, E.K. 1984. Effects of river recreationists on green-backed heron behavior. Journal of Wildlife Management 48, 561-567.

Kahl, R. 1991. Boating disturbance of canvasbacks during migration at Lake Poygan, Wisconsin. Wildlife Society Bulletin 19:242-248.

Knight, R.L. and D. N. Cole. 1991. Effects of recreational activity on wildlife in wildlands. Trans. 56th N.A. Wildl. & Nat. Res. Conf. Pages 238-247.

Korschen, C. E., L. S. George, and W. L. Green. 1985. Disturbance of diving ducks by boaters on a migrational staging area. Wildlife Society Bulletin 13:290-296.

Miller, S.G., R.L. Knight, and C.K. Miller. 1998. Influence of recreational trails on breeding bird communities. Ecological Applications 8:162-169.

Miller, S.G., R.L. Knight, and C.K. Miller. 2001. Wildlife responses to pedestrians and dogs.

Wildlife Society Bulletin 29(1): 124-132.

Morton, J. M., A. C. Fowler, and R. L. Kirkpatrick. 1989. Time and energy budgets of American black ducks in winter. Journal of Wildlife Management 53:401-410(also see corrigendum in J. Wildl. Manage. 54:683).

Owen, M. 1973. The management of grassland areas for wintering geese. Wildfowl. 24:123-130.

Ward, D. H., and R. A. Stehn. 1989. Response of brant and other geese to aircraft disturbance at Izembek Lagoon, Alaska. U.S. Fish and Wildlife Service, Alaska Fish and Wildlife Research Center. Final report to the Minerals Management Service. Anchorage, Alaska. 193 pp.

Williams, G. J., and E. Forbes. 1980. The habitat and dietary preferences of dark-bellied brant geese and widgeon in relation to agricultural management. Wildfowl. 31:151-157.

COMPATIBILITY DETERMINATION

USE:

Wildlife Observation and Photography, Environmental Education, and Interpretation

REFUGE NAME:

Great Bay National Wildlife Refuge

ESTABLISHING AND ACQUISITION AUTHORITY(IES):

Public Law 102-154, Section 319(d) Department of the Interior and Related Agencies Appropriations Bill, 1992.

REFUGE PURPOSE(S):

Great Bay National Wildlife Refuge (Great Bay Refuge, the refuge) was established to

- encourage the natural diversity of plant, fish, and wildlife species within the refuge, and to provide for their conservation and management;
- protect species listed as endangered or threatened or identified as candidates pursuant to the Endangered Species Act of 1973;
- preserve and enhance the water quality of aquatic habitat within the refuge; and
- fulfill the international treaty obligations of the United States relating to fish and wildlife.

NATIONAL WILDLIFE REFUGE SYSTEM MISSION:

"The mission of the 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 of 1997 (Public Law 105–57; 111 Stat. 1282)

DESCRIPTION OF USE:

(a) What is the use? Is the use a priority public use?
The uses are wildlife observation and photography, environmental education, and interpretation. They are priority public uses of the National Wildlife Refuge System, under the National Wildlife Refuge System Administration Act of 1966 (16 U.S.C. § 668dd-668ee), as amended by the National Wildlife Refuge System Improvement Act of 1997.

(b) Where would the uses be conducted?
These uses would primarily be conducted along the two public use trails (Ferry Way Trail and Upper Peverly Trail). Occasional refuge-organized programs or events may also occur in portions of the refuge normally closed to the public.

(c) When would the uses be conducted?
These uses are allowed daily, year-round, from sunrise to sunset, unless a conflict with a trail maintenance activity or an extenuating circumstance necessitates our deviating from those procedures. Examples are the 2-day controlled deer hunt, and closures for snow and ice storms or other events affecting human safety.

(d) How would the uses be conducted?
We will allow wildlife observation and photography, environmental education and interpretation on the 2-mile Ferry Way Trail and the 0.5-mile Upper Peverly Trail. To support these activities, there is currently a map at the information kiosk at the public parking area where both trails originate, as well a general information brochure that include a map showing the trails. This information is also available on the refuge Web site. Horseback riding is not allowed on the refuge. Motorized vehicles and bicycles are not allowed beyond the public entrance road and parking lot.

The Service-preferred alternative would enhance opportunities by investigating the possibility of a trail on the Fabyan Point property with an observation platform; other possible observation platforms along the Ferry Way Trail; a spur trail off the Refuge entrance road connecting to the Ferry Way Trail, and converting the Upper Peverly Trail to boardwalk to make it wheelchair accessible. The refuge will also investigate new partnerships with area schools to enhance outreach and education efforts on the refuge.

(e) Why are these uses being proposed?
The Refuge System Improvement Act defines wildlife observation, photography, environmental education and interpretation as priority public uses that, if compatible, are to receive our enhanced consideration over other general public uses. Authorizing these uses 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 an unstructured environment, and observe wildlife in their natural habitats firsthand. They will provide visitors with compatible educational and recreational opportunities to enjoy refuge resources and gain better understanding and appreciation of wildlife, wild lands ecology, the relationships of plant and animal populations in an ecosystem, and wildlife management. They will enhance public understanding of ecological concepts, enable the public to better understand the problems facing our wildlife and wild lands resources, help them realize what effect the public has on wildlife resources, learn about the Service's role in conservation, and better understand the biological facts upon which we base Service management programs.

Professional and amateur photographers alike will gain opportunities to photograph wildlife in its natural habitat (see separate finding of appropriateness and compatibility determination for "Commercial Wildlife and Nature Photography") . Those opportunities obviously will increase the publicity and advocacy of Service programs. These uses will provide wholesome, safe, outdoor recreation in a scenic setting, and entice 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.

AVAILABILITY OF RESOURCES:

Great Bay Refuge is an unstaffed satellite refuge administered by Parker River Refuge. No additional equipment, facilities, or improvements will be necessary to allow research by non-Service personnel. Staff from Parker River Refuge would be required to review research proposals and oversee permitted projects. We expect that conducting these activities will require less than 10 percent of a work-year for one staff member.

Anticipated costs are:

Senior Visitor Services Specialist (GS-12) —6 days/year = **$2,850**

Refuge Manager (GS-13)—5 days/year = $2,500

Outdoor Recreation Planner (GS-9)—5 days/year = **$2,000**

Law Enforcement Officer (GS-9) (enforcement patrols) 6 days/year = **$2,400**

To support these uses, we propose to construct the following new facilities. Estimated costs for these facilities are partly derived from the Service's Region 5 Construction and Rehabilitation Cost Estimating Guide.

Upper Peverly Trail boardwalk	**$40,000**
Ferry Way Trail observation platforms	**$10,000**
Fabyan Point Trail and platform	**$55,000**

ANTICIPATED IMPACTS OF THE USE:

These public uses can directly and indirectly impact wildlife and their habitats on the refuge. Visitors engaged in these uses are usually walking or taking photographs along existing refuge trails.

Direct Effects

Direct impacts are those where the activity has an immediate effect on wildlife and /or habitats.

Trail use may lead to trampling of vegetation adjacent to the trail or compaction of soil and leaf litter. These impacts are generally localized to areas adjacent to trails or areas of frequent off-trail use. Impacts of off-trail use can include a reduction in the density of plants near trails, soil compaction, increased erosion, and damage or killing of plants (Colorado State Parks 1998). To reduce the potential for these types of disturbance, markers and refuge boundary signs encourage trail users to stay on the trail to minimize effects on surrounding vegetation.

The presence of humans walking along trails can directly disturb migratory birds and other wildlife species. Wildlife often respond to human presence by departing from the disturbed site (Owen 1973, Burger 1981, Kaiser and Fritzell 1984, Korschen et al. 1985, Henson and Grant 1991, Kahl 1991, Klein 1993), using of sub-optimal habitat or non-preferred habitat (Erwin 1980, Williams and Forbes 1980), altering their behavior (Burger 1981, Korschen et al. 1985, Morton et al. 1989, Ward and Stehn 1989, Havera et al. 1992, Klein 1993), and increasing their energy expenditure (Morton et al. 1989, Belanger and Bedard 1990). Human disturbances can also decrease reproductive success by causing nest abandonment, decline in parental care, altering feeding schedules, and other stresses (Colorado State Parks 1998). It can cause shifts in habitat use, lead to abandonment of habitat, and increase energy demands in affected wildlife (Knight and Cole 1991). Hammitt and Cole (1998) conclude that the frequent presence of humans in natural areas can dramatically change the behavior of some wildlife species.

Wildlife responses to human disturbance vary by species, and by the type, level, frequency, duration, and time of year of the human use. For example generalist species, which thrive in disturbed areas, are often more abundant along trails than specialist species that are more sensitive to human disturbance (Colorado State Parks 1998). Adverse impacts also tend to increase as user groups increase in size (Beale and Monaghan 2004).

The impact of walking along trails can have impacts even outside of the immediate trail corridor (Miller et al. 2001). 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. They also found that nest predation was also greater near trails (Miller et. al 1998).

Indirect Effects

When people move from one area to another, they can be vectors for the seeds or other propagules of invasive plants. Once established, invasive plants can outcompete native plants, thereby altering habitats and indirectly impacting wildlife. The threat of invasive plants establishing themselves will always be an issue that requires monitoring.

Cumulative Effects

Effects that are minor when we consider them separately but may be important when we consider them collectively are cumulative effects. The principal concerns are repeated disturbances of birds that are nesting, foraging, or resting. Opening refuge land to public use can often result in litter, vandalism, or other illegal activities.

Our observations and knowledge of the areas involved provide no evidence that, cumulatively, these proposed wildlife-dependent uses will have an unacceptable effect on the wildlife resource. Although we do not expect a substantial increase in the cumulative effects of public use in the near term, it will be important for refuge staff to monitor public use and respond, if necessary, to conserve the high-quality wildlife resources on the refuge.

We expect no additional effects from wildlife observation, wildlife photography, environmental education or interpretation. Refuge staff will monitor and evaluate the effects of public use in collaboration with volunteers to discern and respond to unacceptable impacts on wildlife or habitats.

PUBLIC REVIEW AND COMMENT:

As part of the comprehensive conservation planning process for Great Bay Refuge, this compatibility determination will undergo extensive public review, including a comment period of at least 30 days following the release of the draft Comprehensive Conservation Plan and Environmental Assessment.

DETERMINATION (CHECK ONE BELOW):

____ Use is not compatible

__X__ Use is compatible with the following stipulations

STIPULATIONS NECESSARY TO ENSURE COMPATIBILITY:

We will monitor public use on the trail at various times of the year to assess the disturbance of wildlife. Wildlife observation, photography, environmental education, and interpretation will only be allowed on the refuge from sunrise to sunset on trails open to the public.

Groups of 10 or more people must request a special use permit from the refuge manager. Each request will then be evaluated for impacts to the refuge. Using professional judgment, as long as there is no significant negative impact to natural resources or visitor services, or violation of refuge regulations, a special use permit will be issued outlining the framework in which this use can be conducted.

JUSTIFICATION:

Wildlife observation and photography, environmental education, and interpretation are priority wildlife-dependent uses, through which the public can develop an appreciation for fish and wildlife [Executive Order 12996, March 25, 1996, and the National Wildlife Refuge System Administration Act of 1966, as amended by the National Wildlife Refuge System Improvement Act of 1997].

Service policy is to provide expanded opportunities for those uses when they are compatible and consistent with sound fish and wildlife management, and ensure that they receive enhanced consideration in refuge planning and management. Allowing them on the refuge will not materially interfere with or detract from the mission of the Refuge System or the purposes for which the refuge was established.

SIGNATURE:

Refuge Manager: _____ _____
(Signature) (Date)

CONCURRENCE:

Regional Chief: _____ _____
(Signature) (Date)

MANDATORY 15 YEAR RE-EVALUATION DATE: _____

LITERATURE CITED:

Beale, C. M., and P. Monaghan. 2004. Human disturbance: people as predation-free predators? Journal of Applied Ecology 41:335-343.

Belanger, L., and J. Bedard. 1990. Energetic cost of man-induced disturbance to staging snow geese. Journal of Wildlife Management. 54:36-41.

Burger, J. 1981. Effect of human activity on birds at a coastal bay. Biological Conservation 21:231-241.

Colorado State Parks. 1998. Planning trails with wildlife in mind: a handbook for trail planners prepared by Trails and Wildlife Task Force and Hellmund Associates. 51 pp. Accessed online at: *http://www.fs.fed.us/outdoors/naturewatch/start/planning/Trails-for-Wildlife-Handbk.pdf.*

Erwin, R. M. 1980. Breeding habitat by colonially nesting water birds in 2 Mid-Atlantic U.S. regions under different regimes of human disturbance. Biological Conservation. 18:39-51.

Hammitt, W. E. and D.N. Cole. 1998. Wildland Recreation. John Wiley & Sons, New York, 361pp.

Henson, P. T., and A. Grant. 1991. The effects of human disturbance on trumpeter swan breeding behavior. Wildlife Society Bulletin 19:248-257.

Havera, S. P., L. R. Boens, M. M. Georgi, and R. T. Shealy. 1992. Human disturbance of waterfowl on Keokuk Pool, Mississippi River. Wildlife Society Bulletin 20:290-298.

Kaiser, M.S. & Fritzell, E.K. 1984. Effects of river recreationists on green-backed heron behavior. Journal of Wildlife Management 48, 561-567.

Kahl, R. 1991. Boating disturbance of canvasbacks during migration at Lake Poygan, Wisconsin. Wildlife Society Bulletin 19:242-248.

Knight, R.L. and D. N. Cole. 1991. Effects of recreational activity on wildlife in wildlands. Trans. 56th N.A. Wildl. & Nat. Res. Conf. Pages 238-247.

Korschen, C. E., L. S. George, and W. L. Green. 1985. Disturbance of diving ducks by boaters on a migrational staging area. Wildlife Society Bulletin 13:290-296.

Miller, S.G., R.L. Knight, and C.K. Miller. 1998. Influence of recreational trails on breeding bird communities. Ecological Applications 8:162-169.

Miller, S.G., R.L. Knight, and C.K. Miller. 2001. Wildlife responses to pedestrians and dogs.

Wildlife Society Bulletin 29(1): 124-132.

Morton, J. M., A. C. Fowler, and R. L. Kirkpatrick. 1989. Time and energy budgets of American black ducks in winter. Journal of Wildlife Management 53:401-410(also see corrigendum in J. Wildl. Manage. 54:683).

Owen, M. 1973. The management of grassland areas for wintering geese. Wildfowl. 24:123-130.

Ward, D. H., and R. A. Stehn. 1989. Response of brant and other geese to aircraft disturbance at Izembek Lagoon, Alaska. U.S. Fish and Wildlife Service, Alaska Fish and Wildlife Research Center. Final report to the Minerals Management Service. Anchorage, Alaska. 193 pp.

Williams, G. J., and E. Forbes. 1980. The habitat and dietary preferences of dark-bellied brant geese and widgeon in relation to agricultural management. Wildfowl. 31:151-157.

COMPATIBILITY DETERMINATION

USE:

Hunting

REFUGE NAME:

Great Bay National Wildlife Refuge

ESTABLISHING AND ACQUISITION AUTHORITY(IES):

Public Law 102-154, Section 319(d) Department of the Interior and Related Agencies Appropriations Bill, 1992.

REFUGE PURPOSE(S):

Great Bay National Wildlife Refuge (Great Bay Refuge, the refuge) was established to

- encourage the natural diversity of plant, fish, and wildlife species within the refuge, and to provide for their conservation and management;
- protect species listed as endangered or threatened or identified as candidates pursuant to the Endangered Species Act of 1973;
- preserve and enhance the water quality of aquatic habitat within the refuge; and
- fulfill the international treaty obligations of the United States relating to fish and wildlife.

NATIONAL WILDLIFE REFUGE SYSTEM MISSION:

"The mission of the 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 of 1997 (Public Law 105–57; 111 Stat. 1282)

DESCRIPTION OF USE:

(a) What is the use? Is the use a priority public use?
The use is white-tailed deer hunting. Hunting is a priority public use of the National Wildlife Refuge System under the National Wildlife Refuge System Administration Act of 1966 (16 U.S.C. § 668dd-668ee), and the National Wildlife Refuge System Improvement Act of 1997 (Public Law 105-57).

(b) Where would the use be conducted?
Firearm (shotgun) deer hunting would be allowed throughout the entire refuge excluding Fabyan Point, the enclosed area of the former Weapons Storage Area, and established safety zones.

(c) When would the use be conducted?
The firearm deer hunt would be conducted on the first weekend of the State firearm season for Wildlife Management Unit M, which includes the refuge.

(d) How would the use be conducted?
We will continue to conduct the use according to State and Federal regulations. Federal regulations in 50 Code of Federal Regulations pertaining to the National Wildlife Refuge System Administration Act, as well as existing, refuge-specific regulations will apply. However, the refuge manager may, upon annual review of the hunting program, impose further restrictions on hunting, recommend that the refuge be closed to hunting, or further relax hunting regulations up to the limit of State regulations. We would restrict hunting if it becomes inconsistent with other, higher priority refuge programs or endangers refuge resources or public safety.

All persons participating in the refuge must hold a valid State hunting license, and then obtain a refuge hunting permit. Individuals hunting on the refuge are subject to the inspection of permits, licenses, hunting equipment, game bagged, and vehicles and their contents by Federal and State officers.

Unarmed hunters may scout the appropriate areas open to hunting the first Wednesday of November to the first Saturday of November for the firearm deer hunt. All hunters must possess the appropriate permit while scouting.

"No hunting zones" include, but may not be limited to, the fenced area of the former Weapons Storage Area, Fabyan Point property, administrative areas, and wildlife sensitive areas.

Vehicle access will only be allowed as indicated on hunt maps during the 2-day firearm deer hunt. During scouting, vehicles will park in the visitor parking lot and scout on foot.

Temporary, portable tree stands and ground blinds are acceptable and must be removed daily. Permanent trees stands and ground blinds are prohibited. Hunters cannot use screw-in steps, nails, spikes, wires, or bolts as climbing or hanging devices to attach a stand to a tree.

Prohibited Uses

- Using illuminating devices.
- The distribution of bait, salt, or attractant, or hunting over a baited area.
- Being the under the influence, or in possession, of alcoholic beverages while hunting.
- Possessing axes, hatchets, saws, nails, tacks, paint, or flagging for the marking of trees and shrubs.
- Camping, overnight parking, open fires, dogs, or littering.

Deer may be hunted with shotguns capable of firing a single projectile (slug) during the 2-day firearm hunt in November.

A pre-season lottery will be held for both hunts with 20 permits issued per day for the 2-day firearm hunt. Selected hunters will be required to submit the required fee prior to being issued the permit.

Harvested deer must be tagged at the refuge office.

(e) Why is this use being proposed?
Hunting is one of the priority public uses outlined in the Refuge System Improvement Act of 1997. The Service supports and encourages priority uses when they are compatible on refuge lands. Hunting is used in some instances to manage wildlife populations, and is a traditional form of wildlife-oriented recreation that many national wildlife refuges can accommodate. The refuge hunt has been ongoing since 1996 and has been very successful and popular.

According to the New Hampshire Fish and Game Department (NHFG), deer populations in the more urban Wildlife Management Unit M, exceed the established population target for this unit. Unit M is a total of 534 square miles, of which the refuge comprises less than one-half of 1 percent. NHFG's objective for this unit is to reduce the adult male deer population by approximately 29 percent from the current 757 to 535. The refuge's hunt incrementally helps contribute to this goal. In fall 2011, 22 deer were harvested from the refuge.

