U.S. Fish and Wildlife Service

Eastern Massachusetts National Wildlife Refuge Complex

Draft Comprehensive Conservation Plan and Environmental Assessment

Assabet River, Great Meadows and Oxbow National Wildlife Refuges

April 2003

This goose, designed by J.N. "Ding" Darling, has become a symbol of the National Wildlife Refuge System

The *U.S. Fish and Wildlife Service* is the principal federal agency for conserving, protecting, and enhancing fish and wildlife in their habitats for the continuing benefit of the American people. The Service manages the 94-million acre National Wildlife Refuge System comprised of 540 national wildlife refuges and thousands of waterfowl production areas. It also operates 65 national fish hatcheries and 78 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 Aid program which distributes hundreds of millions of dollars in excise taxes on fishing and hunting equipment to state wildlife agencies.

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

Cover photo: Great Meadows National Wildlife Refuge, USFWS Photo

U.S. Fish and Wildlife Service

Eastern Massachusetts National Wildlife Refuge Complex

Draft Comprehensive Conservation Plan and Environmental Assessment

Vision Statement for the Complex

The Eastern Massachusetts National Wildlife Refuge Complex will contribute to the mission of the National Wildlife Refuge System and support ecosystem–wide priority wildlife and natural communities. Management will maximize the diversity and abundance of fish and wildlife with emphasis on threatened and endangered species, migratory birds, and aquatic resources. The Complex will have a well-funded and community– supported acquisition program which contributes to wildlife conservation. The refuges will be well known nationally and appreciated in their communities. They will be seen as active partners in their communities, school systems, and environmental organizations which will result in high levels of support for the refuges. The refuges will be a showcase for sound wildlife management techniques and will offer top-quality, compatible, wildlife-dependent recreational activities. Refuges open to the public will provide staffed visitor contact facilities that are clean, attractive, and accessible, with effective environmental education and interpretation.

U.S. Fish and Wildlife Service
Northeast Regional Office
300 Westgate Center Drive
Hadley, MA 01035

April 2003

Abstract

Type of Action:	Administrative— Development of a Comprehensive Conservation Plan
Location:	Eastern Massachusetts National Wildlife Refuge Complex, Massachusetts Assabet River, Great Meadows and Oxbow National Wildlife Refuges
Lead Agency:	U.S. Fish and Wildlife Service
Responsible Official:	Dr. Richard O. Bennett, Acting Regional Director
For Further Information:	Libby Herland, Project Leader 73 Weir Hill Rd Sudbury, Massachusetts 01776 (978)443-4661

This Draft Comprehensive Conservation Plan and Environmental Assessment (CCP/EA) describes three alternatives for three of the refuges in the Eastern Massachusetts National Wildlife Refuge Complex (Complex): Assabet River National Wildlife Refuge, Great Meadows National Wildlife Refuge and Oxbow National Wildlife Refuge. Later, we will release a CCP/ Environmental Impact Statement (EIS) for Monomoy, Nomans Land Island and Nantucket national wildlife refuges, and CCP/EAs for Massasoit and Mashpee national wildlife refuges. A brief description of the alternatives in this EA are as follows:

Alternative A. This is the current management alternative required by the National Environmental Policy Act (NEPA). The refuges continue programs they currently have in place. No new efforts are undertaken, and land acquisition occurs only for those parcels already within the approved refuge boundaries.

Alternative B. This alternative represents the U.S. Fish and Wildlife Service Proposed Action; that is, the alternative we recommend for approval. Land acquisition occurs only within the refuge boundaries. This alternative emphasizes inventorying and monitoring refuge resources. This alternative also offers more wildlife observation, photography, environmental education, and interpretation opportunities as well as hunting and fishing on all three refuges.

Alternative C. Alternative C is similar to Alternative A, but places emphasis on a less intrusive management style. Inventory and monitoring of refuge resources would occur, but would be limited. The refuges would support similar programs as existing now, but not expand habitat management programs as Alternative B does. This alternative is distinguished from others by the amount of resources directed towards expanding all priority public use opportunities and active management programs.

This document also includes appendices that provide additional information supporting our analysis.

Reader's Guide

The U.S. Fish and Wildlife Service planning process for all national wildlife refuges involves two levels of planning:

1) the development of a broad Comprehensive Conservation Plan (CCP); and,

2) the formulation of more detailed step-down management plans required to fully implement the CCP.

This Draft EA/ CCP provides NEPA compliance for the future management of three refuges in the Complex: Assabet River, Great Meadows and Oxbow refuges. Following the release of our final NEPA decision document and Finding of No Significant Impact (FONSI) we will release a stand-alone CCP for each refuge.

We have written Chapter 1 and Chapter 5 to apply to all three refuges. However, each refuge has a separate part or section in the Affected Environment, Alternatives, and Environmental Consequences chapters and in some appendices. In these chapters, Assabet River Refuge is Part 1, Great Meadows Refuge is Part 2 and Oxbow Refuge is Part 3. The CCP will consist of information organized in the following sections of this document:

- **Chapter 1. The Purpose of and Need for Action, Issues and Concerns**
  This chapter discusses the purpose of and need for action; it provides background information on the Complex, the U.S. Fish and Wildlife Service and the National Wildlife Refuge System, and the Gulf of Maine Ecosystem. It briefly describes the planning process followed. This chapter also describes issues, concerns, and opportunities identified during public scoping. It identifies issues not addressed in this EA and how the issues help form the alternatives.

- **Chapter 2. Alternatives**
  This chapter describes the alternatives for each refuge based on the issues, concerns and opportunities discussed in Chapter 1. The Service's Proposed Action for each refuge is identified. Alternatives describe what management will occur over the next 15 years. A series of issue questions are answered for each alternative, showing how it responds to the issues. A table at the end of the chapter summarizes the alternatives and compares the differences between them.

- **Chapter 3. Affected Environment**
  This chapter describes the existing environment of the three refuges. It describes the physical, biological, socioeconomic and cultural resources that would be affected by the management actions of each alternative discussed in Chapter 2. The affected environment is the baseline for comparing the consequences of implementing each alternative.

- **Chapter 4. Environmental Consequences**
  This chapter describes the environmental consequences of implementing each of the alternatives. It provides scientific and analytical bases for comparing the alternatives. It describes the probable consequences (impacts or effects) of each of the alternatives on the physical, biological, cultural, and socio-economic resources of the refuges.

- **Chapter 5. Consultation with Others**
  This chapter describes the effort made by the Service to identify the issues, concerns, and opportunities to be described in this EA.

- **Appendices**
  The Appendices contain materials relevant to the decision being made, the affected environments of each of the refuges in the complex, and the analysis involved in determining environmental consequences.