AVAILABILITY OF RESOURCES:

Great Bay Refuge is currently unstaffed. NHFG personnel assist the refuge with the application process by receiving and entering applications into a database, and then randomly selecting the required number of individuals and 10 alternates for each day. NHFG then provides the refuge manager with that information. Parker River Refuge staff then process all mailings and permits for selected hunters and staff Great Bay Refuge during the 2-day hunt. Due to the short time frame of the hunt (2 weekend days) adequate staff are available from Parker River Refuge to implement the hunt at this time.

Anticipated costs are:

Visitor Services Specialist (GS-12) — 3 days/year= **$1,425**

Deputy Refuge Manager (GS-12)—2 days/year= **$950**

Biological Technician (GS-5) —2 days/year = **$300**

Refuge Manager (GS-13) — 5 days/year = **$2,500**

Law Enforcement Officer (GS-9) (enforcement patrols) 5 days/yr. = **$2,000**

ANTICIPATED IMPACTS OF THE USE:

Soils and Vegetation Impacts

The entire refuge would be open to hunters, except safety zones, Fabyan Point, and the enclosed portion of the former Weapons Storage Area. Hunters traveling off-trail may trample vegetation and introduce invasive plant propagules. The short-term impacts of trampling vegetation include damage and killing of individual plants, whereas long-term impacts include soil compaction (Kuss 1986, Roovers et al. 2004). However, due to the low number of hunters anticipated annually and the dispersed nature of hunting, we predict that these impacts will be minor. White-tailed deer foraging can also have negative impacts on native vegetation, including reduced forest regeneration and changes in plant composition and structure (Tilghman 1989, Augustine and Jordon 1998). The refuge's hunt program may contribute to reducing these vegetation impacts by reducing the local deer population.

Wildlife Impacts

The use does have some disturbance to other native wildlife present on the refuge; however, keeping the deer population at a level that refuge habitat can support prevents direct impacts to other wildlife and habitat present.

Impacts on other Public Uses

During the 2-day fall hunt, the refuge is closed to all public users, except permitted deer hunters. The hunt occurs during a time when few visitors are coming to the refuge for uses other than hunting. During this time of year, weather conditions also tend to reduce visitation. Also, at this time of year not much wildlife activity is occurring, therefore, there is less interest in wildlife observation and photography. Based on past seasonal visitation, we estimate that less than 100 people would be displaced during the 2-day hunt. However, it is also important to note, that many refuge visitors support hunting and would not upset by the closure.

PUBLIC REVIEW AND COMMENT:

As part of the comprehensive conservation planning process for Great Bay Refuge, this compatibility determination will undergo extensive public review, including a comment period of at least 30 days following the release of the draft Comprehensive Conservation Plan and Environmental Assessment.

DETERMINATION (CHECK ONE BELOW):

____ Use is not compatible

__X__ Use is compatible with the following stipulations

STIPULATIONS NECESSARY TO ENSURE COMPATIBILITY:

To minimize or avoid negative impacts to wildlife and habitat:

- The application process, including random selection of hunters, will be assisted by NHFG
- Twenty permits will be available for each of the 2 days
- Firearms will be restricted to shotgun only with a single projectile (slug)

JUSTIFICATION:

The Service and the Refuge System maintain goals of providing wildlife dependent priority public uses including hunting. The white-tailed deer hunt has been conducted since 1996 and is a traditional and established program on the refuge. Annual adjustments may be made to ensure continued compatibility.

SIGNATURE:

Refuge Manager: _____ _____
(Signature) (Date)

CONCURRENCE:

Regional Chief: _____ _____
(Signature) (Date)

MANDATORY 10 YEAR RE-EVALUATION DATE: _____

LITERATURE CITED:

Augustine, D.J. and P.A. Jordon. 1998. Predictors of white-tailed deer grazing intensity in fragmented deciduous forests. Journal of Wildlife Management 62(3): 1076-1085.

Kuss, F. R. 1986. A review of major factors influencing plant responses to recreation impacts. Environmental Management, 10:638-650.

Roovers, P., K Verheyen, M. Hermy, and H. Gulinck. 2004. Experimental trampling and vegetation recovery in some forest and heathland communities. Applied Vegetation Science 7:111-118.

Tilghman, N.G. 1989. Impacts of white-tailed deer on forest regeneration in northwestern Pennsylvania. Journal of Wildlife Management 53:524-532.

Appendix D

USFWS

Lower Peverly Pond

Wilderness Review

- Introduction
- Phase I. Wilderness Inventory
- Summary of Wilderness Inventory Findings

Introduction

The purpose of a wilderness review is to identify and recommend to Congress lands and waters of the National Wildlife Refuge System (Refuge System) that merit inclusion in the National Wilderness Preservation System (NWPS). Only Federal lands are eligible to be considered for wilderness designation and inclusion within the NWPS. Wilderness reviews are required elements of comprehensive conservation plans (CCPs), are conducted in accordance with the refuge planning process outlined in the U.S. Fish and Wildlife Service Manual (602 FW 1 and 3), and include compliance with the National Environmental Policy Act (NEPA) of 1969 and public involvement.

The wilderness review process has three phases:

1. Inventory Phase
2. Study Phase
3. Recommendation Phase

Lands and waters that meet the minimum criteria for wilderness are identified in the inventory phase. These areas are called wilderness study areas. During the study phase, a range of management alternatives are evaluated to determine if a wilderness study area is suitable for wilderness designation or management under an alternate set of goals and objectives that do not involve wilderness designation. Finally, the recommendation phase consists of reporting recommendations to Congress in a wilderness study report. If warranted, the wilderness study report is prepared after the record of decision for the final CCP has been signed. If any areas are recommended for designation, they would be managed to maintain wilderness character, in accordance with management goals, objectives, and strategies outlined in the final CCP, until Congress makes a decision or the CCP is amended to modify or remove the wilderness proposal.

Phase I. Wilderness Inventory

Introduction

The wilderness inventory takes a broad look at each planning area (wilderness inventory area) to identify wilderness study areas. A wilderness study area is an area of undeveloped Federal land that retains its primeval character and influence, without permanent improvements or human habitation, and further, meets the minimum criteria for wilderness as identified in section 2(c) of the Wilderness Act of 1964 (16 U.S.C. § 1131-1136, 78 Stat. 890; Public Law 88-577).

Minimum Wilderness Criteria

A wilderness study area is required to

- appear *natural*;
- provide for *solitude or primitive recreation*; and
- be either a *roadless* area that meets the *size* criteria or an island of any size.

The following section provides a more detailed description of the four minimum wilderness criteria: naturalness, solitude or primitive and unconfined recreation, roadless, and size.

Naturalness

The Wilderness Act, section 2(c), defines wilderness as an area that "generally appears to have been affected primarily by the forces of nature with the imprint of human work substantially unnoticeable." The area must appear natural to the average visitor, rather than "pristine." The presence of historic landscape conditions is not required.

An area may include some human impacts provided they are substantially unnoticeable in the unit as a whole. Significant hazards caused by humans, such as the presence of unexploded ordnance from military activity and the physical impacts of refuge management facilities and activities are also considered in evaluating the naturalness criteria.

An area may not be considered unnatural in appearance solely on the basis of the sights and sounds of human impacts and activities outside the boundary of the unit. The cumulative effects of these factors in conjunction with land base size, and physiographic and vegetative characteristics were considered in the evaluation of naturalness. The following factors were the primary considerations in evaluating naturalness:

A. The area appears to have been affected primarily by the forces of nature with the imprint of human work substantially unnoticeable.
B. The area may include some human impacts provided they are substantially unnoticeable in the unit as a whole.
C. Does the area contain significant hazards caused by humans, such as the presence of unexploded ordnance from military activity?
D. The presence of physical impacts of refuge management facilities and activities.

Solitude or Primitive and Unconfined Recreation

A wilderness study area must provide outstanding opportunities for solitude or primitive and unconfined recreation. The area does not have to possess outstanding opportunities for both solitude and primitive and unconfined 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 this criteria; Congress has designated a number of wilderness areas in the Refuge System that are closed to public access to protect resource values.

Opportunities for solitude refer 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 are compatible and do not require developed facilities or mechanical transport. These primitive recreation activities may provide opportunities to experience challenge and risk, self reliance, and adventure. Solitude and primitive unconfined recreation are not well defined by the Wilderness Act, but can be expected to occur together in most cases. 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.

The following factors were the primary considerations in evaluating outstanding opportunities for solitude or primitive unconfined recreation:

A. The area offers the opportunity to avoid sights, sounds, and evidence of other people. A visitor to the area should be able to feel alone or isolated.
B. The area offers non-motorized, dispersed outdoor recreation activities that are compatible and do not require developed facilities or mechanical transport.

Roadless

Roadless refers to the absence of improved roads suitable and maintained for public travel by means of motorized vehicles primarily intended for highway use. A route maintained solely by the passage of vehicles does not constitute a road.
The following factors were the primary considerations in evaluating the roadless criteria:

A. The area does not contain improved roads suitable and maintained for public travel by means of motorized vehicles primarily intended for highway use.
B. The area is an island, or contains an island, that does not have improved roads suitable and maintained for public travel by means of motorized vehicles primarily intended for highway use.
C. The area is in Federal fee title ownership.

Size

The size criteria can be satisfied if an area has at least 5,000 acres of contiguous roadless public land, or is sufficiently large that its preservation and use in an unimpaired condition is practicable.

The following factors were the primary considerations in evaluating the size criteria:

A. An area of more than 5,000 contiguous acres. State and private lands are not included in making this acreage determination.
B. 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.
C. 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.
D. An area of less than 5,000 contiguous acres that is contiguous with a designated wilderness, recommended wilderness, or area under wilderness review by another Federal wilderness managing agency such as the U.S. Department of Agriculture - Forest Service, National Park Service, or Bureau of Land Management.

Supplemental Values

The Wilderness Act states that an area of wilderness may contain ecological, geological, or other features of scientific, educational, scenic, or historical value. Supplemental values of the area are optional, but the degree to which their presence enhances the area's suitability for wilderness designation should be considered. The evaluation should be based on an assessment of the estimated abundance or importance of each of the features.

Great Bay National Wildlife Refuge

The CCP planning team identified the entirety of Great Bay National Wildlife Refuge (Great Bay Refuge, the refuge) (map D.1) as the only wilderness inventory area because there are no natural terrain barriers separating any portion of the refuge from any other portion. The CCP Planning Team evaluated the refuge to determine if it retains a primeval character and influence, is without permanent improvements or human habitation, and further, meets the minimum criteria for wilderness as identified in section 2(c) of the Wilderness Act. Our findings are described below.
Does the wilderness inventory area meet the following criteria:

(1) Have at least 5,000 acres of land, or is it of sufficient size to make practicable its preservation and use in an unconfined condition, or is it a roadless island?

No. The refuge is only 1,103 acres in size and is not a roadless island. It is also not of sufficient size to preserve and use in an "unconfined" or "unimpaired" condition due to its land use history as an Air Force Base. Remnants of the Pease Air Force Base are still visible on the refuge, including a former weapons storage area with concrete bunkers. Adjacent to the refuge is the remainder of the former Air Force Base which has been converted into the Pease International Tradeport. The tradeport is heavily developed and houses an international airport, office and industrial space, restaurants, and hotels.

(2) Generally appear to have been affected primarily by the forces of nature with the imprint of man's work substantially unnoticeable?

No. The majority of the refuge would not look natural to the average visitor because of substantially noticeable human impacts.

The refuge has several administrative buildings, including refuge headquarters, refuge housing, and a maintenance building. Adjacent to refuge headquarters is a visitor parking lot, interpretive kiosk, and public restrooms. There are several service roads throughout the refuge. Two hiking trails begin at the visitor parking lot. The Ferry Way Trail begins as an asphalt path and then follows several old woods roads. The Peverly Pond Trail is paved with crushed stone and is Americans with Disabilities Act (ADA)-accessible. This trail leads to a wildlife blind and viewing platform. The refuge also has several man-made impoundments, including three on Peverly Brook and two other smaller impoundments along trails.

In addition to these facilities, the refuge also has two historic buildings listed on the National Registry of Historic Places: the Margeson-Hawkridge-Loomis Estate and caretaker's residence. As noted above, remnants

Map D.1. Great Bay National Wildlife Refuge

of the former Pease Air Force Base are visible in several locations on the refuge, including the former weapons storage area. This area is currently fenced in with by a chain-linked fence and concrete bunkers are visible. Again, the refuge is adjacent to an international airport that can be heard throughout the refuge.

(3a) Have outstanding opportunities for solitude?

No. There are few opportunities for visitors to be alone and feel secluded from other visitors in the area. Unnatural noise from the Pease International Tradeport detracts from solitude, as do the presence of refuge facilities and the former weapons storage area.

Large portions of the refuge are closed to the public, including the former weapons storage area. Most visitors are confined to two popular nature trails which limit opportunities to feel alone on the refuge. Although hunters have access to a greater portion of the refuge during a 2-day white-tailed deer hunt, the hunt is highly regulated and is only allowed in designated areas. Waterfowl hunting is also permitted along the refuge shoreline, but access is via boat only and not by foot through the refuge.

(3b) Have outstanding opportunities for a primitive and unconfined type of recreation?

No. The refuge does not have outstanding opportunities for primitive or unconfined recreational use. As mentioned above, major portions of the refuge are closed to most visitors limiting opportunities for unconfined and primitive recreation. Most recreation is limited to popular nature trails. Off-trail and off-road access is prohibited, except to white-tailed deer hunters during the 2-day hunt. Although these hunters have a somewhat greater opportunity for dispersed recreation, the hunt is highly regulated and only occurs in designated areas.

Also, noise from the Pease International Tradeport can be heard throughout the refuge. Although the Tradeport is outside of the wilderness study area, its noise has a major impact and would also likely diminish opportunities for a primitive experience.

(4) Contain ecological, geological, or other features of scientific, educational, scenic, or historical value?

Yes. The refuge contains a variety of features of ecological value. The refuge has a diversity of habitat types, from forested uplands, freshwater wetlands, and 6 miles of estuarine shoreline. The refuge also supports eight exemplary natural communities, as identified by the New Hampshire Natural Heritage Bureau, including eelgrass beds, oyster beds, and red maple-sensitive fern swamps. The refuge is home to a variety of animal species, while the larger Great Bay Estuary supports habitat for 23 species of federally and State-listed threatened and endangered plants and animals.

In addition, the refuge has an array of historical and cultural resources. At least 22 archaeological or historical sites are identified on the refuge. The refuge has two buildings on the National Registry of Historic Places: the Margeson-Hawkridge-Loomis Estate and its caretaker's residence. As part of the former Pease Air Force Base, the refuge also contains historical remnants of the base, including a former weapons storage area.

Summary of Wilderness Inventory Findings

The CCP Planning Team found that Great Bay Refuge does not meet any of the minimum criteria for wilderness as identified in section 2(c) of the Wilderness Act. While there are ecological and historic values on the refuge, these do not, in and of themselves, warrant wilderness recommendation. In summary, Great Bay Refuge does not qualify as a wilderness study area, and will not be considered further for wilderness designation in this CCP.

Appendix E

USFWS

Water tower in the former Weapons Storage Area

Refuge Operation Needs System (RONS) & Service Asset Maintenance Management System (SAMMS) Projects

Refuge Operation Needs System & Service Asset Maintenance Management System

Great Bay National Wildlife Refuge's (Great Bay Refuge, the refuge) budget requests contained in the Refuge Operating Needs System (RONS) and Service Asset and Maintenance Management System (SAMMS) databases include a wide variety of new projects and maintenance needs. The RONS and SAMMS lists are regularly updated to include priority projects. Contact the refuge for the most current RONS and SAMMS lists.

Table E.1. Current Projects in the RONS Database for Great Bay Refuge

Station Priority Rank	Project Description	Estimated One-time cost	Recurring Base Cost	Total First Year Need	FTE†	Alternatives
1	Complete and implement Comprehensive Conservation Plan	–	$128,986	$128,986	1.0	Common to All
2	Provide assistance to area partnerships to manage over 10,000 acres	$32,500	$14,500	$47,000	–	Common to All
3	Use prescribed fires to manage and maintain habitat for federally listed and State-listed species	$25,000	$7,500	$32,500	–	A & B
4	Maintain and manage refuge facilities and equipment for managing natural resources and providing visitor services	–	$72,371	$72,371	1.0	Common to All
5	Monitor and manage refuge habitat to provide biological diversity and environmental health	–	$128,986	$128,986	1.0	Common to All
6	Provide and enhance recreational and educational opportunities to residents and visitors about the refuge, conservation, and area environmental issues	–	$106,614	$106,614	1.0	Common to All
7	Manage and restore 400 acres of early successional, marine, and freshwater habitats for rare, threatened, and endangered species, anadromous fish and other aquatic species	$38,500	$29,500	$116,423	–	A
8	Provide and enhance priority public use opportunities and engage youth	$40,000	$23,000	$99,317	–	Common to All
9	Monitor biological diversity and management actions on 1,100 acres to evaluate achievement of biological goals and objectives as outlined in approved management plans	$35,000	$25,000	$60,000	–	A
	Totals	**$171,000**	**$536,457**	**$792,197**	**4.0**	

† *FTE= Full-time equivalent (i.e., full-time staff position)*

Table E.2. Projects Proposed for the RONS Database for Great Bay Refuge under Alternative B

Station Priority Rank*	Project Description	Estimated One-time cost	Recurring Base Cost	Total First Year Need
1	Restore and manage 20 acres of former Weapons Storage Area as predator-free habitat for New England Cottontail rabbit and declining bird species dependent on shrub habitat	$150,000	$45,000	$180,000
2	Remove Lower Peverly Dike and Control Structure, restore 1,000 feet of free-flowing stream, and monitor environmental conditions and habitat pre- and post-restoration	$200,000	$20,000	$220,000
3	Research, monitor, and manage six bat species and associated habitats and convert former military bunkers into hibernacula	$40,000	$30,000	$70,000
4	Monitor water quality and sediments within the Peverly Brook Drainage on the refuge to track contamination levels from the former Pease Air Force Base and current uses adjacent to the refuge	$75,000	$35,000	$110,000
5	Partner with New Hampshire Fish and Game to restore and manage pine barrens habitat for the federally endangered Karner blue butterfly, and to increase the population through a captive rearing program	$60,000	$15,000	$75,000
6	Establish monitoring sites with partners to track habitat changes due to sea level rise and climate change using Sediment Elevation Tables (SET) in salt marshes and phenological changes in other habitats following standard protocols used by multiple agencies	$50,000	$25,000	$75,000
7	Eradicate, control, and monitor multiple invasive plant species within the refuge to improve habitat conditions for listed, candidate, and declining species that are present or could be restored	$30,000	$45,000	$75,000
8	Research, monitor, and restore aquatic habitats and resources with emphasis on eelgrass, oysters, and horseshoe crabs within 400 acres of marine and estuarine habitats. Work with Great Bay area partners to support and coordinate actions using standard practices and techniques.	$250,000	$50,000	$50,000
	Totals	**$855,000**	**$265,000**	**$855,000**

**Ranking based only on these proposed RONS projects for alternative B. Actual ranking may differ when updating existing RONS projects and eliminating projects unique to either alternatives A and/or C.*

Table E.3. Projects Proposed for the RONS Database for Great Bay Refuge under Alternative C

Station Priority Rank*	Project Description	Estimated One-time cost	Recurring Base Cost	Total First Year Need
1	Remove Upper Peverly dike and water control structure, and restore approximately 1,500 feet of free-flowing stream, and monitor environmental conditions and habitat pre- and post-restoration	$250,000	$50,000	$300,000
2	Remove Stubbs Pond dike, water control structure, fish ladder, and restore approximately 0.5 miles of stream habitat and associated salt marsh and riverine habitat. Monitor environmental conditions and habitat pre- and post- restoration.	$1,500,000	$75,000	$1,575,000
	Totals	**$1,750,000**	**$125,000**	**$1,875,000**