Public involvement and NEPA compliance have been incorporated into the process at all appropriate stages.

The final approved CCP will provide the vision and strategic direction for the refuges. When fully implemented, each CCP will help achieve the refuge's purpose, fulfill the National Wildlife Refuge System (System) mission, maintain or restore the biological integrity, diversity, and environmental health of the Complex, and meet other mandates. It will be adjusted to consider new and better information, ensuring that refuge activities best serve the intended purpose and mission of the System. The CCP will also guide management decisions and set goals, objectives, and strategies to accomplish these ends. We also require step-down management plans to provide additional details about meeting CCP goals and objectives and to describe strategies and implementation schedules. The CCP will be based on the principles of sound fish and wildlife management, available science, legal mandates, and our other policies, guidelines, and planning documents. It will, above all else, ensure that wildlife comes first on the refuges.

We greatly appreciate the time and efforts of the many citizens who contributed to the creation of the refuges and the development of their CCPs. While this plan does not satisfy all the concerns expressed during the planning process, public involvement and participation substantially shaped the plan. Public involvement also greatly assisted the Service in determining how best to balance the important conservation of the natural resources found on the refuges while ensuring that environmental education and visitor use needs are met, as mandated by legislation.

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Great Blue Heron at Great Meadows National Wildlife Refuge *Photo by Sandy Selesky*

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Introduction and Background

This Draft Comprehensive Conservation Plan and Environmental Assessment (CCP/EA) has been prepared for three of the eight refuges of the Eastern Massachusetts National Wildlife Refuge Complex (Complex). These three refuges are Assabet River, Great Meadows (Concord and Sudbury Units), and Oxbow national wildlife refuges.

We will prepare a separate CCP and Environmental Impact Statement (CCP/EIS) for Monomoy and Nomans Land Island national wildlife refuges. CCP/EAs for Nantucket, Massasoit and Mashpee national wildlife refuges will undergo the CCP process at a later date.

NEPA ensures that this document assess and evaluate a reasonable range of alternatives and the predictable socioeconomic, physical, cultural and biological impacts of implementing each alternative. Appendices for each refuge provide additional references and information used in compiling this draft CCP/EA.

Purpose and Need for a CCP

The purpose of a CCP is to provide managers and other interested partners guidance and direction for each refuge over the next 15 years, thus achieving refuge purposes and contributing to the mission of the Refuge System. The plan identifies what role the refuges play, consistent with sound principles of fish and wildlife conservation, in the protection, enhancement and restoration of trust resources.

This plan is also needed to:

- provide a clear statement of desired future conditions for habitat, wildlife, visitors and facilities;
- provide refuge neighbors, visitors, and partners with a clear understanding of the reasons for management actions;
- ensure management reflects the policies and goals of the Refuge System and legal mandates;
- ensure the compatibility of current and future uses;
- review current boundaries of the refuges, and evaluate the need to revise boundaries to better achieve refuge purposes;
- provide long-term continuity and direction for Complex management; and,
- provide a basis for staffing and operations, maintenance, and the development of budget requests.

Currently, there is no management plan in place for Assabet River, Great Meadows or Oxbow refuges that establishes priorities or provides consistent direction for managing fish, wildlife, habitats, and public uses on these refuges. This plan will help to resolve issues related to control of nuisance and invasive species, public uses in

conflict with wildlife needs, lack of opportunities for wildlife dependent recreation, and the needs of our Federal trust wildlife species.

The National Wildlife Refuge System Improvement Act of 1997 (Refuge Improvement Act; Public law 105-57) requires that all national wildlife refuges have a CCP in place by 2012 to help fulfill the new mission of the Refuge System. The Refuge Improvement Act states that wildlife conservation is the priority of the Refuge System's lands, and that the biological integrity, diversity, and environmental health of refuge lands shall be maintained. Additionally, the Refuge Improvement Act identifies six wildlife-dependent recreational uses that will receive priority consideration over other recreational uses of the refuge: wildlife observation and photography, hunting, fishing, environmental education, and interpretation.

Decision to be Made

Based on the assessment described in this draft document, our Regional Director will select a preferred alternative to fully develop into CCPs for the refuges. The Regional Director's selected alternative could be the Proposed Action, the Current Management Alternative, Alternative C or a combination of actions or alternatives presented. Selection of the preferred alternative will be made based on an evaluation of the Service's mission, the purposes for which the refuges were established, legal mandates, and responses to this Draft CCP/EA. In accordance with NEPA, our Regional Director must also determine whether the selected management alternative will have a significant impact on the quality of the human environment. If there is a significant impact, additional analysis will be required in an EIS. If there is no impact, we will is issue a Finding of No Significant Impact (FONSI). Once the Regional Director has signed the FONSI and Decision Memorandum and we have completed stand-alone CCPs for each refuge, we will notify the public in the *Federal Register* and implement the plan.

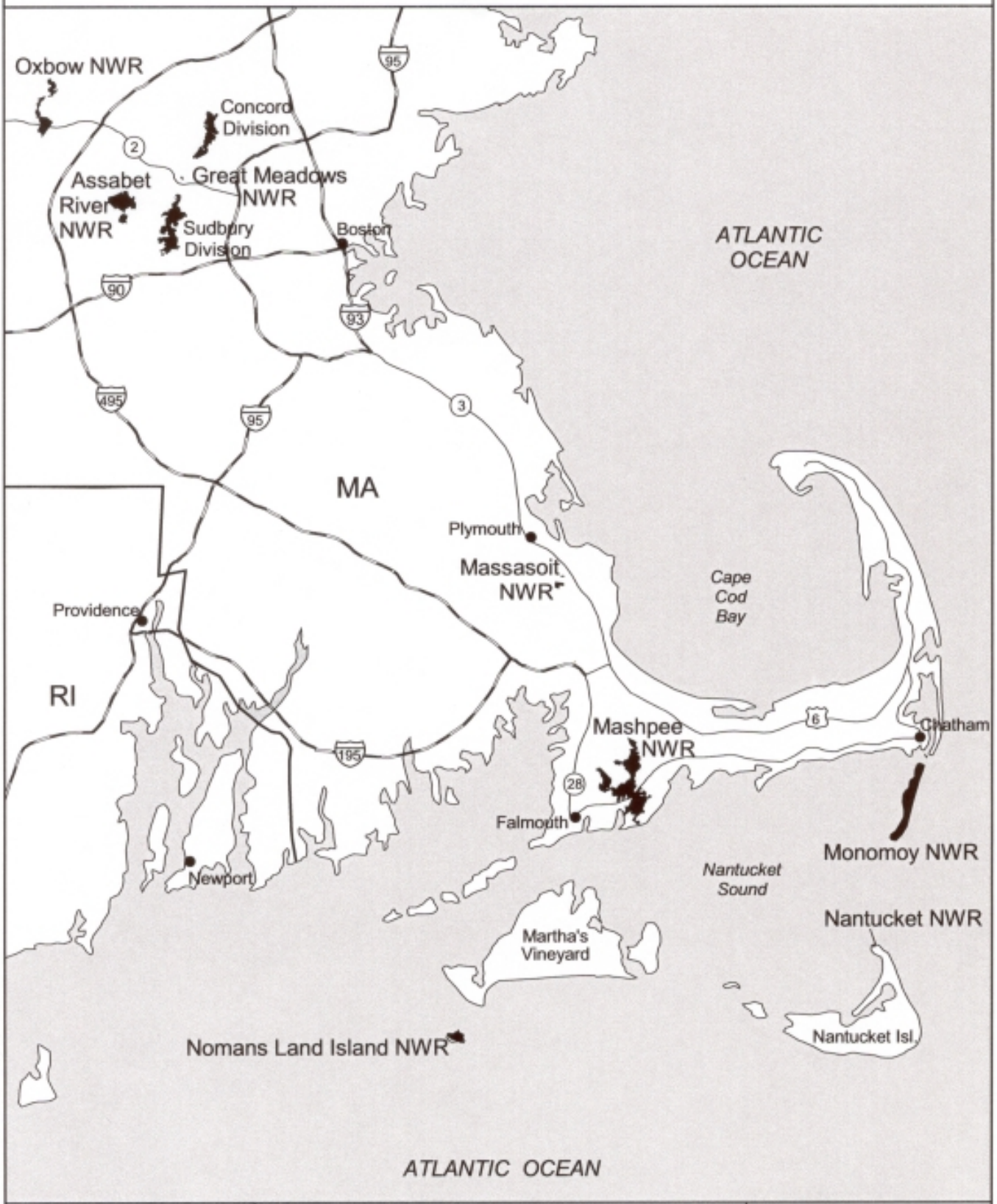
Planning Areas

The Complex consists of eight refuges located in Massachusetts (Map 1-1). This plan addresses Assabet River, Great Meadows and Oxbow refuges.

- **Assabet River National Wildlife Refuge,** in the towns of Maynard, Sudbury, Stow, and Hudson;
- **Great Meadows National Wildlife Refuge** (Concord and Sudbury Units) in the towns of Concord, Sudbury, Bedford, Billerica, Carlisle, Wayland, Framingham and Lincoln;
- **Oxbow National Wildlife Refuge**, in the towns of Shirley, Harvard, Ayer and Lancaster.

We will discuss Massasoit, Mashpee, Monomoy, Nantucket, and Nomans Land Island refuges in later NEPA documents.

Eastern Massachusetts National Wildlife Refuge Complex
Massachusetts



Data Sources:
USFWS refuge boundaries

Map prepared for Eastern Massachusetts National Wildlife Refuge Complex Comprehensive Conservation Plan, August 2001. This map is for planning purposes only.

0 10 20 30 Miles

0 10 20 30 40 Kilometers

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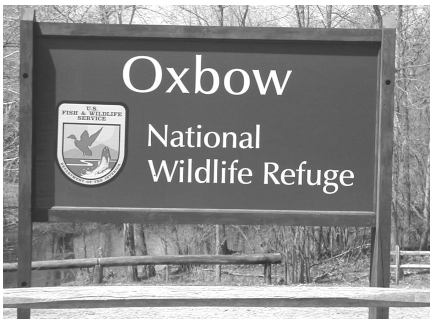


Oxbow Refuge entrance sign.
USFWS Photo

Establishment and History of the Eastern Massachusetts Refuges

National Wildlife Refuge System lands are acquired under a variety of legislative and administrative authorities. Refuges can be established by Congress through special legislation, by the President through Executive Orders, or administratively by the Secretary of Interior who is authorized by Congress through a number of different legislation including: Migratory Bird Conservation Act of 1929, Fish and Wildlife Coordination Act of 1934, Fish and Wildlife Act of 1956, Refuge Recreation Act of 1962, National Wildlife Refuge System Administration Act of 1966, Transfer of Certain Real Property for Wildlife Conservation Purposes Act of 1972, Endangered Species Act of 1973, Emergency Wetland Resources Act of 1986, and the North American and the Wetland Conservation Act of 1989. Lands are also acquired through military excess, bequests and donations.

Assabet River National Wildlife Refuge

Formerly known as the Sudbury Training Annex, Assabet River Refuge is the most recent addition to the Complex, created in the Fall of 2000, when Fort Devens Army Base transferred 2,230 acres to the Service. This transfer was made in accordance with the Defense Base Closure and Realignment Act of 1990, with the purpose of having "*particular value in carrying out the national migratory bird management program.*" All acres within the boundary are acquired. The large wetland complex and the contiguous forested areas are important feeding and breeding areas for migratory birds. Under Army administration, the refuge was not opened to general public use; however, hunting, fishing, and interpretive opportunities remain a high priority for local community members.

Great Meadows National Wildlife Refuge

Established in 1944, the Concord impoundments became the first tract of land in the Great Meadows Refuge. The refuge's 3,629 acres extend into eight towns. The refuge was created under the Migratory Bird Conservation Act *"for use as an inviolate sanctuary, or for any other management purpose, for migratory birds."*

The refuge is divided into two units: the Concord Unit (1,492 acres) and the Sudbury Unit (2,137 acres). The Concord and Sudbury units provide habitat for a variety of species. For example, the Concord impoundments are utilized by many migrating waterfowl, shorebirds, wading and marsh birds. The upland areas support woodcock, songbirds, and many raptors. The marsh habitats are utilized by amphibians and reptiles.

Great Meadows Refuge faces a growing problem with invasive species, particularly purple loosestrife, water chestnut and common reed. The refuge has implemented control methods for water

chestnut and purple loosestrife in an effort to reestablish a rich diversity of native vegetation.

The visitor center, located at the Complex headquarters in Sudbury, offers interpretive exhibits and educational and interpretive programing for visitors. A walking trail offers visitors wildlife observation and photography opportunities.

Oxbow National Wildlife Refuge

Oxbow Refuge. *USFWS Photo*

Oxbow Refuge was also formerly part of the Fort Devens base. The two original transfers from the Army in 1973 totalled 711 acres. All acres within the boundary are acquired. The refuge was established for its "*particular value in carrying out the national migratory bird management program* under an "Act Authorizing the Transfer of Certain Real Property for Wildlife Conservation Purposes Act of May 1948." In 1999, 836 additional acres along the Nashua River were transferred to the Service after the Fort Devens base closed. Recent acquisitions complete the boundary at 1,667 acres.