**Ranking based only on those proposed RONS Projects for alternative C. Actual ranking may differ when updating existing RONS projects and eliminating projects unique to either alternatives A and/or B.*

Table E.4. Current Projects in the SAMMS Database for Great Bay Refuge

Project Number	Project Description	Estimated Cost
01110818	Rehabilitate at the Weapons Storage Area	$195,000
01110820	Remove communication building #420	$32,000
01110826	Remove military water storage tank	$96,000
03126013	Rehabilitate water supply building	$39,000
03126354	Replace and remove building #436	$114,000
03126355	Remove building #437	$183,600
03126356	Remove and replace building #465	$11,000
03126357	Remove and replace building #466 with solar	$503,900
03126358	Remove building #468	$168,100
04133936	Remove cabin at 150 Fabyan Point Road	$14,200
04133945	Remove old stone house at Fabyan Point	$55,700
05038515	Remove cabin at 154 Fabyan Point Road	$21,300
05038517	Remove cabin at 158 Fabyan Point Road	$16,300
05038520	Remove cabin at 162 Fabyan Point Road	$16,300
05138522	Remove cabin at 166 Fabyan Point Road	$21,300
05138532	Remove house at 138 Fabyan Point Road	$43,800
05138593	Remove storage shed formerly used as hanger	$10,000
2005207406	Rehabilitate service road	$515,000
2005207464	Remove and replace deteriorated building	$168,100
2005256059	Remove caretaker residence	$26,000
2005256102	Rehabilitate Karner Blue Easement trailhead contact point	$47,000
2005256237	Replace fencing at Karner Blue Butterfly	$327,000
2006506630	Replace electronic gate controller and gate	$33,000
2008865067	Replace service road culverts to Stubbs Pond	$30,000
2008865068	Replace Upper Peverly Pond water control structure	$197,000
2008865094	Removing Lower Peverly Dam by breaching Dam	$500,000
2008869147	Rehabilitate service and access road	$750,000
2008869148	Rehabilitate entrance road	$365,800
2008869149	Rehabilitate public parking lot	$103,900
2008869151	Replace Loomis well pump	$30,000
2008869182	Remove rescue team facility	$36,000
2008869184	Remove electrical substation #480	$28,000
2008869185	Remove electrical substation #481	$28,000
2008869187	Remove electrical substation #482	$28,000
2008869189	Remove electrical substation #483	$28,000
2008869191	Remove electrical substation #484	$28,000

Project Number	Project Description	Estimated Cost
2008869193	Remove electrical substation #485	$28,000
2008869195	Remove electrical substation #486	$28,000
2008869197	Remove electrical substation #487	$28,000
2008869200	Remove electrical substation #488	$28,000
2010137228	Rehabilitating Margeson Estate Main House	$100,000
2010129650	Repair and Rehabilitate Stubbs Pond Dam	$36,650
2010129771	Repair Stubbs Pond Fish Ladder	$6,000
2010129772	Repair Stubbs Pond WCS	$10,000
2010131080	Repair Upper Peverly Dam	$23,125
2011178789	Repairs to refuge residence	$10,000
2011178791	Repair and replace sections Peverly Trail	$10,000
01110822	Remove Military Storage Igloo	$36,000
01110823	Remove Military Storage Igloo	$36,000
2008869156	Remove Military Storage Igloo	$36,000
2008869158	Remove Military Storage Igloo	$36,000
2008869160	Remove Military Storage Igloo	$36,000
2008869162	Remove Military Storage Igloo	$36,000
2008869164	Remove Military Storage Igloo	$36,000
2008869166	Remove Military Storage Igloo	$36,000
2008869168	Remove Military Storage Igloo	$36,000
2008869170	Remove Military Storage Igloo	$36,000
2008869172	Remove Military Storage Igloo	$36,000
2008869174	Remove Military Storage Igloo	$36,000
2008869176	Remove Military Storage Igloo	$36,000
2008869178	Remove Military Storage Igloo	$36,000
2008869180	Remove Military Storage Igloo	$36,000
	Total Costs	**$5,658,075**

Table E.5. Proposed Projects for the SAMMS Database for Great Bay Refuge under Alternative B

Project Description	Estimated Cost
Create an RV Site with two hookups for seasonal volunteers	$15,000
Remove Margeson Estate	$75,000
Construct medium-size Office and Visitor Contact Station	$3,500,000
Construct maintenance/storage facility	$1,000,000
Construct ferry Way Trail Overlook	$5,000
Remove the WSA Water Control Structure	$5,000
Replace the fence surrounding the former WSA	$200,000
Create new access road to the south end of the WSA	$30,000
Replace refuge signs	$25,000
Replace Peverly Pond blind	$15,000
Construct information kiosk at Karner Blue Easement	$10,000
Install photovoltaic panels for existing modular office	$40,000
Install photovoltaic panels for existing modular residence	$25,000
Total Costs	**$4,945,000**

Table E.6. Proposed Projects for the SAMMS Database for Great Bay Refuge under Alternative C

Project Description	Estimated Cost
Remove former Weapons Storage Area fencing	$100,000
Remove former Weapons Storage Area roads	$200,000
Construct the Woodman Point Trail	$75,000
Construct the Fabyan Point Trail parking area	$50,000
Construct the Fabyan Point Trail	$50,000
Construct the Fabyan Point Observation Platform	$15,00
Total Costs	**$475,000**

Appendix F

Donna Dewhurst/USFWS

Bufflehead and scaup

Staffing Chart

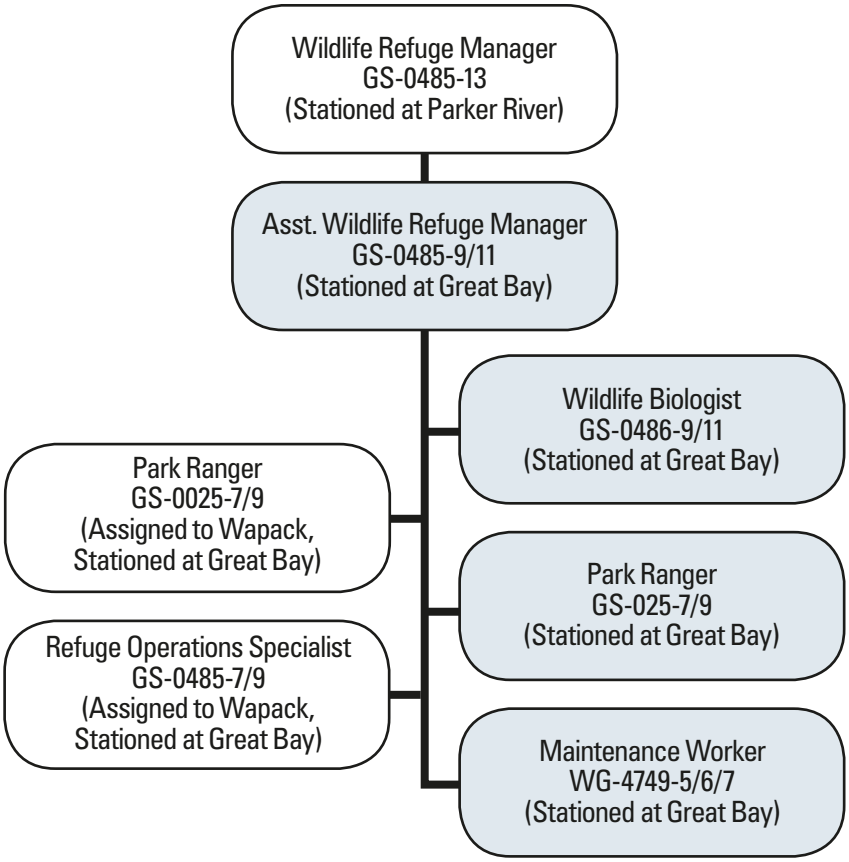
U.S. Fish and Wildlife Service
Northeast Region
Regional Chief, National Wildlife Refuge System
Great Bay National Wildlife Refuge

Alternative A

Great Bay and Wapack Refuges administrated by Parker River Refuge
No staff stationed at Great Bay Refuge

Alternatives B and C

Great Bay Refuge and Wapack Refuges administrated by Parker River Refuge
Staff for both Great Bay and Wapack Refuges stationed at Great Bay Refuge



Appendix G

Rob Bozeman

Prescribed burning

Fire Management Program Guidance

- Introduction
- The Role of Fire
- Wildland Fire and Management Policy and Guidance
- Fire Management Planning
- Fire Management Program at Great Bay National Wildlife Refuge

Introduction

The mission of the National Wildlife 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" as stated in the National Wildlife Refuge Improvement Act (October 9, 1997). The U.S. Fish and Wildlife Service's (Service) Northeast Regional Fire Program (Fire Program) helps support this mission by creating and managing important wildlife habitat with prescribed fire and protecting human safety by reducing the risk of wildfire and through fire suppression. This document provides an outline of the Fire Program's guidance on fire management, explains the fire management planning process, and describes the fire management program at Great Bay National Wildlife Refuge (Great Bay Refuge, the refuge). This guidance is a review that serves as a precursor updating the refuge's current Fire Management Plan (FMP).

The Role of Fire

Historically, natural fire and ignitions by Native American people has played an important disturbance role in many ecosystems by

- removing fuel accumulations;
- decreasing the impacts of insects and diseases;
- stimulating regeneration of vegetation;
- cycling nutrients; and
- providing a diversity of habitats for plants and wildlife.

The role of fire has been greatly modified in the heavily developed areas of the Northeast U.S. However, when fire is used properly it can

- reduce hazardous fuels build-up in both the wildland-urban interface[1] and other areas;
- improve wildlife habitats by reducing the density of vegetation, and/or changing plant species composition;
- sustain and increase biodiversity;
- improve woodlands and shrublands by reducing plant density;
- reduce the susceptibility of plants to insect and disease outbreaks; and
- assist in the control of invasive and noxious species.

Wildland Fire and Management Policy and Guidance

In 2001, the Secretaries of the Interior and Agriculture approved an update to the 1995 "Federal Fire Policy." The 2001 "Federal Wildland Fire Management Policy" directs Federal agencies to achieve a balance between using fire suppression to protect life, property, and resources, and using wildland fire to regulate fuels and maintain healthy ecosystems. It also directs agencies to provide a management response to all wildfires that is commensurate with the values at risk, human safety, and the costs for suppression.

This policy provides nine guiding principles that are fundamental to the success of the fire management program. These guiding principles are as follows:

1. Firefighter and public safety is the first priority in every fire management activity.

2. The role of wildland fire as an essential ecological process and natural change agent will be incorporated into all land management planning processes.

3. Fire management plans, programs, and activities support land and resource management plans and their implementation.

[1] The wildland-urban interface is the line, area, or zone where human development and structures meet with undeveloped wildland or vegetative fuels.

4. Sound risk management is a foundation for all fire management activities.

5. Fire management programs and activities are economically viable, based upon values to be protected, costs, and land and resource management objectives.

6. Fire management plans and activities are based upon the best available science.

7. Fire management plans and activities incorporate public health and environmental quality considerations.

8. Federal, State, Tribal, local, interagency, and international coordination and cooperation are essential.

9. Standardization of policies and procedures among Federal agencies is an ongoing objective.

The following provide further direction on fire management decisions:

- Every fire requires a response and decision on how to respond to it.

- The Service's initial reaction to human caused fires will be to suppress the fire while providing for firefighter and public safety, limiting damage and loss, and minimizing costs of the fire.

- The interagency nature of fire management work requires the involvement and participation of cooperators, including both State and local agencies, in planning for, and potentially responding to, wildland fire.

Fire Management Planning

A FMP is required for every national wildlife refuge that has burnable acres. A FMP defines the refuge's fire management direction based on the objectives outlined in the refuge's Comprehensive Conservation Plan (CCP) and Habitat Management Plan (HMP). It provides a detailed description of how the refuge will

- respond to wildland fires;
- manage fuels to reduce the risk of wildland fires; and
- use prescribed burning to meet management objectives, if applicable.

In order for a refuge to use wildlife fire, prescribed burning, and other hazardous fuel reduction techniques, these methods must be specified and pre-approved as appropriate management responses in the refuge's FMP. If none of these methods are described in the FMP, the refuge's only allowed response to wildland fire is aggressive suppression.

Fire Management Program at Great Bay National Wildlife Refuge

Management Direction

Great Bay Refuge was established in 1992 when land from the former Pease Air Force Base was transferred to the Service. The refuge currently encompasses 1,103 acres in Newington, New Hampshire with a diversity of habitat types including oak-hickory forest, grasslands, shrub thickets, fresh and saltwater wetlands, and open water habitats. The refuge also includes a 29-acre conservation easement in the pine barrens of Concord, New Hampshire that is managed primarily for the federally endangered Karner blue butterflies. The refuge's purposes are the following:

- To encourage the natural diversity of plant, fish, and wildlife species within the refuge, and to provide for their conservation and management

- To protect species listed as endangered or threatened or identified as candidates pursuant to the Endangered Species Act of 1973
- To preserve and enhance the water quality of aquatic habitat within the refuge
- To fulfill the international treaty obligations of the U.S. relating to fish and wildlife

Since the refuge's establishment, there have been no wildfires on the refuge. Prescribed fire is currently used as a management tool, particularly on refuge grasslands and shrublands and on the Karner blue butterfly easement. In the future, the refuge may use prescribed fire as a management tool to promote and accomplish the following five goals, as defined in the refuge's CCP.

1. Perpetuate the biological integrity, diversity, and environmental health of estuarine and freshwater habitats to protect water quality and sustain native plant communities and wildlife, including species of conservation concern.
2. Perpetuate the biological integrity, diversity, and environmental health of upland and forested wetland habitats to sustain native plant communities and wildlife, including species of conservation concern.
3. Foster and maintain conservation, research, and management partnerships to promote protection and stewardship of the ecological resources of the Great Bay Estuary.
4. Promote enjoyment and awareness of the Great Bay Refuge and estuarine system by providing high-quality, compatible, wildlife-dependent public uses on refuge lands and on partner lands and waters around Great Bay.
5. Contribute to the recovery of the federally endangered Karner blue butterfly and other rare Lepidoptera through the conservation, protection, and restoration of the pine barrens habitat.

All aspects of the fire management program will be conducted in a manner consistent with applicable laws, policies, and regulations. Great Bay Refuge will maintain a FMP to accomplish the fire management goals that follow (see "Fire Management Objectives" below). Any future prescribed fire, chemical, manual, and mechanical fuel treatments will be applied in a scientific way, under selected weather and environmental conditions.

Fire Management Program Implementation

The objectives and strategies of the National Wildlife Refuge System Wildland Fire Management Program Strategic Plan are consistent with Department of the Interior and the U.S. Forest Service policies, National Fire Plan direction, the President's Healthy Forest Initiative, the 10-year Comprehensive Strategy and Implementation Plan, National Wildfire Coordinating Group Guidelines, initiatives of the Wildland Fire Leadership Council, and Interagency Standards for Fire and Aviation Operations.

The fire management program guiding principles for Great Bay Refuge are to

- protect Service lands and wildlife from wildfire; and
- use prescribed fire to meet the habitat goals and objectives identified in the refuge's CCP.

Fire Management Objectives

The purpose of the fire management program at Great Bay Refuge would be to use chemical, manual, and mechanical fuel treatments to ensure public and firefighter safety, while protecting property and natural resource values from wildfire. The objectives of Great Bay Reefuge's fire management program include the following:

- Ensure public and firefighter safety while protecting property and natural resource values from wildfire.
- Reduce the wildfire impacts to all resource management activities.
- Protect adjacent landowners from wildfire and prescribed burn impacts.
- Reduce the threats associated with accumulations of hazardous fuel loads to refuge shrublands and grasslands.
- Provide, enhance, and protect habitats for State and Federal endangered and threatened species and species of special concern.
- Provide, maintain, enhance, and protect feeding, resting, nesting, and brood habitat that meet the requirements of migratory waterfowl, other migratory birds, and resident wildlife.
- Facilitate the control of invasive and exotic species.
- Increase habitat diversity in refuge upland habitats.
- Demonstrate and educate the public about the role and benefits of wildfire protection and prescribed fire use in resource management.
- Maintain current ecosystem diversity within the landscape context.
- Comply with state Air Quality Implementation Plans and regulations to protect public health and the environment.

Fire Management Strategies

The refuge will use fire management strategies and tactics that consider public and firefighter safety, as well as the resource values at risk. The FMP will provide a more detailed description of the wildfire suppression, prescribed fire, chemical, manual, and mechanical treatment methods the refuge plans to use. The FMP will also explain the timing and monitoring of the refuge's fire management strategies. The refuge will develop prescribed fire burn plans for specific sites, following the interagency Prescribed Fire Planning and Implementation Procedures Reference Guide (2009) template.

Some fire management strategies techniques, such as prescribed burning, may impact air quality. Prescribed fire temporarily reduces air quality by diminishing visibility and releasing particulates and pollutants through combustion. However, the refuge will meet the Clean Air Act emission standards by adhering to the New Hampshire air quality requirements during all prescribed fire activities.

Fire Management Organization, Contracts, and Cooperation

The Service's Northeast Regional Fire Program is divided into four fire management zones which provide technical fire management oversight to refuges. Great Bay Refuge is currently within the New England fire management zone, which includes all the national wildlife refuges in New Hampshire. All fire management activities are conducted in a coordinated and collaborative manner with the refuge, the Zone Fire Management Officer located at Rhode Island National Wildlife Refuge Complex, and other Federal and non-Federal partners. The fire management zone has also developed a close working relationship with the New Hampshire Fish and Game Department and The Nature Conservancy.

A new FMP will be developed for the refuge in 2012.

Appendix H

USFWS

Herods Cove shoreline looking north

Forest Health Assessment

Forest Health Assessment
Great Bay National Wildlife Refuge

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Introduction

An assessment of the health of forested land at Great Bay National Wildlife Refuge was requested by the U.S. Fish and Wildlife Service in 2006. This assessment is being conducted by the USDA Forest Service, Durham Field Office, Forest Health Protection staff. The survey design was implemented during the summer/fall of 2006 and is summarized in this report.

Forest health assessments provide a general overview of the conditions of forested areas and can be used to guide forest management decisions and/or inform natural resource managers about potential health concerns in forests under their stewardship. Assessments consider the "health" of overstory trees (e.g., crown condition, growth form etc.), regeneration in stands, presence/absence of native insects at damaging levels, and presence of exotic or invasive species that could threaten the integrity of native ecosystems. Forest health assessments also provide a means for comparing the condition of targeted forest stands to regional growth patterns found in other forest stands.

The Great Bay National Wildlife Refuge, established in 1992, is a 1,100+ acre refuge located on the former Pease Air Force Base in Newington, NH. The refuge was established to encourage the natural diversity of plant, fish and wildlife species within the refuge and to provide for their conservation and management; to protect species listed as endangered, threatened or candidate species; to preserve and enhance water quality of aquatic habitat within the refuge; and to fulfill international treaty obligations of the United States relating to fish and wildlife. The refuge contains a diverse set of ecosystem types including tidal, wetlands, and forests. Forests make up approximately 70% (763 acres) of the land area and have been classified into ten separate natural community types. These forested areas are the focus of this forest health assessment.