Oxbow Refuge protects forested upland, marsh and grassland habitats. The upland habitat is important for migratory song birds, turkey, white-tailed deer and small game mammals. Marshes and ponds along the Nashua River are important habitat for waterfowl and beaver.

A number of recreational activities occur at Oxbow Refuge. Visitors canoe, view wildlife, cross-country ski, fish and in some areas, hunt.

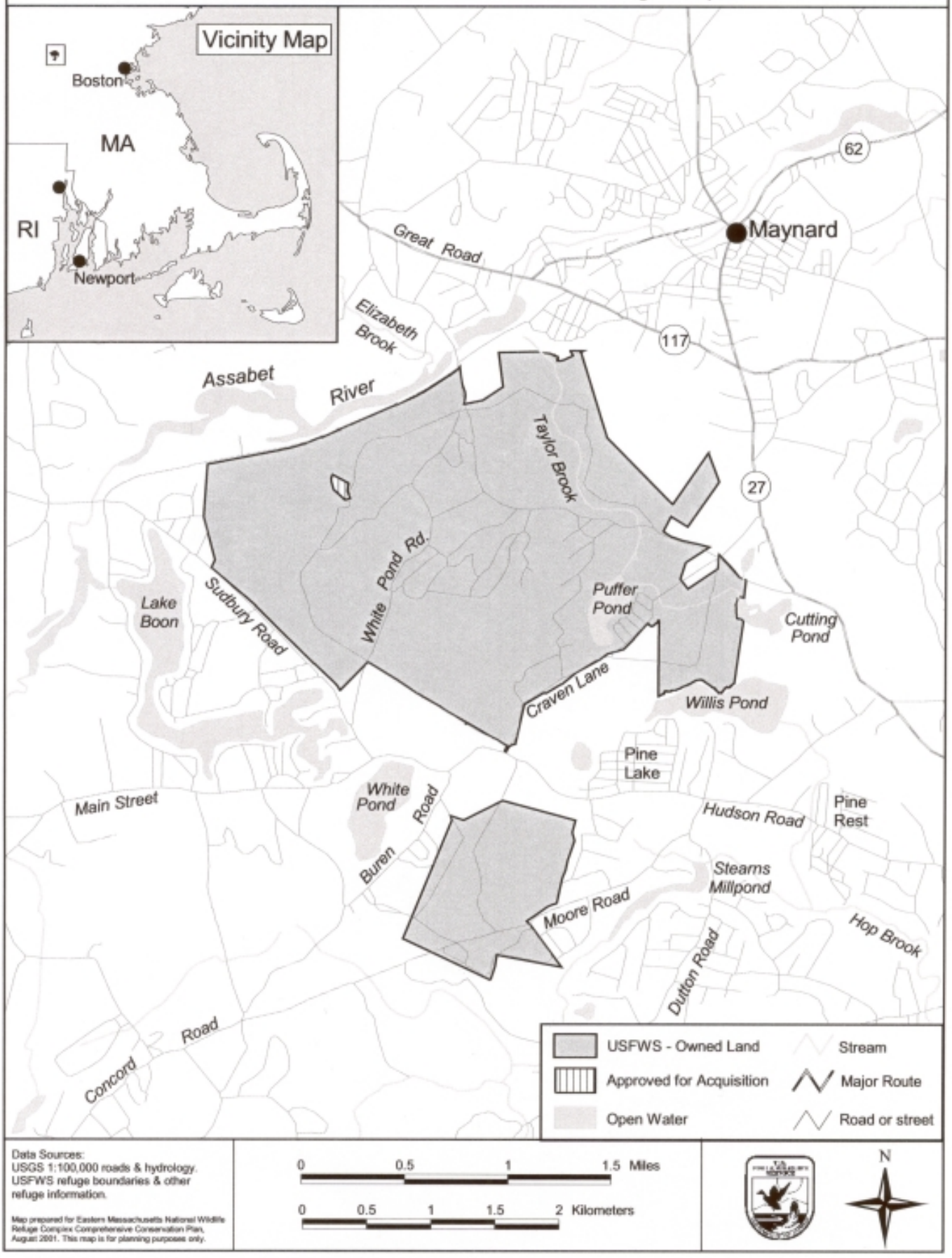
Other Areas Evaluated

Land protection in eastern Massachusetts is a high priority for many communities. As part of the CCP process, we evaluated lands which may be appropriate for Service management or ownership to support refuge purposes. In addition to areas immediately adjacent to the current refuge lands, we evaluated focus areas containing significant and important habitats within eastern Massachusetts. The Service worked intensively with communities, conservation organizations and state agencies to identify significant habitats in eastern Massachusetts for possible protection. In the future, We may look to expand refuge boundaries beyond what is currently protected to include these areas.

Assabet River National Wildlife Refuge - 2,230 acres

Middlesex County, Massachusetts

Eastern Massachusetts National Wildlife Refuge Complex



Data Sources:
USGS 1:100,000 roads & hydrology.
USFWS refuge boundaries & other refuge information.

Map prepared for Eastern Massachusetts National Wildlife Refuge Complex Comprehensive Conservation Plan, August 2001. This map is for planning purposes only.

0 0.5 1 1.5 Miles

0 0.5 1 1.5 2 Kilometers

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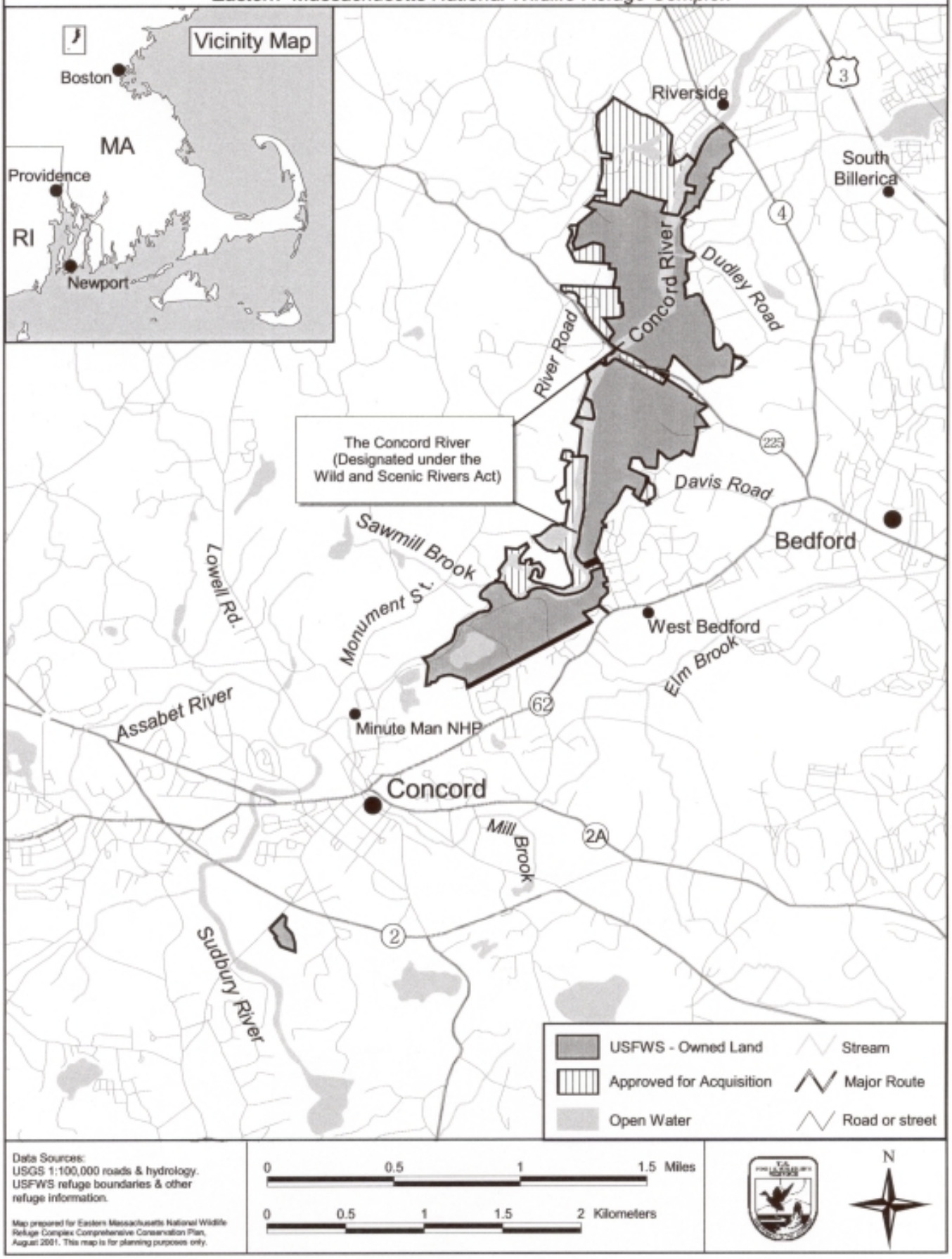
Great Meadows National Wildlife Refuge