Methods

Inventory Design

Plot Design: Temporary variable radius plots (BAF 10) were placed on transects throughout the forested areas of GBNWR during the summer and fall 2006. Within each plot, tree measurements (species, diameter at breast height, crown class, stocking level), estimates of tree health, and snag density were recorded. Snags were placed into one of three decay classes. Visual inspections for native and invasive insect species were conducted. Signs or symptoms of bark beetles (Coleoptera: Scolytinae), woodborers (Coleoptera: Cerambycidae, Buprestidae; Hymenoptera: Siricidae), and late season defoliators on trees were recorded. Visual surveys for invasive species including hemlock woolly adelgid (*Adelges tsugae* Annand), Asian longhorned beetle (*Anoplophora glabripennis* Motschulsky), emerald ash borer (*Agrilus planipennis* Fairmaire), and *Sirex noctilio* F. were conducted. Inspections for native and invasive tree pathogens were also completed.

Inventory Stratification: A Natural Communities map created by the New Hampshire Natural Heritage Bureau (Sperduto 2000) was used to stratify the inventory. These natural communities are recurring assemblages of plants found in particular physical environments (Sperduto et al. 2004). Each natural community is distinguished by three characteristics: 1) a definite plant species composition; 2) a consistent physical structure (such as forest, shrubland, or grassland); and 3) a specific set of physical conditions (such as different combinations of nutrients, drainage, and climate conditions). The New Hampshire Natural Heritage inventory identified 763 acres of forest, divided into 10 natural communities (Figure 1). The 10 natural communities identified were:

1) Black gum-red maple basin swamp (not sampled)
2) Dry Appalachian oak-hickory forest
3) Dry-mesic Appalachian oak-hickory forest
4) Forest on fill
5) Low red maple-elm/musclewood/ladyfern silt forest
6) Mesic Appalachian oak-hickory forest
7) Plantation
8) Red maple/sensitive fern-tussock sedge basin/seepage (not sampled)
9) Red pine forest/woodland
10) Seasonally saturated red maple swamp

The assessment consisted of a stratified random sample, utilizing variable radius plots as detailed above. This portion of the assessment was implemented to characterize the forested vegetation, including species and size class distribution, stocking, and volume estimates in the natural communities and to familiarize the authors with Refuge lands. While not all stands were inventoried, we attempted to stratify the sample so that examples of each of the natural communities were represented. The black gum-red maple basin swamp and the red maple/sensitive fern/tussock sedge basin/seepage natural communities were not inventoried due to excessive water levels.

Variables collected on the inventory points:

Species

Diameter at breast height

Timber Product Quality Assessment: Common forest health and general forestry metrics. They are used to gauge the overall quality of the site and growth potential. The amount and quality of the wood products are measures of productivity of the site. They also give insights to the current composition, as well as vertical structure potential.

- Timber quality - A determination if the tallied tree will produce a sawtimber product. AGS means Acceptable Growing Stock for timber - capable of producing sawtimber when it reaches appropriate size, and expected to live at least 15 years; UGS = Unacceptable Growing Stock for timber - not capable of producing sawtimber at any time in future and/or not expected to survive for 15 years.
- Product - An estimate of the highest value product or grade obtained in the tree.
- Sawlog height - The total height of sawtimber products in the tree in feet.

- Pulp height - The portion of the tree above sawtimber height, or if the tree does not contain any sawtimber, the merchantable pulpwood height.

Cavity - Cavity present in main stem or large branches.
- Live/Dead - condition of tree where cavity was found.
- Tree species - tree species if identifiable. Grouped as conifer or hardwood for analysis.

Crown class - The position of the tree crown using these classifications:
- Open grown - a tree that is free of competition and receives light on top and on all sides of the crown as a result of a very heavy thinning or being in an isolated, open-grown position.
- Dominant - a tree with the crown extending above the general level of the main crown canopy and receiving full light from above and partly from the sides.
- Codominant - a tree with a crown forming the general level of the main canopy, receiving full light from above but little from the sides.
- Intermediate - a tree with a crown extending into the lower portions of the main crown canopy, but shorter than the codominants and receiving little direct light from above and none from the sides.
- Suppressed - a tree whose crown is entirely below the general level of the canopy and receives no direct light from either above or the sides.

Crown condition - An estimate of the tree crown's condition based upon the percent of the normal crown relative to total height; often called live crown ratio. Trees with live crowns less than 25% are considered poor condition; between 25% and 50% in fair condition; and in good condition if they have more than 50% live crown.

Snags: An estimate of forest structure and potential wildlife habitat. Snags were classified based on the following groups slightly modified from Bull et al. 1997:
- Class I – recently dead tree, fine branches often present, bark tight on tree, with little decay present.
- Class II – Bark loose or falling off of bole and branches, fine branches absent, larger limbs decaying or falling, decay in bole present.
- Class III – Small and large branches absent, most bark gone, in advanced stages of decay.

The inventory data was collected electronically using NEDLite (Knopp and Twery, 2006). Data was processed, and stand reports generated using NED-1 software (Simpson et al, 1995).

Results

A total of 61 stands were mapped on the original natural community map that consisted of ten forest community types (Figure 1). Of the 61 forest stands, 18 were inventoried (29.5%) for a total of 399.7 acres of the 763 acres of forested covertype (52.4%).

Figure 1. Natural Communities of Great Bay National Wildlife Refuge based on Sperduto (2000).

Great Bay National Wildlife Refuge has a diverse forested habitat given its relatively small area. Twenty four overstory species were inventoried. The overstory species are dominated by northern red oak (17.6% of trees per acre), eastern white pine (16.5%), red maple (16.4%), shagbark hickory (12.8%), and black cherry (16.8%). Nineteen tree species account for the remaining 20% of stems per acre.

Most of the stands inventoried are overstocked, larger diameter stands (Table 1). This forest condition is common for stands that have had no active management for a long period of time. The distribution of size classes is not balanced, meaning that some size classes are under or over-represented.

An overstocked condition in a forest has several complicating factors. Stands that are overstocked tend to be less vigorous with too many trees competing for the limited resources present at a site. Less vigorous trees are more susceptible to primary and secondary pests, which further weaken and may kill trees. Overstocked stands often lack adequate regeneration in the understory. For species that are moderate to intolerant to shade, including paper birch, quaking aspen, and sweet birch that are present on GBNWR, the lack of sunlight in overstocked stands

creates an unbalanced age class distribution that could ultimately lead to the loss of these species in future stands.

Table 1. Characteristics of forest stands surveyed on Great Bay National Wildlife Refuge.

Natural Community	Stand Area	Forest Type	Size Class	Medial DBH	Canopy Closure (%)	Relative Density	Basal Area
Black gum-red maple basin swamp	14.4	**Not Sampled**					
Dry Appalachian oak-hickory forest	80.5	Other Hardwood	Small Sawtimber	12.36	93	116.7	140.0
Dry-mesic Appalachian oak-hickory forest	146.8	Other Hardwood	Small Sawtimber	16.34	97	109.9	153.3
Forest on Fill	12.5	Allegheny Hardwood	Small Sawtimber	16.04	63	62.9	115.0
Low red maple-elm/musclewood/ladyfern silt forest	69.2	Pine Hardwoods	Small Sawtimber	13.80	75	78.2	125.0
Mesic Appalachian oak-hickory forest	357.6	Other Mixedwood	Small Sawtimber	15.90	93	109.8	165.6
Plantation	25.4	Pine	Pole	8.78	80	90.1	156.0
Red maple/sensitive fern-tussock sedge basin/seepage	10.7	**Not Sampled**					
Red pine forest/woodland	7.7	Red Pine	Large Sawtimber	16.84	84	86.0	190.0
Seasonally saturated red maple swamp	38.2	Oak	Large Sawtimber	17.22	89	88.6	115.0

A measure of size class distribution is the *q* factor. The *q* factor is the ratio of numbers of trees between successive diameter classes. A *q* of 1.3 means that there are 1.3 times as many 10 inch trees as 11 inch trees, and that there are similar ratios between the other diameter classes. The range of *q* factors at the refuge were 1.14-1.26, with most below 1.2. In northeastern forest types, *q* factors between 1.3 and 1.8 (for 2 inch diameter classes) are frequently recommended for timber management. Values below 1.3 could be useful for wildlife and visual goals and are common on the refuge. At a low *q*, large trees occupy a relatively large proportion of the growing space. Consequently, regeneration is often limited in these stands as available resources are used by the dominant trees. Attempts to maintain a very low *q* may not be sustainable and future stands of similar types may be jeopardized. If current forest and stand conditions are considered the desired future condition, active management with long-term goals geared towards maintaining given forest types should be considered.

Cavity trees are vitally important to many types of wildlife; they provide nesting, roosting, and denning sites for approximately 25% of the wildlife species in the Northeast, including birds, mammals, reptiles, and amphibians (DeGraaf and Shigo 1985). Presence of cavities were tallied for live and dead trees, and are summarized in Table 2. Except for the red pine forest/woodland natural community, most of the cavities were in hardwood species, with a mixture of live and dead cavities. No cavities were recorded in the forest on fill, low red maple-elm/musclewood/ladyfern silt forest, or the plantation natural communities.

Snags were a common occurrence on GBNWR and occurred in all natural community types surveyed (Table 3). Class II snags were the most common and accounted for 61.6% of all snags. Class I (26.8%) and Class III (11.6%) were less frequently encountered. Snags are an important component of a healthy forest ecosystem and are used by a variety of invertebrates, vertebrates, and other organisms as habitat.

A summary of data collected for each natural community surveyed, including a description of the natural community, overstory narrative, and a timber narrative are included on pages 12 to 30.

Table 2. Description of tree cavities for the natural communities found on Great Bay National Wildlife Refuge.

Stand	Total # Cavities per Acre	Cavities in Live Trees	Cavities in Dead Trees	Cavities in Conifer Trees	Cavities in Hardwood Trees
Black gum-red maple basin swamp	**Not Sampled**				
Dry Appalachian oak-hickory forest	16.3	1.1	15.2	6.1	10.2
Dry-mesic Appalachian oak-hickory forest	5.1	0.3	4.8	0	5.1
Forest on Fill	0	0	0	0	0
Low red maple-elm/musclewood/ladyfern silt forest	0	0	0	0	0
Mesic Appalachian oak-hickory forest	3.1	2.7	0.4	0.3	2.8
Plantation	0	0	0	0	0
Red maple/sensitive fern-tussock sedge basin/seepage	**Not Sampled**				
Red pine forest/woodland	18.3	13.4	4.9	17.7	0.6
Seasonally saturated red maple swamp	23.5	23.5	0	0	23.5

Table 3 Snags by decay class for the natural communities found on Great Bay National Wildlife Refuge. See text for description of decay classes.

Stand Number	Snags per acre			
	Class I	Class II	Class III	Total
Black gum-red maple basin swamp	**Not Sampled**			
Dry Appalachian oak-hickory forest	0	12	19	31
Dry-mesic Appalachian oak-hickory forest	0	25	10	35
Forest on Fill	0	5	0	5
Low red maple-elm/musclewood/ladyfern silt forest	60	57	1	118
Mesic Appalachian oak-hickory forest	10	13	10	33
Plantation	34	127	0	161
Red maple/sensitive fern-tussock sedge basin/seepage	**Not Sampled**			
Red pine forest/woodland	0	0	2	2
Seasonally saturated red maple swamp	0	0	3	3

Insect & Disease Surveys

Visual surveys for non-native insects were conducted on the inventory plots as well as on transects through the stands. Introduced insects of concern are the hemlock woolly adelgid, Asian longhorned beetle, emerald ash borer, and *Sirex noctilio*. These invasive species have been found in North America and several have caused serious economic and ecological impacts. While no evidence was found for these species during our initial survey period, in July 2007, two red pine were located in NHI point 67 that showed characteristics similar to trees attacked by *S. noctilio*. With permission from GBNWR, we removed one of these suspect trees, dissected the bole, and found no sign of *S. noctilio* larvae or adults in the wood. Because *S. noctilio* often attacks trees but does not oviposit, we have placed four semiochemical-baited traps within the stand to survey for presence of adult woodwasps. Results from this survey will be complete by December, 2007.

Native insects, including bark beetles and fall webworm were found on GBNWR. *Ips* spp. are bark beetles usually considered secondary species, but occasionally kill living trees when populations are epidemic. On GBNWR, *Ips* were found attacking severely suppressed red pine in one stand (NHI point 67). Codominant trees showed no sign of attack and likely will not be impacted by this beetle unless epidemic populations build in the surrounding area. However, given the small amount of pine in poor condition on the Refuge, it is unlikely *Ips* will become a primary tree killer. Another bark beetle, the Columbian timber beetle (*Corthylus columbianus* Hopkins), was found attacking mature red maple on GBNWR (NHI point 137). This ambrosia beetle attacks apparently healthy trees, but has little direct effect on tree health. Attacked trees are capable of tolerating the insect damage, but adult entrance holes often become inoculation points for other wood decay fungi. Wood products may be affected, but because high-value timber production is not the goal of GBNWR there should be no concern for the presence of this insect. Fall webworm, *Hyphantria cunea* (Drury), was noted on hardwoods, but populations of this insect rarely cause tree mortality.

Visual surveys for forest diseases were conducted as well. While lab confirmation was not possible, white pine showing symptoms of Caliciopsis pine canker, *Caliciopsis pinea* (Peck) infection were found in one stand (NHI point 157). This canker is thought to be a weak perennial fungus which attacks thin barked areas of the branch and bole, and while tree mortality is usually low, increased crown transparency and reduced crown density suggests tree vigor is being reduced by heavy infections of this disease. The canker was found in an overstocked pine stand, which is also a candidate for another pine pathogen, white pine blister rust, *Cronartium ribicola* (Fisch).

While not currently found on GBNWR, a pathogen threat to continue to monitor for is ash yellows. Ash yellows is caused by mycoplasmalike organisms that invade the vascular system of infected trees. Reported in New Hampshire and northeastern Massachusetts, this pathogen is a major threat to the ash resource. Symptoms include poor growth, reduced vigor, and premature mortality of infected trees. In severe cases, complete loss of the ash component of a stand can occur.

Management Recommendations

There are several conifer plantations (red and white pine, white fir) that are overstocked. These plantations would benefit from a thinning to reduce the density and increase the vigor of the stands. They are currently stagnating, with evidence of decline agents present (Caliciopsis pine canker, *Ips* beetles). With no intervention, these stands will continue to decline and break up, with competing hardwoods eventually overtaking the site. This would eliminate the pure conifer component from the landscape. There are several silvicultural prescription options available, dependent upon the habitat goals of the refuge.

Many of the stands at GBNWR are mature, with low *q* factor values, or an uneven distribution of tree sizes. One simple management regime to address this would be to create wildlife openings in some of these stands. This technique will increase the range of vertical structure, as well as create conditions that favor more shade intolerant species. Small openings in several of these stands would create more habitat heterogeneity and diversify the habitat for species that favor early successional habitats. One factor to consider in opening up canopies is increased browse availability for deer. Deer browsing can influence future forest conditions by altering tree species composition, understory plant species richness, and abundance/distribution of invasive plant species (Augustine and Frelich 1998, Horsley et al. 2003, Rossell et al. 2007).

Mature stands create challenges to any recreation opportunities. With active recreation (i.e., hiking trails) traversing these types of stands, hazard tree management becomes an important issue. Older, unmanaged stands tend to have higher rates of failure on tree limbs with latent defects. If not previously undertaken, we recommend a hazard tree survey be completed in the high activity areas (e.g., parking areas and trail corridors). This survey may help prevent an incident, as well as lay the foundation for management of risk to the public.

Natural Community Summary Overview

The following natural community summaries include basic metrics of the stand, a description of the natural community (taken from Sperduto 2004), and an overstory summary narrative. Many of the metrics and terminology in the overstory narrative are timber management oriented. They are presented here for use in comparison with other forested stands in northeastern forests. They can be used to forecast future conditions in these stands, and model ecological development. The types of habitats and vertical structure required for species of importance to the Refuge can be planned for and developed using these metrics.

The effective age of the natural community is computed using species specific growth factors related to size (diameter) of the tree at the time of inventory. An adjusted median age is calculated.

Acceptable growing stock are trees capable of producing sawtimber when it reaches appropriate size, whereas unacceptable growing stock is considered incapable of producing sawtimber at any time in future because of species, growth form, or current vigor.

Black gum-red maple basin swamp

Identification and Location
Stand ID: 1
Compartment: Black gum-red maple basin swamp
Date of inventory: **Not sampled**

Measures
Area: 14.4 ac

Natural Community Description

Black gum - red maple basin swamps are very similar in vegetation, soils, and hydrology to red maple - *Sphagnum* basin swamps. A principal distinction between these communities is the codominance of black gum with red maple in the canopy of black gum - red maple basin swamps. These swamps typically occur in perched upland till basins with watersheds smaller than one square mile. Species typical of acidic, relatively stagnant conditions are prevalent, but these swamps are highly variable in structure and composition ranging from forest (greater than 65% tree cover) to sparse woodland (10-25% tree cover). The shrub layer density increases in woodland and sparse woodland examples. Historical logging activities may also have influenced the structure and composition of some examples, and additional research on stand history is needed to clarify the relationships between land use history and current vegetation. Soils are typically acidic, nutrient-poor, very poorly drained Histosols (deep peat or muck) or poorly to very poorly drained mineral soils with histic epipedons. Peat is well decomposed near the surface, and pHs average approximately 4.4 (range: 3.7–5.3). Hummocks are well developed and average approximately 0.4 m high. There is little evidence of seepage or surface water flow in black gum swamps. Examples in lakeside settings may be influenced somewhat by surface flow, but water sources are generally restricted to precipitation, seasonal runoff or subsurface flow from surrounding uplands. Many of these swamps have stagnant outlet streams but no perennial inlets or streams running through them; others have neither inlets nor outlets.

Dry Appalachian oak-hickory forest

Identification and Location
Stand ID: 2
Compartment: Dry Appalachian oak-hickory forest
Date of inventory: 8/16/2006

Measures
Area: 80.5 ac
Plot count: 5
Number of plot size classes: 2
Trees per acre: 736.36 #/ac
Basal area: 140.0 sq ft/ac
Relative density: 116.7 pct.
Canopy closure: 93%

Stand Characteristics
Forest type: other hardwoods
Forest type for prescription: other

Natural Community Description

These oak - hickory and oak forests occur in southern and south-central New Hampshire and are characterized by southern species that reach the northern extent of their ranges in this region. It is distinguished from dry red oak - white pine forests, which tend to lack significant representation of southern or Appalachian species. The ability of many oak species to root or stump sprout contributes to their perpetuation under regular fire regimes or harvests. Oak forests appear to be fire-dependant over long periods in other regions of the country. Some of these forests may succeed to other overstory species in time due to lack of adequate red oak regeneration, and from increases in beech on drier sites and sugar maple and beech on more mesic sites. Repeated fire would tend to knock back fire-sensitive species like beech and sugar maple. As such, any natural, semi-natural, and/or controlled fire regimes may be necessary for the long-term maintenance of oak and hickory on some sites. These forests are typically found on middle and upper slopes of low hills with acidic, well to excessively drained soils of low available nutrient status (oligotrophic). They are also common on slopes with south or west aspects. Known or potential soil series include Hollis, Shapleigh, Brimfield, Charlton, Canton, and perhaps Paxton soils.