Concord Unit - 1,492 acres

Middlesex County, Massachusetts

Eastern Massachusetts National Wildlife Refuge Complex

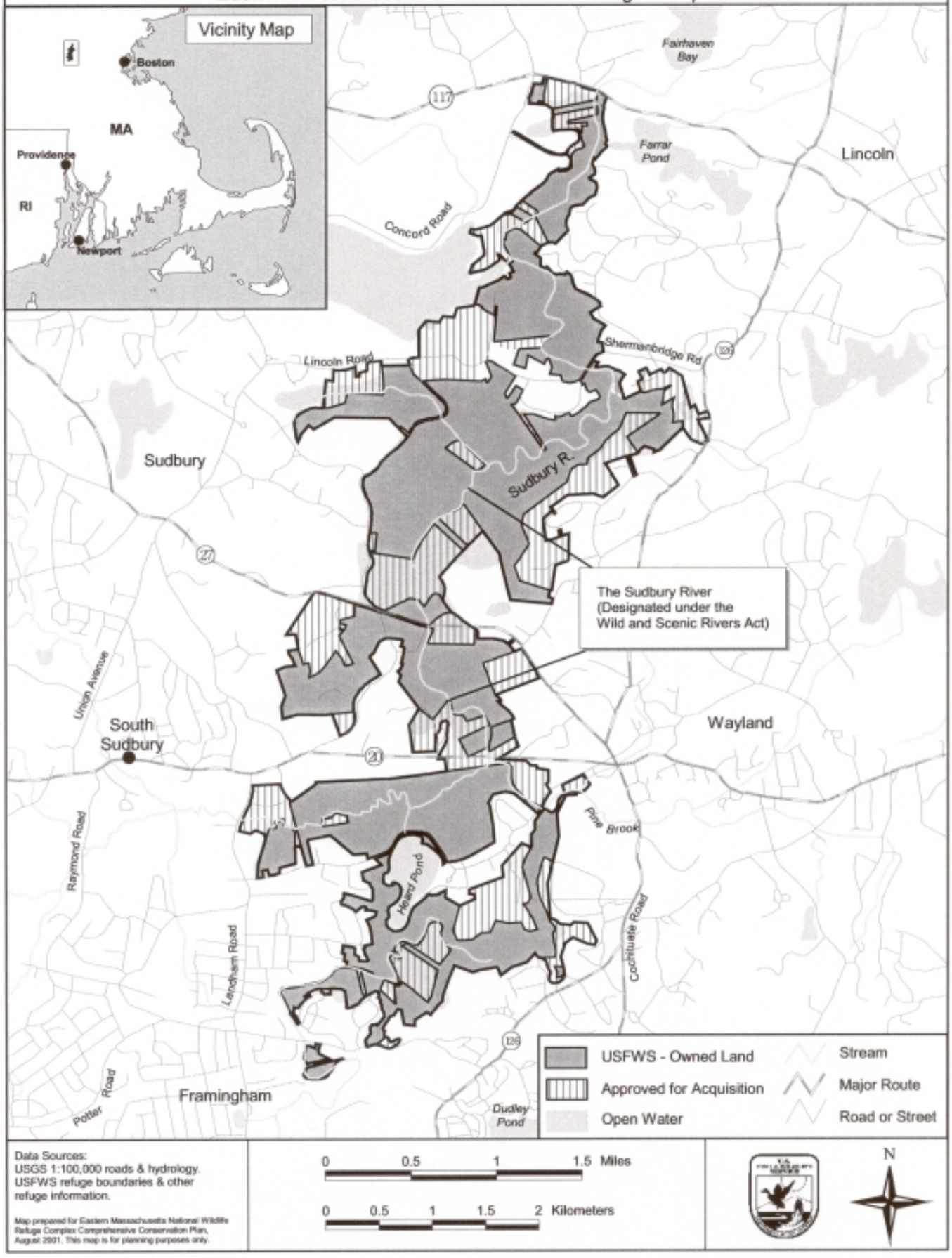


Great Meadows National Wildlife Refuge

Sudbury Unit - 2,137 acres

Middlesex County, Massachusetts

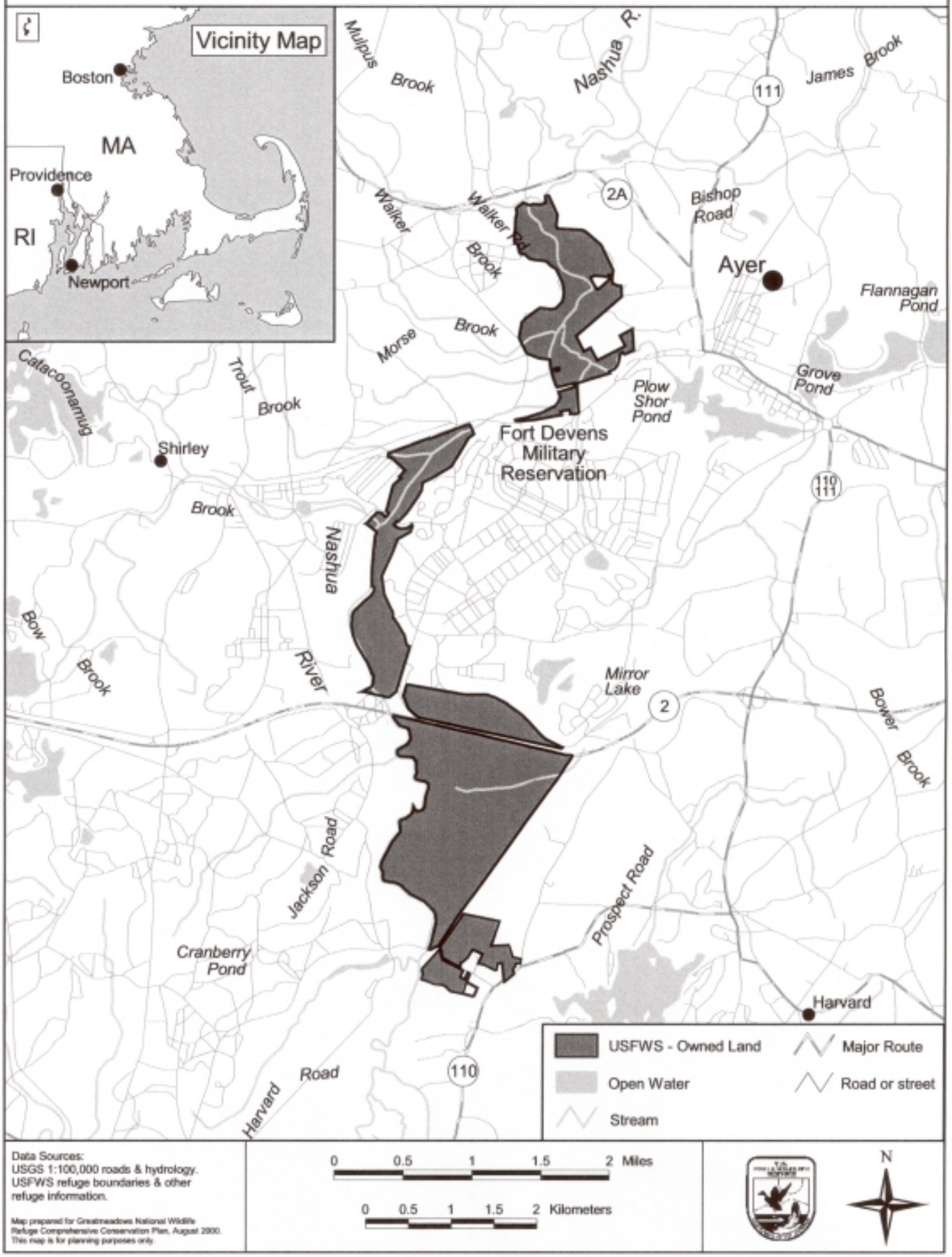
Eastern Massachusetts National Wildlife Refuge Complex



Oxbow National Wildlife Refuge - 1,667 acres

Middlesex and Worcester Counties, Massachusetts

Eastern Massachusetts National Wildlife Refuge Complex



Other Refuges of the Complex

As described earlier, Assabet River, Great Meadows and Oxbow refuges are managed as part of a complex of eight national wildlife refuges. In an effort to provide a better idea of how the vision and goals fit in the context of the Complex, we provide a brief overview of the other refuges in the Complex below.

Established in 1983, **Massasoit Refuge** is located in the Town of Plymouth, MA. The refuge was established under the Endangered Species Act of 1973 with the purpose of protecting and conserving land for the endangered Northern red-bellied cooter. The refuge consists of 184 acres of land cooperatively managed with the State of Massachusetts Division of Fisheries and Wildlife.

Mashpee Refuge is located in the towns of Mashpee and Falmouth. The refuge was established in 1995 and is an example of cooperative management between the Service and other agencies, Tribes, and organizations. The overall approved refuge boundary encompasses 5,871 acres of salt marsh, pine barrens, cranberry bogs, Atlantic white cedar swamps, freshwater marshes and a vernal pool, though the refuge protects only 275 acres in fee and easement.

Established in 1944, **Monomoy Refuge** was established "*for use as an inviolate sanctuary, or for any other management purpose, for migratory birds*." It is the only refuge in the Complex with Wilderness designation. Most of the refuge above mean low water is designated as Wilderness, part of the National Wilderness Preservation System.

Great Point Lighthouse. *Nantucket National Wildlife Refuge. USFWS Photo*

Nantucket Refuge includes 24 acres located in the town of Nantucket at the tip of Great Point. The refuge was established for its "*particular value in carrying out the national migratory bird management program.*" The Trustees of Reservations (TTOR), who owns and manages the adjacent wildlife sanctuary of Coskata-Coatue, currently manages the refuge for the Service under a Memorandum of Understanding.

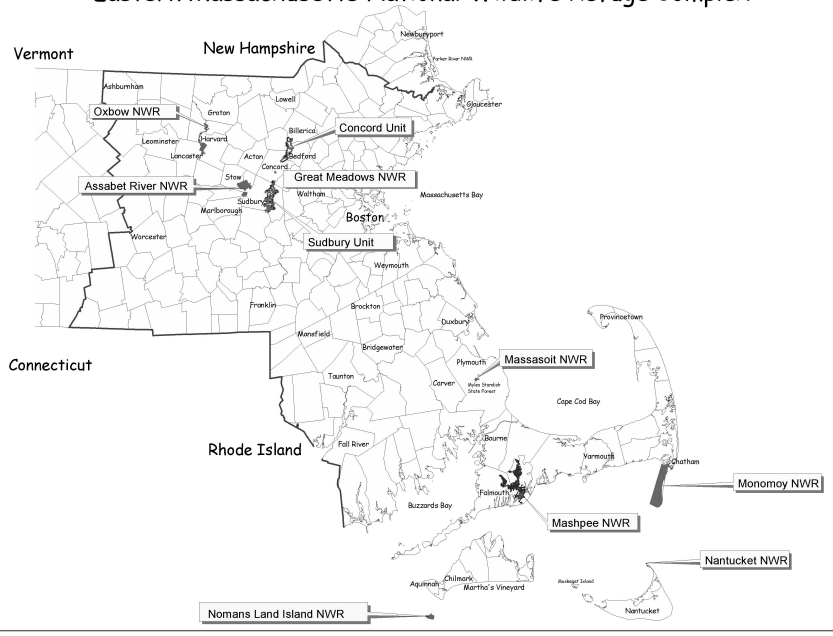
Since 1975, the Service has been managing **Nomans Land Island Refuge** as an overlay National Wildlife Refuge under a Joint Management Agreement between the Department of the Interior and Department of the Navy. In 1998, the Navy transferred the 628 acre island to the U.S. Fish and Wildlife Service. The establishment purpose for the refuge is "*for use as an inviolate sanctuary, or for any other management purpose, for migratory birds*" under the Migratory Bird Conservation Act.

Vision Statement for the Complex

The Eastern Massachusetts National Wildlife Refuge Complex will contribute to the mission of the National Wildlife Refuge System and support ecosystem–wide priority wildlife and natural communities. Management will maximize the diversity and abundance of fish and wildlife with emphasis on threatened and endangered species, migratory birds, and aquatic resources. The Complex will have a well-funded and community– supported acquisition program which contributes to wildlife conservation. The refuges will be well known nationally and appreciated in their communities. They will be seen as active partners in their communities, school systems, and environmental organizations which will result in high levels of support for the refuges. The refuges will be a showcase for sound wildlife management techniques and will offer top-quality, compatible, wildlife-dependent recreational activities. Refuges open to the public will provide staffed visitor contact facilities that are clean, attractive, and accessible, with effective environmental education and interpretation.

Goals for the Complex

The following goals of the Complex support the mission of the Refuge System and the Gulf of Maine Ecosystem Priorities (see section Regional Plans). These goals provide a general management direction for the refuges and will aid in choosing the preferred alternative for management in the final CCP.



Our vision and goals are for all the refuges in the Complex.

1. Recover threatened and endangered species of the Complex.

2. Protect and enhance habitats that support self-sustaining populations of Federal trust species and wildlife diversity.

3. Build a public that understands, appreciates, and supports refuge goals for wildlife.

4. Adequately protect cultural resources that occur in the complex.

5. Maintain a well-trained, diverse staff working productively toward a shared refuge vision.

Using these goals, we will develop a selected management approach in the final CCP. Each goal is supported by objectives identified in the following alternative section with specific strategies and tasks needed to accomplish them. Objectives are intended to be accomplished in a 10-to-15 year time frame. Actual implementation will vary as a result of available funding.

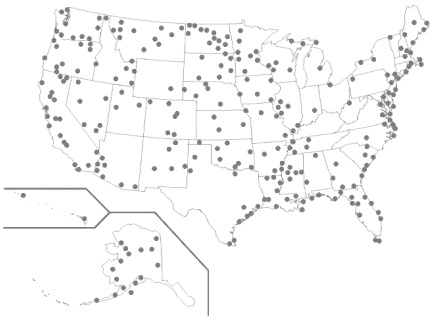
National and Regional Mandates and Plans Guiding this Project

U.S. Fish and Wildlife Service Mission

National Wildlife Refuges are managed by the Service under the Department of Interior. 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."*

The Service has primary responsibility for migratory birds, endangered species, anadromous and interjurisdictional fish, and certain marine mammals. These are referred to as Federal trust species. The Service also manages national fish hatcheries, enforces Federal wildlife laws and international treaties on importing and exporting wildlife, assists with State fish and wildlife programs, and helps other countries develop wildlife conservation programs.



The National Wildlife Refuge System.

Our mission is:

"To administer a national network of lands and waters for the conservation, management, and where appropriate, restoration of the fish, wildlife, and plant resources and their habitats within the United States for the benefit of present and future generations of Americans."

The National Wildlife Refuge System Mission

The Refuge System is the world's largest collection of lands and waters set aside specifically for the conservation of wildlife and ecosystem protection. The Refuge System consists of 538 national wildlife refuges that provide important habitat for native plants and many species of mammals, birds, fish, and threatened and endangered species, encompassing over 93 million acres. Refuges offer a wide variety of recreational opportunities, and many have visitor centers, wildlife trails, and environmental education programs. Nationwide, over 34 million visitors annually hunt, fish, observe and photograph wildlife, or participate in interpretive activities on national wildlife refuges.

In 1997, the Refuge Improvement Act established a unifying mission for the Refuge System, a new process for determining compatible public uses, and the requirement to prepare a CCP for each refuge. The new law states that the Refuge System must focus on wildlife conservation. It further states that the national mission, coupled with the purpose(s) for which each refuge was established, will provide the principal management direction for each refuge.

Laws

While the Refuge System mission and each refuge's purpose provide the foundation for management, national wildlife refuges are also governed by other Federal laws, Executive Orders, treaties, interstate compacts, and regulations pertaining to the conservation and protection of natural and cultural resources (See Appendix A for a more complete list of guiding laws).

A primary law affecting refuge management is the **National Wildlife Refuge System Administration Act of 1966** (Administration Act) which authorizes the Secretary of the Interior to permit any uses of a refuge "...whenever it is determined that such uses are compatible with the major purposes for which such areas were established." The Administration Act was amended by the Refuge Improvement Act of 1997. It is also the key legislation on managing public uses, and protecting the Refuge System from incompatible or harmful human activities to insure that Americans can enjoy Refuge System lands and waters.

Before activities or uses are allowed on a refuge, the uses must be found to be a "compatible use." A compatible use is a use, "...that will not materially interfere with or detract from the fulfillment of the mission of the Refuge System or the purposes of the refuge." Wildlife-dependent recreational uses may be authorized on a refuge when they are compatible and not inconsistent with public safety.

Additionally, it is Service policy to address how each refuge, with an approved CCP, can help achieve the goals of the National Wilderness Preservation System. Thus, concurrent with the CCP process, we have incorporated a summary of a wilderness review into this document (see Wilderness Review section).