Overstory Summary Narrative

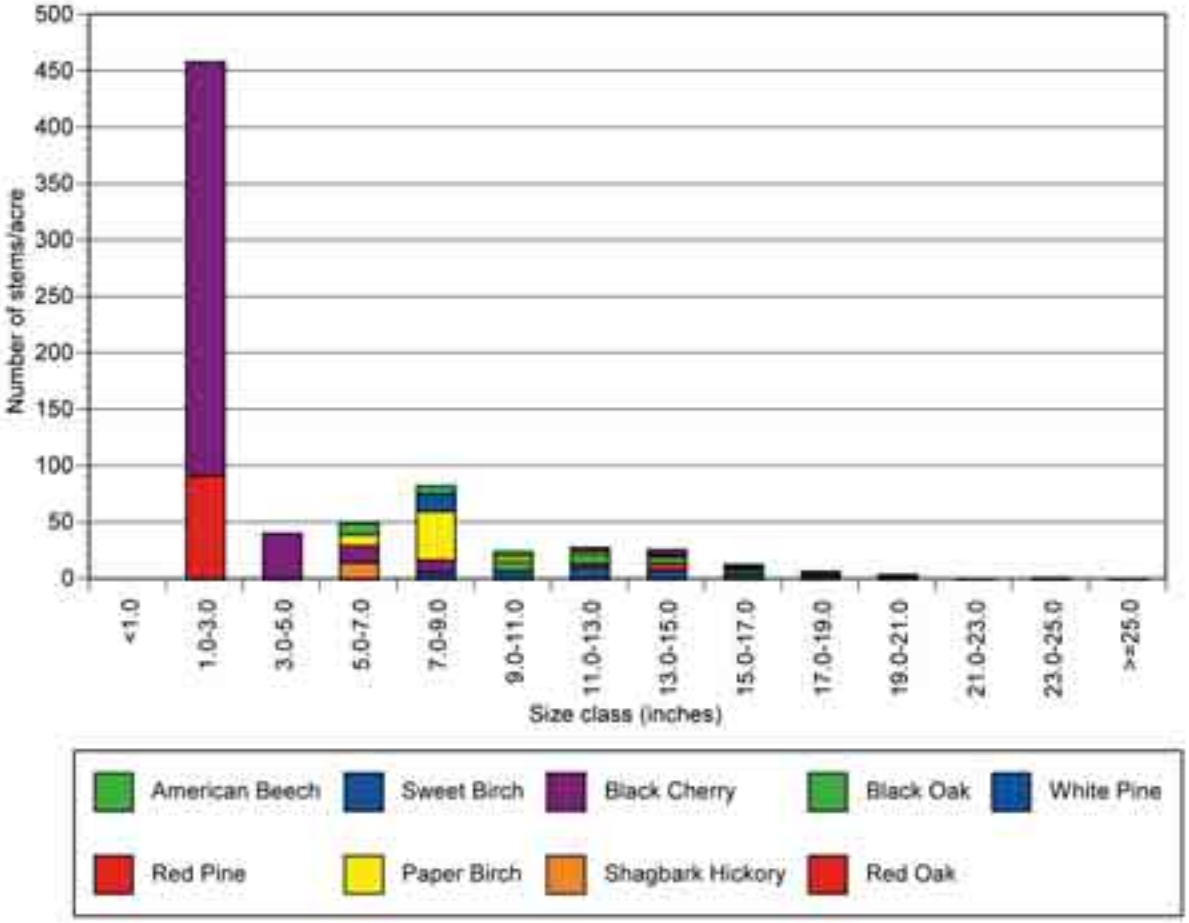
This dry Appalachian oak – hickory forest is currently considered mature and has a diverse group of tree species present. Effective stand age was estimated at 101 years. Species distribution by basal area was: eastern white pine (30%), northern red oak (14%), paper birch (14%), black oak (14%), black cherry (10%), American beech (6%), shagbark hickory (6%), sweet birch (4%), and red pine (1%).

In a timber management setting, this natural community would be considered small sawtimber having a medial stand diameter of 12.36 in. Relative stand density was 116.7 percent of the average maximum stocking expected in undisturbed stands of similar size and species. This

density is well above the optimum for best individual tree growth. At this relative density, growth rate of the biggest trees is probably moderate, while growth of medium and smaller-sized trees is probably fair, and mortality due to crowding moderate. Mortality due to crowding will add important structure to the stand.

The growing stock amounted to 114.0 sq ft/ac. Gross total volume in all trees to a 4 inch top was 2898.2 cu.ft/ac. There were 736 trees/ac in this stand. The basal area of acceptable growing stock was 114.0, while unacceptable growing stock represented 26.0 sq ft/ac of basal area. Acceptable growing stock represented 80.1 of the relative density, while unacceptable growing stock represented 36.7 of the relative density. The *q* factor for this stand was 1.25.

The mean diameter of this dry Appalachian oak-hickory forest was 3.94. The quadratic mean diameter was 5.90. The net board foot volume of this stand was 10,209 bd.ft/ac and 24% of the basal area were considered of high value. Trees of acceptable quality for future growing stock provide a fully stocked stand by themselves.



Dry-mesic Appalachian oak-hickory forest

Identification and Location
Stand ID: 3
Compartment: Dry-mesic Appalachian oak-hickory forest
Date of inventory: 9/21/2006

Measures
Area: 146.8 ac
Plot count: 6
Number of plot size classes: 2
Trees per acre: 344.94 #/ac
Basal area: 153.3 sq ft/ac
Relative density: 109.9 pct.
Canopy closure: 97%

Stand Characteristics
Forest type: other hardwoods
Size class: small sawtimber

Natural Community Description

This community occurs on dry-mesic sites in coastal and southern New Hampshire and is characterized by a broad diversity of trees, including Appalachian (central hardwood) oaks, hickories, white pine, and transitional hardwood trees. The shrub and herb layers are sparse to moderately well developed. Heaths and other dry site understory plants are absent or in low abundance, as are species characteristic of more northern forests, such as sugar maple, yellow birch, and wood ferns (*Dryopteris* spp.). Soils range from well drained sandy to very fine sandy loams (such as Eldridge, Chatfield-Hollis, and Pennichuck series) on gentle to moderate slopes.

Overstory Summary Narrative

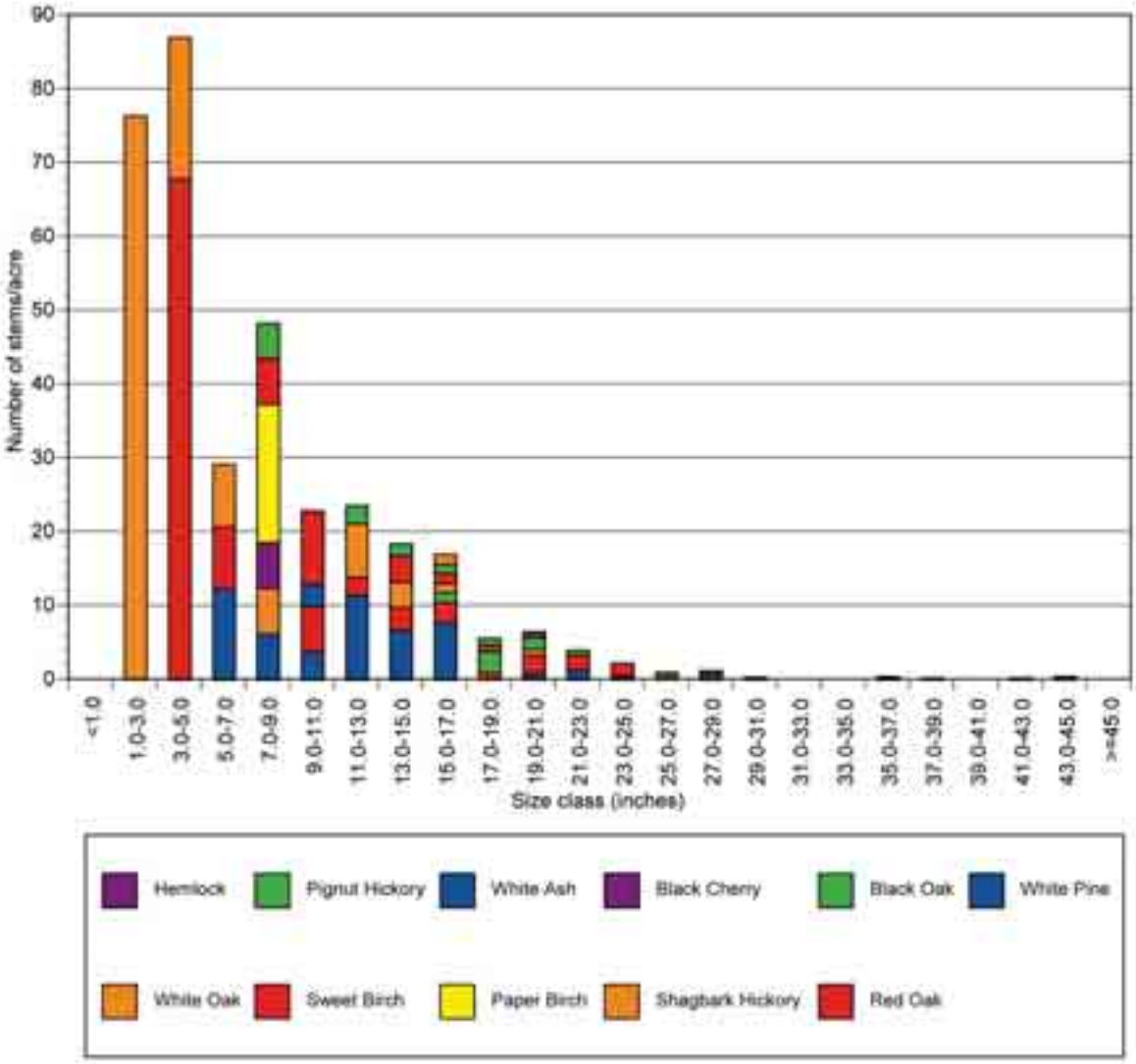
This dry-mesic Appalachian oak – hickory is currently considered mature. Effective stand age was estimated to be 158 years. There were eleven tree species present in the stand, with the following species distribution by basal area: eastern white pine (29%), northern red oak (25%), shagbark hickory (13%), pignut hickory (10%), sweet birch (9%), black oak (5%), paper birch (3%), white ash (2%), black cherry (1%), white oak (1%), and eastern hemlock (1%).

In a timber management setting, this natural community would be considered small sawtimber, having a medial stand diameter of 16.34 in. Relative stand density was 109.9 percent of the average maximum stocking expected in undisturbed stands of similar size and species. This density is well above the optimum for best individual tree growth. At this relative density, growth rate of the biggest trees is probably moderate, while growth of medium and smaller-sized trees is probably fair, and mortality due to crowding moderate. If this natural community is managed under an even-age silvicultural system, the several species groups will mature at about the same time.

The growing stock amounted to 138.3 sq ft/ac. Gross total volume in all trees to a 4 inch top was 3049.6 cu.ft/ac. There were 345 trees/ac in this stand. The basal area of acceptable growing

stock was 138.3, while unacceptable growing stock represented 15.0 sq ft/ac of basal area. Acceptable growing stock represented 101.7 of the relative density, while unacceptable growing stock represented 8.2 of the relative density. The *q* factor for this stand was 1.15.

The mean diameter of this dry-mesic Appalachian oak-hickory forest was 7.01. The quadratic mean diameter was 9.03. The net board foot volume of this stand was 10,245 bd.ft/ac and 27% of the basal area in this stand were considered of high value. Trees of acceptable quality for future growing stock provide a fully stocked stand by themselves.



Forest on Fill

Identification and Location
Stand ID: 4
Compartment: Forest on fill
Date of inventory: 9/22/2006

Measures
Area: 12.5 ac
Plot count: 2
Number of plot size classes: 1
Trees per acre: 139.36 #/ac
Basal area: 115.0 sq ft/ac
Relative density: 62.9 pct.
Canopy closure: 63%

Stand Characteristics
Forest type: Allegheny hardwoods
Size class: small sawtimber

Natural Community Description

This community is highly variable, existing on extremely disturbed sites. Species typically are planted varieties, recruited from neighboring stands, or introduced invasive and pioneer. Physical characteristics of nutrient cycles and drainage may have been altered during the disturbance, rendering the community different from its original as well as neighboring communities.

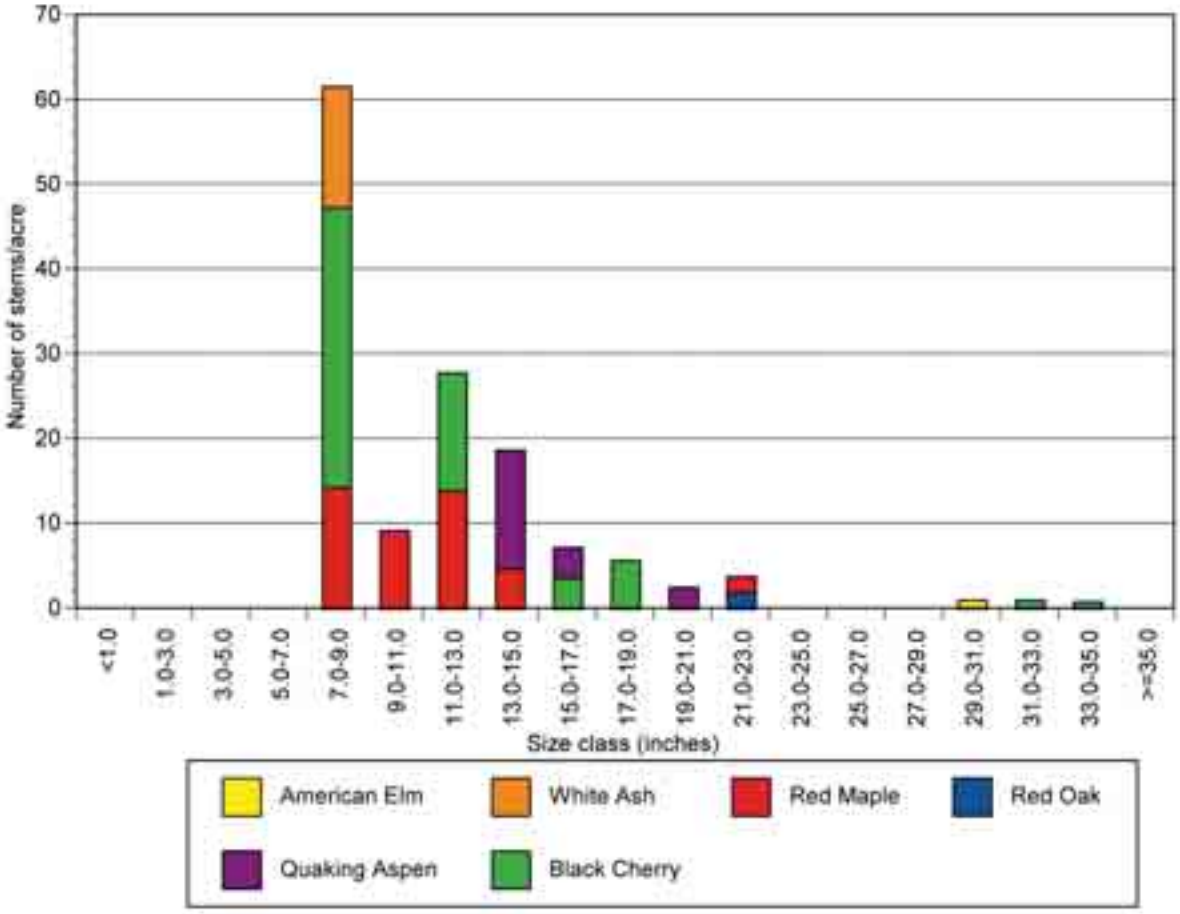
Overstory Summary Narrative

This Allegheny hardwoods stand is currently considered mature. Effective stand age was estimated to be 125 years. There were six tree species present in the stand with the following species distribution by basal area: black cherry (39%), red maple (26%), quaking aspen (22%), northern red oak (4%), white ash (4%), and American elm (4%).

In a timber management setting, this natural community would be considered small sawtimber having a medial stand diameter of 16.04 in. Relative stand density was 62.9 percent of the average maximum stocking expected in undisturbed stands of similar size and species. This density is in the optimum range for optimal individual tree growth. At this relative density, growth rate of the biggest trees is probably excellent, while growth rate of medium and smaller-sized trees is probably good and mortality due to crowding low.

The growing stock amounted to 95.0 sq ft/ac. Gross total volume in all trees to a 4 inch top was 2535.0 cu.ft/ac. There were 139 trees/ac in this stand. The basal area of acceptable growing stock was 95.0, while unacceptable growing stock represented 20.0 sq ft/ac of basal area. Acceptable growing stock represented 50.2 of the relative density, while unacceptable growing stock represented 12.7 of the relative density. The overall stand relative density was 62.9. The *q* factor for this stand was 1.14.

The mean diameter of this forest on fill forest was 11.36. The quadratic mean diameter was 12.30. The net board foot volume of this stand was 6882 bd.ft/ac and 43% of the basal area in this stand were considered of high value. Trees of acceptable quality for future growing stock are inadequate to provide a fully stocked stand in themselves.



Low red maple-elm/musclewood/ladyfern silt forest

Identification and Location
Stand ID: 5
Compartment: Low red maple-elm/musclewood/ladyfern silt forest
Date of inventory: 05/23/2007

Measures
Area: 69.2 ac
Plot count: 4
Number of plot size classes: 3
Trees per acre: 422.81 #/ac
Basal area: 125.0 sq ft/ac
Relative density: 78.2 pct.
Canopy closure: 75%

Stand Characteristics
Forest type: pine hardwoods
Size class: small sawtimber

Natural Community Description

This forest type is intermediate between upland and wetland communities. It has a seasonally high water table and silt soils with a high water holding capacity and intermediate nutrient status. The vegetation consists of a moderately diverse combination of upland, moist-site forest species and facultative wetland species. The woody and herbaceous understories are sparse to moderately well developed. Unlike most swamps, there is very little or no organic soil horizon or hummock-hollow microtopography development. Soils are somewhat poorly drained silt loams with a seasonally high water table, high moisture holding capacity due to the silt content, and moderate base-cation status judging from species composition and silty soils. Soil types include some Buxton and Scitico silt loams (of marine origin), among other soils. There is typically no or a very shallow O horizon (<2 cm), very dark gray-black silt loam A horizon, and olive gray silt loam B horizon with redoxymorphic features (mottles) found near the transition to the B horizon. One example has a distinct plow layer, although others have a more distinct horizon development and have not been plowed. This community is similar in some respects to somewhat poorly drained floodplains forests and seepage forests, but are not flooded and do not have mucky organic horizons. It is also similar to hemlock – cinnamon fern and red maple - red oak - cinnamon fern forests in terms of drainage class.

Overstory Summary Narrative

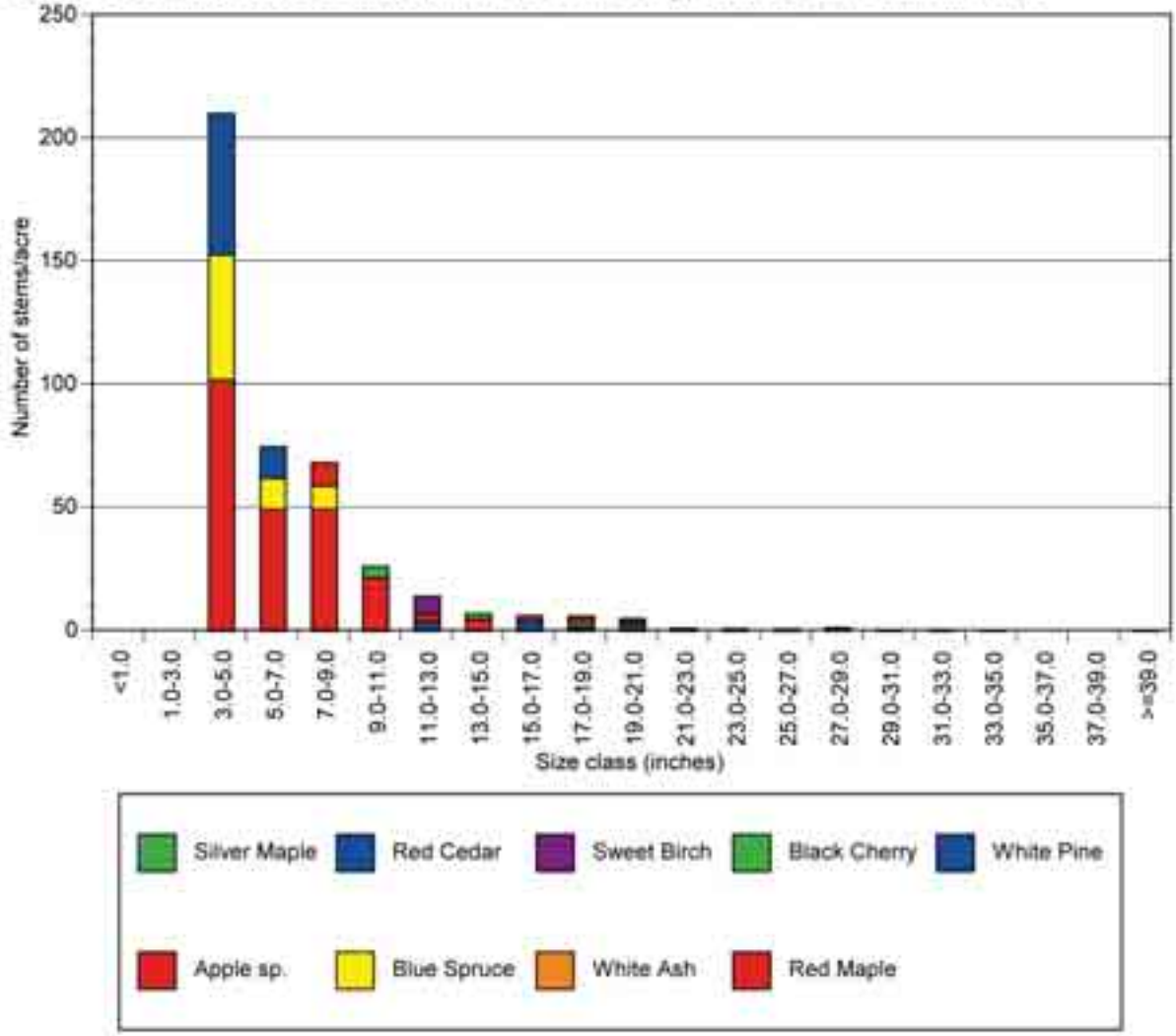
This pine hardwoods stand is currently considered mature. Effective stand age was estimated at 156 years. Nine tree species were present in the stand with the following species distribution by basal area: red maple (40%), eastern white pine (28%), black cherry (6%), blue spruce (6%), redcedar (6%), apple sp. (6%), sweet birch (4%), white ash (2%), and silver maple (2%).

In a timber management setting, this natural community would be considered small sawtimber stand, having a medial stand diameter of 13.80 in. Relative stand density was 78.2 percent of the average maximum stocking expected in undisturbed stands of similar size and species. This

density is in the optimum range for best individual tree growth. At this relative density, growth rate of the biggest trees is probably excellent, while growth rate of medium and smaller-sized trees is probably good and mortality due to crowding low.

The growing stock amounted to 87.5 sq ft/ac. Gross total volume in all trees to a 4 inch top was 2133.9 cu.ft/ac. There were 423 trees/ac in this stand. The basal area of acceptable growing stock was 87.5, while unacceptable growing stock represented 37.5 sq ft/ac of basal area. Acceptable growing stock represented 56.2 of the relative density, while unacceptable growing stock represented 22.1 of the relative density. The *q* factor for this stand was 1.19.

The mean diameter of this low red maple-elm/musclewood/ladyfern silt forest was 6.01. The quadratic mean diameter was 7.36. The net board foot volume of this stand was 5760 bd.ft/ac and 6% of the basal area in this stand were considered of high value. Trees of acceptable quality for future growing stock are inadequate to provide a fully stocked stand in themselves.



Mesic Appalachian oak-hickory forest

Identification and Location
Stand ID: 6
Compartment: Mesic Appalachian oak-hickory forest
Date of inventory: 8/17/2006

Measures
Area: 357.6 ac
Plot count: 9
Number of plot size classes: 2
Trees per acre: 234.98 #/ac
Basal area: 165.6 sq ft/ac
Relative density: 109.8 pct.
Canopy closure: 93%

Stand Characteristics
Forest type: other mixedwoods
Size class: small sawtimber

Natural Community Description

This community occurs on mesic sites in coastal and southern New Hampshire and is characterized by a broad diversity of trees, including Appalachian (central hardwood) oaks, hickories, white pine, and transitional hardwood trees. The shrub and herb layers are sparse to moderately well developed. Heaths and other dry site understory plants are absent or in low abundance, as are species characteristic of more northern forests, such as sugar maple, yellow birch, and wood ferns (*Dryopteris* spp.). Soils range from well drained sandy to very fine sandy loams (such as Eldridge, Chatfield-Hollis, and Pennichuck series) and moderately well drained silt loams (such as Scitico and Boxford silt loams) on gentle to moderate slopes. The moisture regime of sandy loams tends to be dry-mesic and the silt loams tend to be mesic.

Overstory Summary Narrative

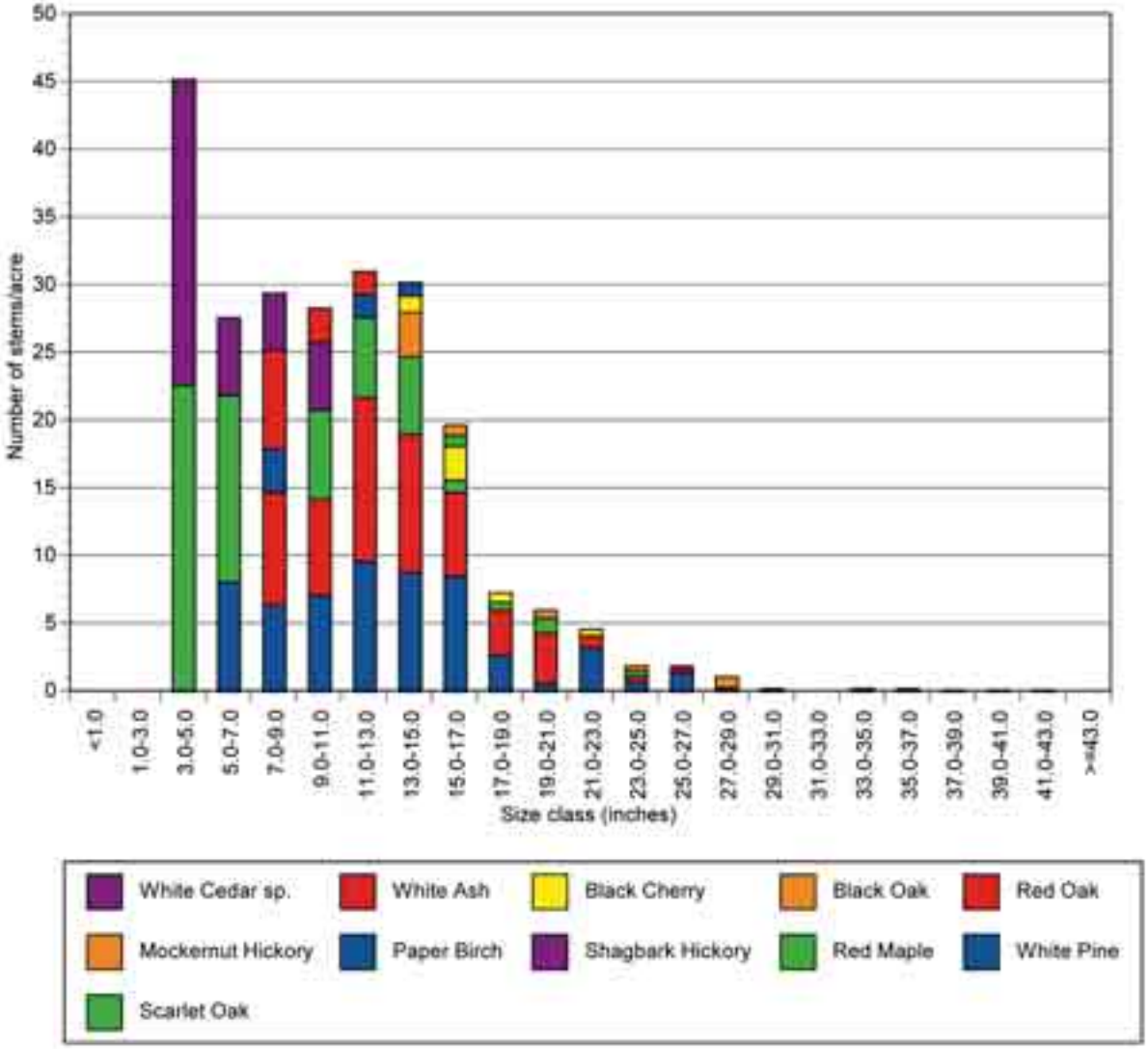
This mesic Appalachian oak-hickory forest is currently considered mature. Effective stand age was estimated at 131 years. There were 11 tree species present in the stand with the following species distribution by basal area: eastern white pine (34%), northern red oak (32%), red maple (14%), black oak (6%), black cherry (4%), shagbark hickory (3%), white ash (3%), paper birch (2%), scarlet oak (1%), mockernut hickory (1%), and white-cedar sp. (1%).

In a timber management setting this natural community would be considered a sawtimber stand, with a medial stand diameter of 15.90 in. Relative stand density was 109.8 percent of the average maximum stocking expected in undisturbed stands of similar size and species. This density is well above the optimum for best individual tree growth. At this relative density, growth rate of the biggest trees is probably moderate, while growth of medium and smaller-sized trees is probably fair, and mortality due to crowding moderate.

The growing stock amounted to 137.8 sq ft/ac. Gross total volume in all trees to a 4 inch top was 3606.4 cu.ft/ac. There were 235 trees/ac in this stand. The basal area of acceptable growing

stock was 137.8, while unacceptable growing stock represented 27.8 sq ft/ac of basal area. Acceptable growing stock represented 93.0 of the relative density, while unacceptable growing stock represented 16.7 of the relative density. The *q* factor for this stand was 1.18.

The mean diameter of this mesic Appalachian oak-hickory forest was 9.90. The quadratic mean diameter was 11.37. The net board foot volume of this stand was 13,882 bd.ft/ac and 36% of the basal area in this stand were considered of high value. Trees of acceptable quality for future growing stock provide a fully stocked stand by themselves.



Plantation

Identification and Location
Stand ID: 7
Compartment: Plantation
Date of inventory: 9/19/2006

Measures
Area: 25.4 ac
Plot count: 5
Number of plot size classes: 2
Trees per acre: 467.51 #/ac
Basal area: 156.0 sq ft/ac
Relative density: 90.1 pct.
Canopy closure: 80%

Stand Characteristics
Forest type: pine
Size class: pole

Natural Community Description

This forest type is an artificial community, planted typically in a monoculture and mainly of conifer species. They are often planted in rows, adding to the artificial appearance. Plantations are typically used in production forests, where maximum wood fiber is the objective, or in watershed protection.

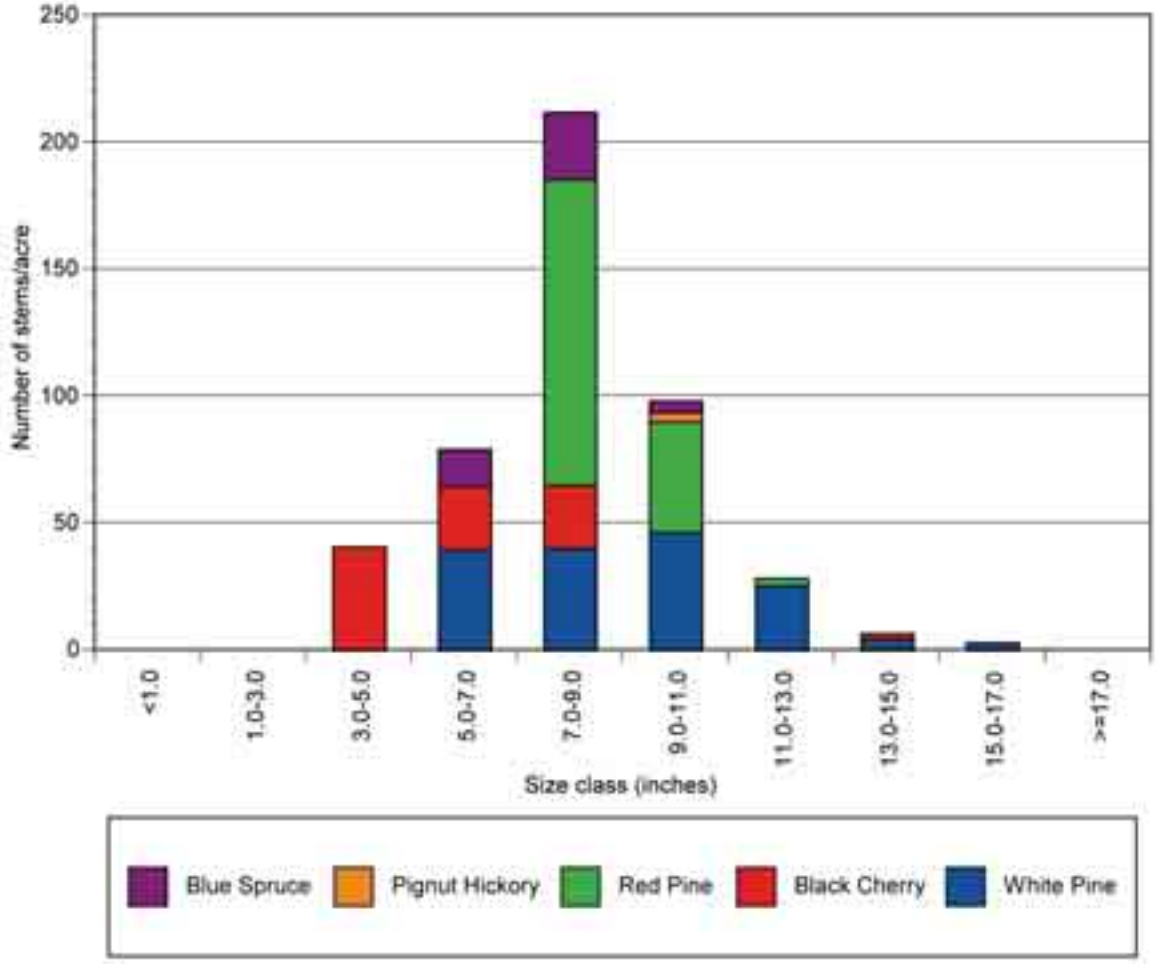
Overstory Summary Narrative

This pine plantation is currently considered mature. Effective stand age was estimated at 66 years. There were five tree species present in the stand with the following species distribution by basal area: eastern white pine (44%), red pine (37%), black cherry (10%), blue spruce (8%), and pignut hickory (1%).

In a timber management setting this natural community would be considered a pole stand, with a medial stand diameter of 8.78 in. Relative stand density was 90.1 percent of the average maximum stocking expected in undisturbed stands of similar size and species. This density is higher than optimum for best individual tree growth. At this relative density, growth rate of the biggest trees is probably moderate, while growth of medium and smaller-sized trees is probably fair, and mortality due to crowding moderate.

The growing stock amounted to 128.0 sq ft/ac. Gross total volume in all trees to a 4 inch top is 2338.0 cu.ft/ac. There were 468 trees/ac in this stand. The basal area of acceptable growing stock was 128.0, while unacceptable growing stock represented 28.0 sq ft/ac of basal area. Acceptable growing stock represented 71.4 of the relative density, while unacceptable growing stock represented 18.6 of the relative density. The overall stand relative density was 90.1. The *q* factor for this stand was 1.26.

The mean diameter of this pine plantation was 7.48. The quadratic mean diameter was 7.82. The net board foot volume of this stand was 2086 bd.ft/ac and 10% of the basal area in this stand were considered of high value. Trees of acceptable quality for future growing stock are inadequate to provide a fully stocked stand in themselves.



Red maple/sensitive fern-tussock sedge basin/seepage

Identification and Location
Stand ID: 8
Compartment: Red maple/sensitive fern-tussock sedge basin/seepage
Date of inventory: **Not sampled**

Measures
Area: 10.7 ac
Plot count: 0
Number of plot size classes: 0

Natural Community Description

This is a common type of red maple swamp characterized by a diverse assemblage of herbaceous species, relatively little *Sphagnum* moss, and saturated or seasonally saturated to seasonally flooded soils. The swamps may be small or very large (10-100 acres) and typically occupy headwater basins that give rise to drainages or along drainages where seepage or non-channelized upland runoff contributes to the water budget. It lacks seasonal flooding from over-bank flooding (typical of seasonally flooded red maple swamps) and is more minerotrophic than red maple - Sphagnum basin swamps. *Onoclea sensibilis* (sensitive fern) is a good indicator of minerotrophic conditions in this type. Subsurface groundwater discharge is likely in at least some of these swamps. These swamps are often found with other swamp communities in a larger mosaic.

Red pine forest/woodland

Identification and Location
Stand ID: 9
Compartment: Red pine forest/woodland
Date of inventory: 8/16/2006

Measures
Area: 7.7 ac
Plot count: 3
Number of plot size classes: 1
Trees per acre: 139.51 #/ac
Basal area: 190.0 sq ft/ac
Relative density: 86.0 pct.
Canopy closure: 84%

Stand Characteristics
Forest type: red pine
Size class: large sawtimber

Natural Community Description

Red pine dominated forests and woodlands are most prominent on dry, montane rocky ridges, outcrops, and summits where acidic, nutrient-poor conditions prevail. Red pine stands are often evenaged and have park-like understories with a low heath shrub layer. Even-aged cohorts typically develop following an intense fire. This community is most common on southerly aspects, ranging from west to south to east, between 750-2700 ft. elevation. Typical examples consist of mosaics of open or partially vegetated rock outcrops interspersed with a scattered or patchy tree canopy. Rock exposures generally cover 25-50% of the ground surface. In some areas, particularly those with deeper soils or ones that have only a distant fire-history, red pine may form an essentially closed canopy. Red pine trees may exceed 60-70 ft (18-21 m) in height, but are, on average, shorter in woodland settings and at higher elevations. A closed forest canopy may form in the absence of fire for long periods or where soils are more well developed. Shade-intolerant species tend to be less abundant or absent in forested examples [e.g., *Corydalis sempervirens* (pale corydalis), *Potentilla tridentata* (three-toothed cinquefoil), *Deschampsia flexuosa* (common hair-grass), and *Danthonia spicata* (poverty oat-grass)]. Fire plays an important role in the formation and maintenance of this community, and controlled burns or wildfire may be required for substantial regeneration of red pine, whether or not harvesting is performed. Red pine can exceed 200 years of age, and its thick, platy bark affords mature trees some protection from fire when trees reach about 70 years of age. Younger trees have thinner bark and may not survive an intense fire. Several native red pine forests occur in central New Hampshire on deep sandy kame terraces with very little bedrock exposure. These are classified as red pine - white pine - balsam fir forests. Red pine is less frequent in sand plain settings relative to montane outcrops. Although individual red pine trees may be found in southern New Hampshire, native stands are rare or absent. Some outcrops in other landscape positions, such as along rocky lake shores, exhibit similar vegetation and are included in this type. Soils are thin, dry, and acidic with turfy (fibric) organic surface horizons and gravelly and/or coarse sand mineral layers over acidic to intermediate bedrock (oligotrophic). This is a distinct, narrowly defined community that intergrades with other northern rocky ridge communities. It is

considered distinct from the red oak and jack pine types due to differences in dominant tree species and probable differences in ecological histories or circumstances.

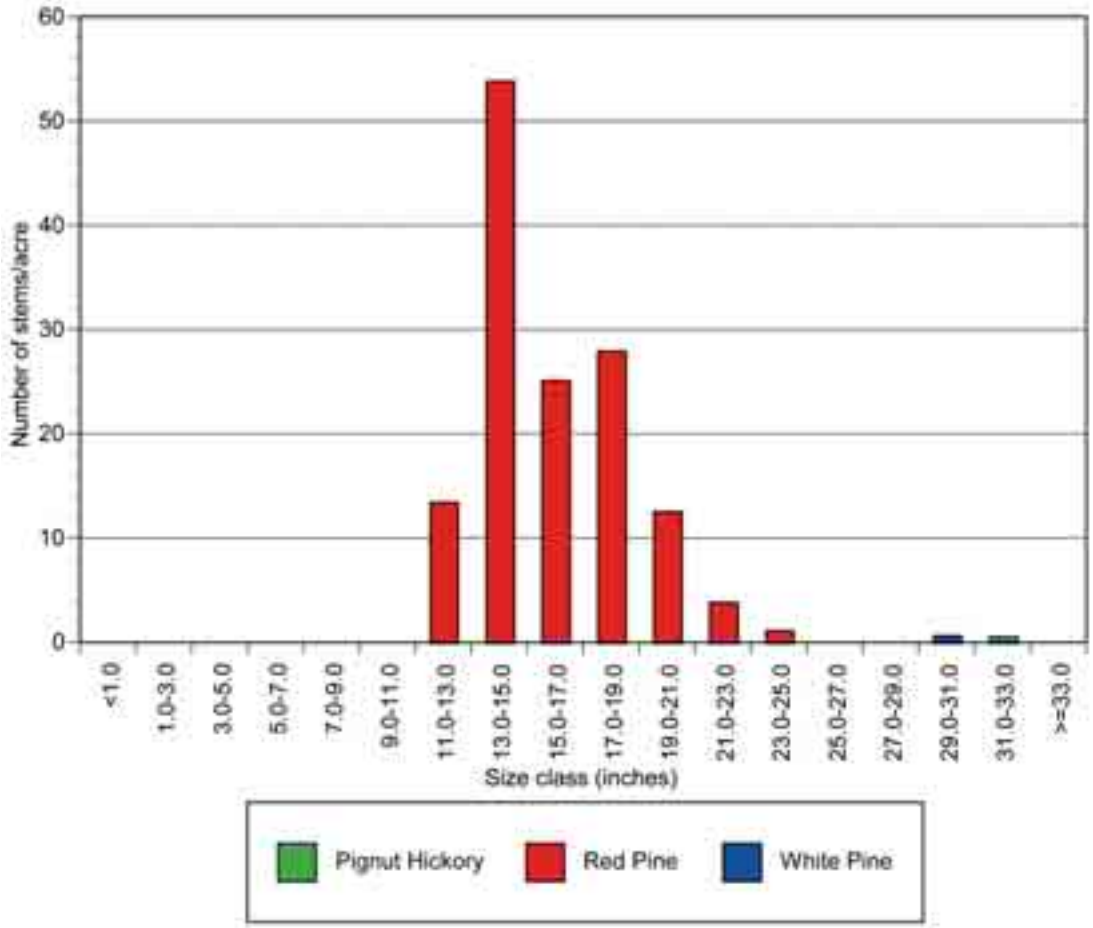
Overstory Summary Narrative

This red pine forest/woodland is currently considered mature. Effective stand age was estimated at 126 years. There were three tree species present in the stand with the following species distribution by basal area: red pine (96%), eastern white pine (2%), and pignut hickory (2%).

In a timber management setting this natural community would be considered a large sawtimber stand, with a medial stand diameter of 16.84 in. Relative stand density was 86.0 percent of the average maximum stocking expected in undisturbed stands of similar size and species. This density is higher than optimum for best individual tree growth. At this relative density, growth rate of the biggest trees is probably moderate, while growth of medium and smaller-sized trees is probably fair, and mortality due to crowding moderate.

The growing stock amounted to 183.3 sq ft/ac. Gross total volume in all trees to a 4 inch top was 4723.1 cu.ft/ac. There were 140 trees/ac in this stand. The basal area of acceptable growing stock was 183 sq ft/ac, while unacceptable growing stock represented 6.7 sq ft/ac of basal area. Acceptable growing stock represented 82.8 of the relative density, while unacceptable growing stock represented 3.2 of the relative density. The overall stand relative density was 86.0. The *q* factor for this stand was 1.19.

The mean diameter of this red pine forest/woodland was 15.50. The quadratic mean diameter was 15.80. The net board foot volume of this stand was 24,659 bd.ft/ac and none of the basal area of the trees in this stand were considered of high value. Trees of acceptable quality for future growing stock provide a fully stocked stand by themselves.


60
50
40
30
20
10
0
Number of stems/acre
<1.0
1.0-3.0
3.0-5.0
5.0-7.0
7.0-9.0
9.0-11.0
11.0-13.0
13.0-15.0
15.0-17.0
17.0-19.0
19.0-21.0
21.0-23.0
23.0-25.0
25.0-27.0
27.0-29.0
29.0-31.0
31.0-33.0
>=33.0
Size class (inches)
Pignut Hickory
Red Pine
White Pine

28

Seasonally saturated red maple swamp

Identification and Location
Stand ID: 10
Compartment: Seasonally saturated red maple swamp
Date of inventory: 8/17/2006

Measures
Area: 38.2 ac
Plot count: 2
Number of plot size classes: 1
Trees per acre: 231.60 #/ac
Basal area: 115.0 sq ft/ac
Relative density: 88.6 pct.
Canopy closure: 89%
Size class: large sawtimber

Natural Community Description

This community occurs in somewhat poorly drained mineral soil settings in transition zones between wetland and upland communities. It is dominated by hardwood trees, particularly red maple, oaks, and birches, with a relatively minor component of pine and hemlock. *Osmunda cinnamomea* (cinnamon fern) and tall wetland shrubs such as *Vaccinium corymbosum* (highbush blueberry) are present in moderate abundance (~1-15%). Other wetland plants are sparse. More coastal or southern examples contain Appalachian oaks, hickories, and possibly black huckleberry, which are absent from central NH examples. Soils consist of sand, sandy loams and silt loams, typically with a dark brown or black A horizon over B horizon materials with mottling within ~30 cm of the surface. This community is typically somewhat poorly drained, and therefore intermediate and transitional to more well drained upland forests and poorly or very poorly drained swamps. Soils series include Pipestone sand, Boxford silt loam, and possibly Raynham silt loam and Eldridge fine sandy loam.

Overstory Summary Narrative

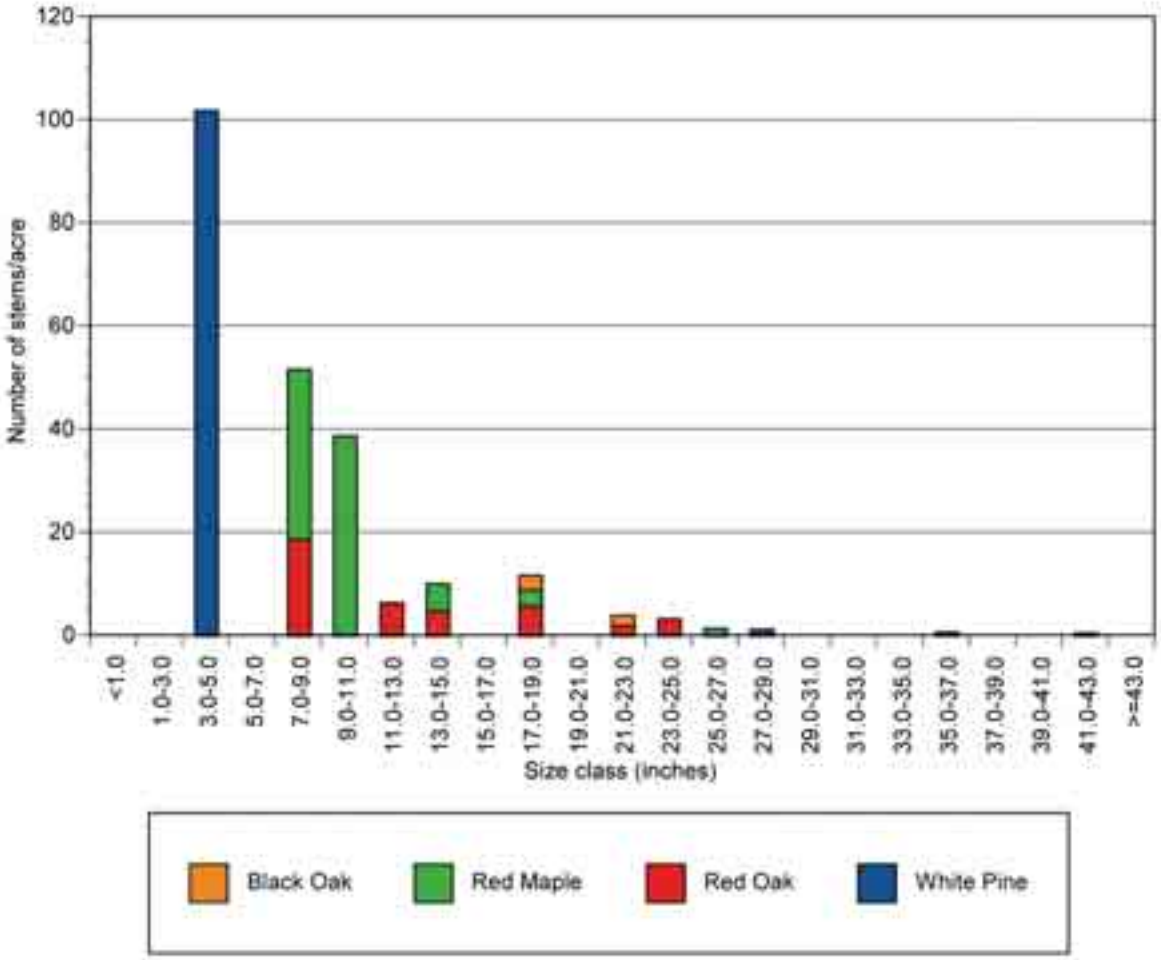
This seasonally saturated red maple swamp is currently considered mature. Effective stand age was estimated at 156 years. There were four tree species present in the stand with the following species distribution by basal area: northern red oak (39%), red maple (39%), black oak (13%), and eastern white pine (9%).

In a timber management setting this natural community would be considered a large sawtimber stand, with a medial stand diameter of 17.22 in. Relative stand density was 88.6 percent of the average maximum stocking expected in undisturbed stands of similar size and species. This density is higher than optimum for best individual tree growth. At this relative density, growth rate of the biggest trees is probably moderate, while growth of medium and smaller-sized trees is probably fair, and mortality due to crowding moderate.

The growing stock amounted to 100.0 sq ft/ac. Gross total volume in all trees to a 4 inch top was 2617.7 cu.ft/ac. There were 232 trees/ac in this stand. The basal area of acceptable growing stock was 100.0, while unacceptable growing stock represented 15.0 sq ft/ac of basal area.

Acceptable growing stock represented 77.6 of the relative density, while unacceptable growing stock represented 11.0 of the relative density. The overall stand relative density was 88.6. The *q* factor for this stand was 1.14.

The mean diameter of this seasonally saturated red maple swamp was 7.59. The quadratic mean diameter was 9.54. The net board foot volume of this stand was 9419 bd.ft/ac, and 39% of the basal area in this stand were considered of high value. Trees of acceptable quality for future growing stock are inadequate to provide a fully stocked stand in themselves.



References

Augustine, D.J. and L.E. Frelich. 1998. Effects of white-tailed deer on populations of an understory forb in fragmented deciduous forests. Conservation Biology. 12: 995-1004.

Avery, E.A. and H.E. Burkhart. 1983. Forest Measurements. McGraw-Hill Book Company, New York. 331p.

Bull E. L., C. G. Parks, and T. R. Torgersen. 1997. Trees and logs important to wildlife in the interior Columbia River Basin. General Technical Report, PNW-GTR-391. U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station, Portland, OR. 55 p.

DeGraaf, R. M. and A. L. Shigo. 1985. Managing cavity trees for wildlife in the northeast. General Technical Report NE-101. U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station, Broomall, PA. 21 p.

Horsley, S.B., S.L. Stout, and D.S. deCalesta. 2003. White-tailed deer impact on the vegetation dynamics of a northern hardwood forest. Ecological Applications. 13: 98-118..

Knopp, P.D., and M.J. Twery. 2006. NEDLite user's manual: forest inventory for Palm OS handhelds. General Technical Report NE-340. Newtown Square, PA: USDA Forest Service, Northeastern Research Station. 64p.

Lancaster, K. F., and W. B. Leak. 1978. A silvicultural guide for white pine in the Northeast. Gen. Tech. Rept. NE-41. St. Paul, MN: USDA Forest Service, North Central Research Station. 13p.

Leak, W.B., D.S. Solomon, and P.S. Debald. 1987. Silvicultural Guide for Northern Hardwood Types in the Northeast (revised). Research Paper NE-603. Broomall,PA: USDA Forest Service, Northeastern Forest Research Station. 36p.

Roach, B.A., S.F. Gingrich. 1968. Evenaged Silviculture for Upland Central Hardwoods. Agriculture Handbook 355. Upper Darby, PA: USDA Forest Service, Northeastern Forest Experiment Station. 39p.

Rossell, C.R., Jr., S. Patch, and S. Salmons. 2007. Effects of deer browsing on native and non-native vegetation in a mixed oak-beech forest on the Atlantic Coastal Plain. Northeastern Naturalist. 14: 61-72.

Sampson, T.L., J.P. Barrett, and W.B. Leak. 1983. A Stocking Chart for Northern Red Oak in New England. New Hampshire Agricultural Experiment Station Research Report Number 100. 14p.

Simpson, B.T., R.P. Kollasch, M.J. Twery, and T.M. Schuler. 1995. NED/SIPS User's manual – Northeast Decision Model Stand Inventory Processor and Simulator. Gen. Tech. Rpt. NE-205. Radnor, PA: USDA Forest Service, Northeastern Forest Experiment Station. 103p.

Sperduto, D.D. 2000. Natural Communities Map of Great Bay National Wildlife Refuge. GIS Data, provided by US Fish and Wildlife Service.

Sperduto, D.D.,and W.F. Nichols. 2004. Natural Communities of New Hampshire. NH Natural Heritage Bureau, Concord, NH. Pub. UNH Cooperative Extension, Durham, NH. 229p.

Appendix I

USFWS

Stubbs Pond

Contaminants Review of the Peverly Brook Drainage Area

UNITED STATES GOVERNMENT
MEMORANDUM

U.S. FISH AND WILDLIFE SERVICE
NEW ENGLAND FIELD OFFICE
70 COMMERCIAL STREET, SUITE 300
CONCORD, NEW HAMPSHIRE 03301-5087

TO: Graham Taylor, Refuge Manager, Parker River National Wildlife Refuge

February 3, 2011

FROM: Thomas Chapman, Supervisor, New England Field Office

SUBJECT: Sampling Review

Attached as you requested is the contaminants review containing data collected as part of the clean-up of the former Pease Air Force Base. This review focuses on the Peverly Brook drainage area located at Great Bay National Wildlife Refuge. I understand that this review will be used as an appendix for the Great Bay Comprehensive Conservation Plan.

If you have any questions, please contact Mr. Drew Major of this office at 603-223-2541.

Attachment

Introduction

This is a retrospective review of sampling plans and data compiled as part of the clean-up of the former Pease Air Force Base. This review focuses on the Peverly Brook drainage area located at Great Bay National Wildlife Refuge (maps I-1 and I-2). Below is a summary of the major points of each of the plans and data reports. Also included is a discussion section which describes key findings and trends, explains current sources of contamination, and suggests further sampling.

Summary of Important Points of Sampling Reports and Data

Basewide Surface Water, Sediment, and Fish Tissue Monitoring (United States Air Force 1998)

This report documents sample sites, analytes, and sampling frequency for monitoring. This document also states the cleanup goals and is a useful reference document for interpreting monitoring results.

Long-Term Monitoring Sampling and Analysis Plan (United States Air Force 1999)

This plan details the field protocols that were used during the subsequent site monitoring and sample collection. It is also a useful reference document for interpreting monitoring results.

Draft Fieldwork Notification Biota Sampling: Pease Air Force Base (Watson 2001)

This report details the objectives, methods, and analysis of the 2001 fish collection. It is also useful as a reference document for interpreting monitoring results.

Basewide Surface Water, Sediment, and Fish Tissue Monitoring (Bechtel 1999)

This review is limited to drainage area G (Peverly Brook).

Peverly Brook and Upper Peverly Pond

- *Surface Water* - Surface water samples exceeded cleanup goals for arsenic (As), iron (Fe), and lead (Pb). Landfill-1 may be contributing metals to Upper Peverly Pond.
- *Sediment* - Sediment samples exceeded cleanup goals for arsenic, lead, nickel (Ni), and zinc (Zn). Time series plots indicate an increasing concentration trend in Upper Peverly Pond.

Lower Peverly and Stubbs Pond

- *Surface Water* - Surface water samples exceeded cleanup goals for arsenic.
- *Sediment* - All sediment samples met cleanup goals. Time series plots indicate an increasing concentration trend in Stubbs Pond and a decreasing trend in Lower Peverly Pond.

No fish tissue monitoring was required for the time period covered by this report. Since pesticide/PCB (polychlorinated biphenyl) levels were low, the author recommended that water and sediment samples not be analyzed for these constituents in the future.

Basewide Surface Water, Sediment, and Fish Tissue Monitoring (MWH Americas 2002)

This review is limited to drainage area G (Peverly Brook).

Peverly Brook and Upper Peverly Pond

- *Surface Water* - Iron levels exceeded the cleanup goal at four different sampling stations between the years 1993-2001. In 2001, only the farthest upstream station exceeded the iron cleanup goal. Pesticide analysis was discontinued in 2000 because levels were below detection limits.
- *Sediment* - No sediment samples exceeded metals cleanup goals in 2001. The area around Station 8015 (center of Upper Peverly Pond) continues to act as a sediment and metals trap. Pesticides continue to be flushed out of the tributaries and are accumulating in the sediments of Upper Peverly Pond. There are no cleanup goals established for pesticides.

Human and Ecological Health Risk

No human health risk from ingestion of recreationally caught catfish and bass from Stubbs Pond. This is limited ecological risk to belted kingfisher from ingestion of fish from Stubbs Pond from arsenic and zinc.

Fish

The report compared the results of the 2001 sampling event to the 1996 sampling event. Fish were not sampled in Stubbs Pond in 2001 due to insufficient water levels. In Upper Peverly Pond, the highest concentrations of mercury (Hg) (0.42 ppm) and DDE (0.2 ppm) were found in largemouth bass, while the lowest (0.04 and 0.017 ppm respectively) were found in bluegill sunfish. The same relationships were true for Lower Peverly Pond, although the levels were approximately half that found in Upper Peverly Pond fish (i.e., 0.24 ppm mercury and 0.089 ppm DDE in largemouth bass).

The average mercury (Hg) concentrations found in largemouth bass fillets were 0.318 ppm in Upper Peverly Pond and 0.226 ppm in Lower Peverly Pond. These levels are consistent with those found throughout the Region. The U.S. Environmental Protection Agency recommends limiting fish meals to no more than three per month when mercury levels are between 0.23 and 0.31 ppm.

Note: During the review of the document, the Department of the Interior, the U.S. Environmental Protection Agency (EPA), and the New Hampshire Department of Environmental Services (NHDES) requested that fish sampling be conducted in 2006 (especially in Stubbs Pond). The Air Force disagreed and stated "*There is currently no requirement to sample in 2006*

and neither the EPA nor the NHDES has articulated a clear objective for continued fish tissue sampling." There has been no additional fish tissue sampling conducted by the Air Force since 2001.

Stubbs Pond-Peverly Brook Drainage System (Vanasse Hangen Brustlin 2005)

Stubbs Pond is located within Drainage Area G. The largest contributor of contaminants to the Peverly Brook drainage is Zone 2 which includes Landfill 1, Fire Department Training Area 1, Munitions Maintenance Area, Construction Rubble Dump, and the McIntyre Drum Disposal Area. Historic contaminants of concern in the drainage include metals (aluminum [Al], arsenic, iron, lead, manganese [Mn], nickel, and zinc) and pesticides (DDT and metabolites). Landfill 1 was primarily responsible for the metals while historic base-wide use of DDT was responsible for the pesticide levels.

Nineteen sediment samples were collected in December 2004 and submitted for analysis. Chromium (Cr) levels from one sample (SP-10A in the center of the pond) exceeded the probable effect concentration (PEC) as defined by McDonald *et al.* (2000). PEC values are screening thresholds above which adverse effects are likely. When results were compared to NOAA's Screening Quick Reference Tables, arsenic, cadmium (Cd), chromium, nickel, lead, and zinc exceeded the Effects Range-Low in at least one sample, but no samples exceeded the Effects Range-Medium. Concentrations between the Effects Range-Low and Effects Range-Medium are occasionally associated with adverse effects.

Discussion

Upper Peverly Pond has acted as a sediment and heavy metal trap, preventing the majority of the contaminants from migrating farther down the watershed. However, some metals have migrated from Upper Peverly Pond, through the system, and have been deposited into the low flow velocity area of Stubbs Pond. Landfill 1 is the primary source of the metals. The metal levels in Stubbs Pond are relatively low with the exception of sampling sites in the middle of the pond. There was a decline in sediment metal levels in Upper Peverly Pond between 1999-2000. This trend may be continuing as clean sediment has been deposited on top of the contaminated sediment. It would be prudent to resample Upper Peverly Pond sediments to confirm that Landfill 1 is no longer depositing metals into the pond. During any resampling, at least one sample should be taken from the deepest spot in the pond in order to ensure representative sampling.

Levels of mercury and DDE in largemouth bass from Upper Peverly Pond are elevated in relation to the other waterbodies of the Peverly Brook drainage area. Although the level of mercury in largemouth bass (mean of 0.32 ppm) appears to pose a limited risk to piscivorous birds, it is important to note that the size of the bass sampled in Upper Peverly Pond was selected to estimate the risk to human health and not ecological health. In order to properly estimate the risk to piscivorous species that would be expected to use Upper Peverly Pond (such as belted kingfisher, osprey, and bald eagle), sampling of more appropriate size classes would be required. High levels of DDE in feed (10 ppm) can also result in eggshell thinning and have other

reproductive effects in waterfowl. However, it does not appear that DDE levels in Upper Peverly Pond are high enough pose a risk to waterfowl and other piscivorous wildlife.

In addition to existing contaminants from operations at the former Pease Air Force Base, the adjacent Pease International Tradeport is a possible continuing source of contaminates to the Peverly Brook drainage area. These contaminants may include herbicides and de-icing material (propylene glycol). Given the correct equipment and appropriate funding, these contaminants can be detected and monitored.

At the request of the Great Bay Refuge, the New England Field Office can draft a contaminants monitoring plan for the Peverly Brook drainage area. The plan would outline a three-year on-refuge study to monitor water quality and contaminant levels in sediments and fish tissue, as well as to track any changes and trends in contamination levels. However, due to the high cost of contamination monitoring, it may be difficult to guarantee a funding source for the plan's implementation. Potential funding sources would need to be identified and pursued.

Documents Reviewed

The following documents are on file at Great Bay Refuge Headquarters.

Reference Documents

United States Air Force. 1998. Pease Air Force Base Basewide Surface Water, Sediment, and Fish Tissue Monitoring: Long-term Monitoring Plan *prepared by* Bechtel Environmental, Inc. *for* Air Force Base Conversion Agency and Air Force Center for Environmental Excellence, Base Closure Division. April 1998.

United States Air Force. 1999. Pease Air Force Base: Long-Term Monitoring Sampling and Analysis Plan *prepared by* Bechtel Environmental, Inc. *for* Headquarters Air Force Base Conversion Agency and Air Force Center for Environmental Excellence, Base Closure Division. January 1999.

MacDonald D.D., C.G. Ingersoll and T.A. Berger. 2000. Development and evaluation of consensus-based sediment quality guidelines for freshwater ecosystems. Arch. Environ. Contam. Toxicol. 39:20-31.

Montgomery Watson. 2001. Draft Fieldwork Notification Biota Sampling: Pease AFB, Portsmouth, N.H. *prepared by* Montgomery Watson *for* Air Force Center for Environmental Excellence, Environmental Restoration Division. August 2001.

Sampling Results

Bechtel Environmental, Inc. 1999. Pease Air Force Base: Basewide Surface Water, Sediment, and Fish Tissue Monitoring Annual Report *prepared by* Bechtel Environmental, Inc. *for* Air Force Base Conversion Agency and Air Force Center for Environmental Excellence, Base Closure Division. November 1999.

MWH Americas, Inc. 2002. Basewide Surface Water, Sediment, and Fish Tissue Monitoring, Pease AFB, Portsmouth, N.H. *prepared by* MWH Americas, Inc. *for* Air Force Center for Environmental Excellence, Environmental Restoration Division. June 2002.

Vanasse Hangen Brustlin, Inc. 2005. Stubbs Pond-Peverly Brook Drainage System (Formerly Known as Bass Pond), Great Bay National Wildlife Refuge, Newington, New Hampshire *prepared by* Vanasse Hangen Brustlin, Inc. *for* Department of Environmental Services, New Hampshire Coastal Program.

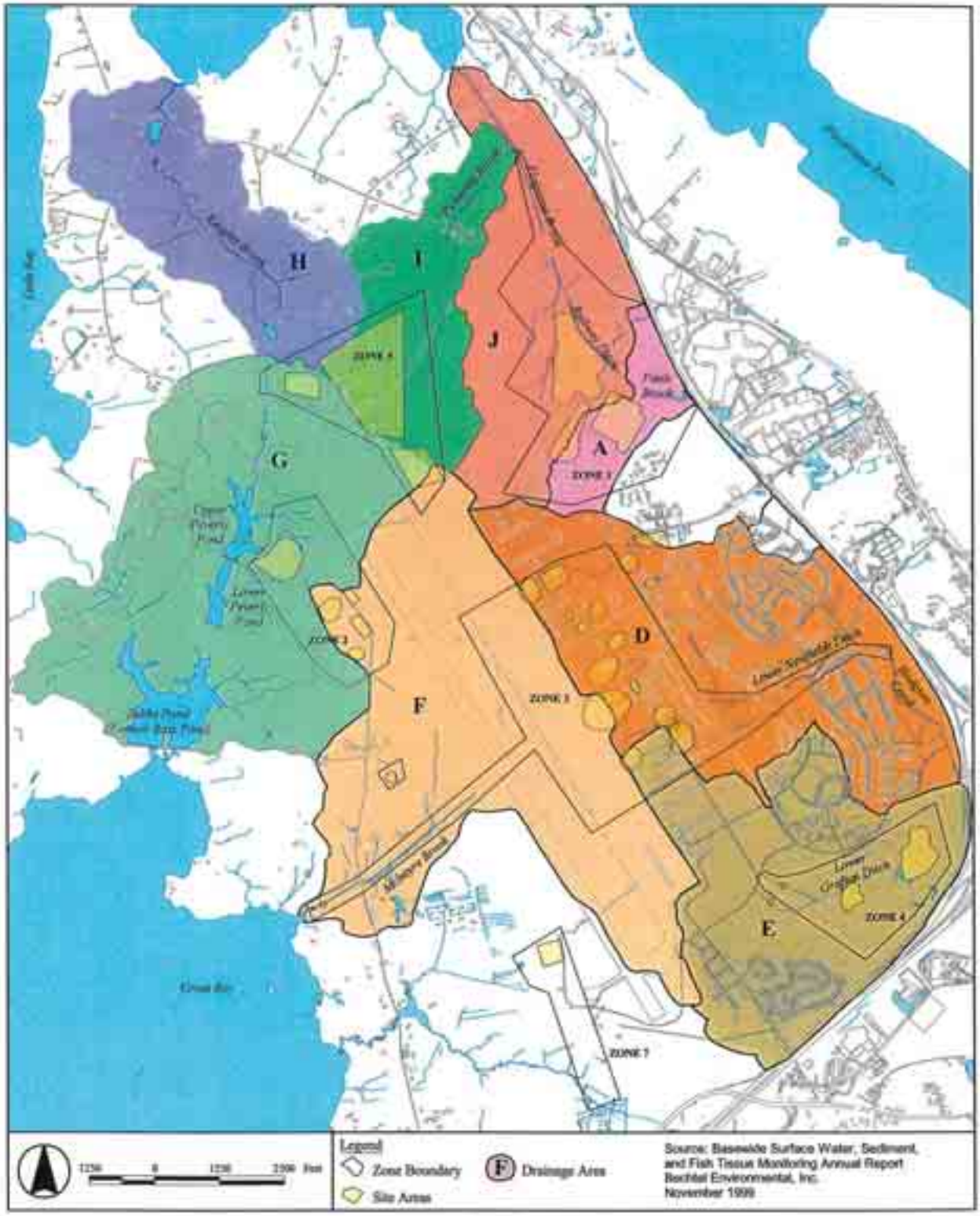


Figure 1-2
Drainage Areas and Associated Sites
Pease Air Force Base, New Hampshire

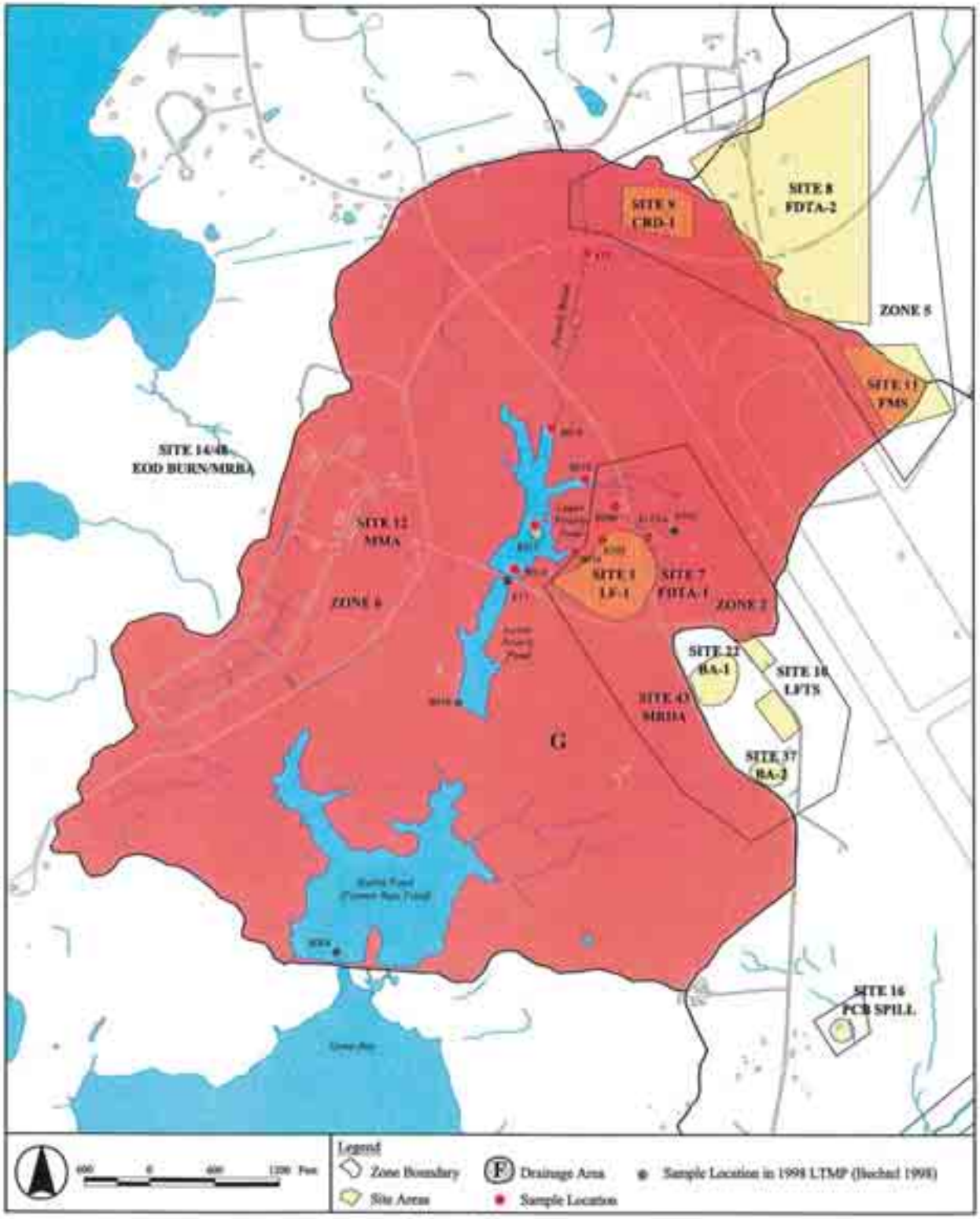


Figure 5-1
Drainage Area G
Pease Air Force Base, New Hampshire

Appendix J

USFWS

Great Bay Refuge welcome sign

Refuge Headquarters/ Visitor Contact Station Proposed Under Alternatives B and C

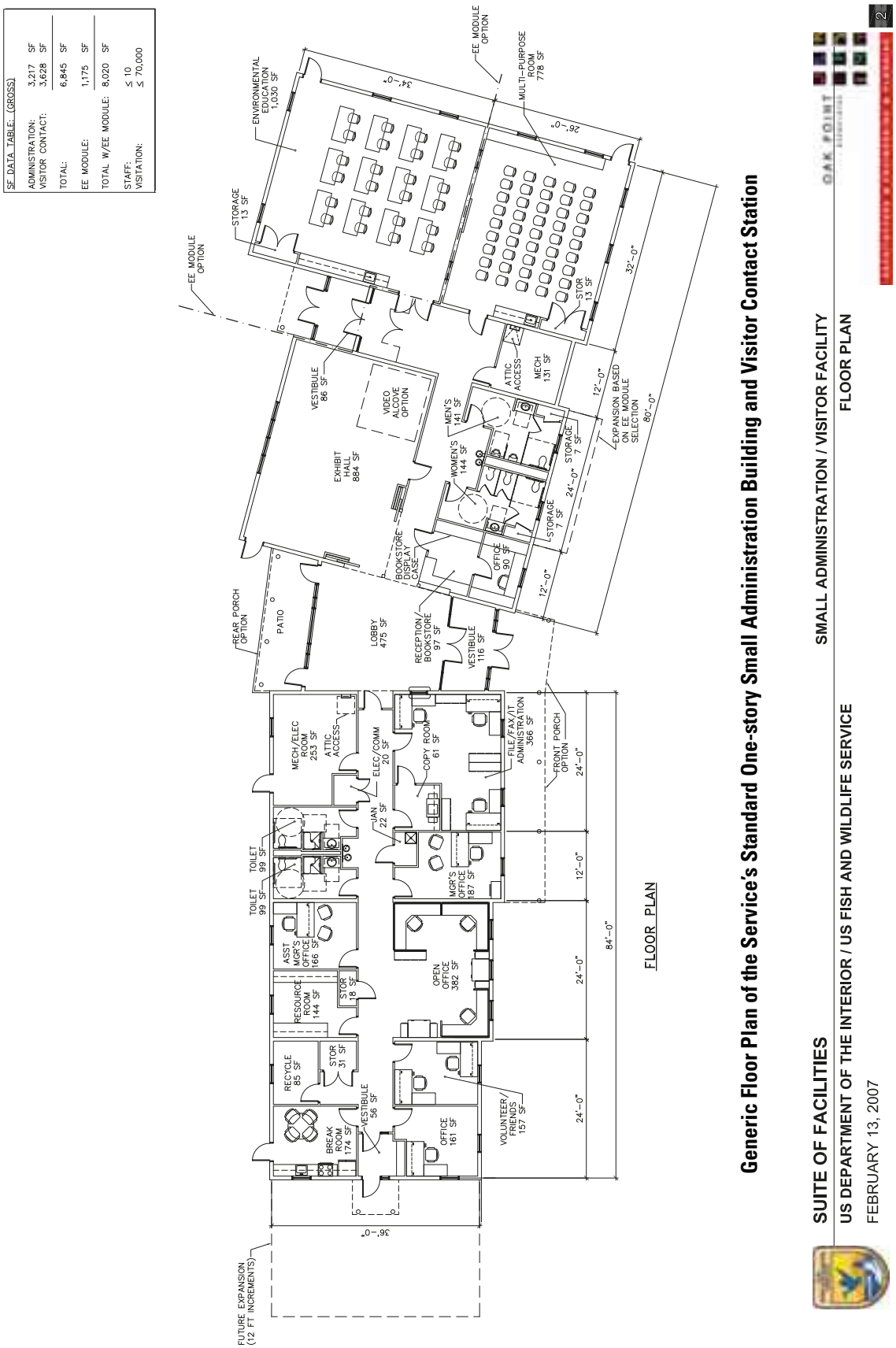
Refuge Headquarters/ Visitor Contact Station Proposed Under Alternatives B and C

This appendix provides additional information on the new refuge headquarters/ visitor contact station building proposed under alternatives B and C. The facility would be approximately 7,000-square feet. We would construct it in an area already disturbed as part of the former Weapons Storage Area (map J.1). Figure J.1 is a conceptual drawing representing the Service's standard one-story, small administrative building and visitor contact station. Figure J.2 shows a generic floor plan for this standard building. We have included the drawing and floor plan for general reference only and they do not necessarily represent the exact building facade or room configuration that would be part of the design for Great Bay National Wildlife Refuge.

Great Bay National Wildlife Refuge - Comprehensive Conservation Plan
Location of Proposed Refuge Headquarters/Visitor Contact Station
McIntyre Road
New Observation Platform
New Admin/HQ and Visitor Contact Facility
Parking Lot
Kiosk
Current Office (Remove)
Residence
Observation Platform
New Observation Platform
Current Maintenance Shop (Convert to Storage)
Entrance Road
Admin Road (no public access)
Non-FWS Road
New trails
Existing trails
Chain link Fence
Parking lot
New office and maintenance shop building size and shape approximate
Feet
Meters

Conceptualization of the Service's Standard One-story Small Administration Building and Visitor Contact Station

US DEPARTMENT OF THE INTERIOR FISH AND WILDLIFE SERVICE
ADMINISTRATION BUILDING AND VISITOR CONTACT STATION - SMALL
JANUARY 31, 2005



Generic Floor Plan of the Service's Standard One-story Small Administration Building and Visitor Contact Station

Great Bay National Wildlife Refuge
c/o Parker River National Wildlife Refuge
6 Plum Island Turnpike
Newburyport, MA 01950
Phone: 978/465 5753
http://www.fws.gov/northeast/greatbay/

Federal Relay Service
for the deaf or hard of hearing
1 800/877 8339

U.S. Fish & Wildlife Service
http://www.fws.gov

For Refuge Information
1800/344 WILD

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