The Refuge Recreation Act of 1962 requires that any recreational use of refuge lands be compatible with the primary purposes for which a refuge was established and not inconsistent with other previously authorized operations.

The **National Historic Preservation Act of 1966** provides for the management of historic and archaeological resources that occur on any refuge. Other legislation, such as the **Endangered Species Act**, the **North American Wetlands Conservation Act**, the **Wilderness Act of 1964** and particularly the **National Environmental Policy Act (NEPA)** all provide guidance for the conservation of fish and wildlife and their habitats. This EA is written to fulfill compliance with NEPA.

Regional Plans

In the past decade, partnerships with private landowners, tribes, conservation organizations, corporations, and State and Federal agencies have enabled the Service to manage from the perspective of interrelated parts of an ecosystem. The focus is on the resources of

Pickerel weed and tussock grass.
Photo by Marijke Holtrop

major watersheds or ecosystems. Goals and priorities for management, research and acquisition are guided by these cooperative efforts.

Gulf of Maine - Ecosystem Priorities

There are 52 Ecosystem teams across the country. The Complex falls in two of them, the Connecticut River/Long Island Sound Ecosystem and the Gulf of Maine Ecosystem.

Assabet River, Oxbow, Great Meadows, and Massasoit refuges are located in the Gulf of Maine Ecosystem (See Map 1-6). The ecosystem priorities are:

- Recover populations and habitats of endangered and threatened species.
- Protect, enhance, and restore habitats for migratory birds, anadromous and catadromous fishes, and listed species of concern in the Penobscot, Kennebec and Androscoggin River basins.
- Protect, enhance, and restore coastal habitats for trust resources of concern.
- Protect, enhance, and restore populations of migratory bird species of special concern and their habitats.
- Rebuild American shad and river herring populations in coastal rivers including the Merrimac River.
- Restore and rehabilitate Atlantic salmon populations in the Merrimac River.
- Manage Service lands to protect, enhance and restore habitats to maintain biodiversity.

North American Waterfowl Management Plan

The North American Waterfowl Management Plan (NAWMP) documents the strategy between the United States, Canada and Mexico to restore waterfowl populations through habitat protection, restoration, and enhancement. Implementation of the plan is at the regional level. Ten regional habitat "Joint Ventures" are partnerships involving federal, state, provincial, tribal nations, local businesses, conservation organizations, and individual citizens. Units of the Complex are contained within the Atlantic Coast Joint Venture.

"Protect and manage priority wetland habitats for migration, wintering, and production of waterfowl, with special consideration to black ducks, and to benefit other wildlife in the joint venture area." Goal for the Atlantic Coast Joint Venture

The Atlantic Coast Joint Venture Program identifies seven focus areas in Massachusetts. One of these focus areas includes the inland rivers of the Blackstone, Nashua, and the Sudbury-Assabet-Concord Rivers. Oxbow, Assabet River, and Great Meadows refuges are part of this focus area, with nationally significant wetlands that support migrating waterfowl.

Gulf of Maine Rivers Ecosystem

Data Sources:
USGS 1:2,000,000 hydrology & states.
All other data provided by USFWS.

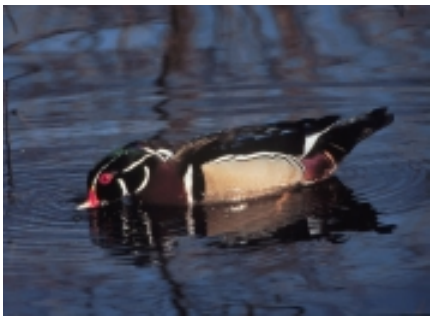
Map prepared for Eastern Massachusetts NWR Complex Comprehensive Conservation Plan October 2001.

Not to be used for legal purposes.

Partners in Flight Bird Conservation Plan: Southern New England Physiographic Area

Partners in Flight (PIF) was initiated in 1990 as a voluntary, international coalition of agencies, organizations, institutions, industries, and other citizens dedicated to landbird conservation. The foundation for PIF's long-term strategy for bird conservation is a series of scientifically based Bird Conservation Plans. The goal of each PIF Bird Conservation Plan is to ensure long-term maintenance of healthy populations of native landbirds. These plans use information on bird population trends, species' distributions, and the vulnerability of the species and their habitats to threats, to rank the conservation priority of birds occurring within a particular physiographic area. The PIF approach differs from many existing Federal and State-level listing processes in that it (1) is voluntary and nonregulatory, and (2) focuses proactively on relatively common species in areas where conservation actions can be most effective, rather than local emphasis on rare and peripheral populations.

PIF has completed a bird conservation plan for the Southern New England physiographic area, which includes all of eastern Massachusetts. This plan identifies 72 bird species and 7 major habitat types as priorities for conservation in this area. Of the priority species for this physiographic area, at least 23 of them are known to nest on refuges in the Complex, and an additional 34 species have been recorded as occurring on the refuges in the Complex. In the plan, focal species are selected for each habitat type and used in developing population and habitat objectives. Implementation strategies and management guidelines for achieving these objectives are also included for each habitat type. Priority habitats for Southern New England include maritime marshes, beaches/dunes, mature forest, early successional scrub/pine barrens, freshwater wetlands, and grasslands. The list of priority species, objectives, and conservation actions recommended in the Southern New England Bird Conservation Plan will be help direct landbird management on the refuges in the Complex.

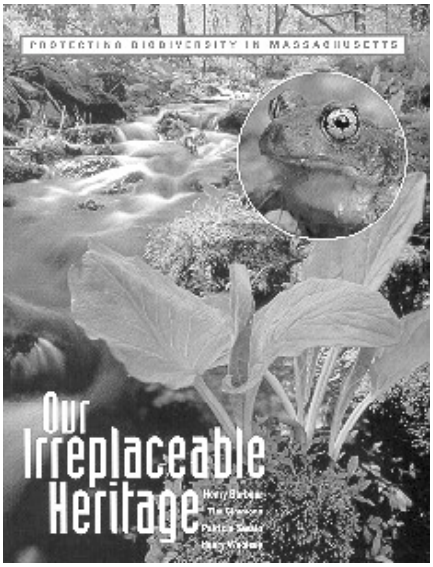


Wood duck. *Photo by Bruce Flaig*

Regional Wetlands Concept Plan- Emergency Wetlands Resources Act

In 1986, Congress enacted the Emergency Wetlands Resources Act to promote the conservation of our nation's wetlands. This Act requires identification of the location and types of wetlands, and which lands should be targeted for state and federal land acquisition efforts. In 1990, the Northeast Regional Office of the Service completed a Regional Wetlands Concept Plan to identify wetlands in the region. The Regional plan identifies a total of 850 wetland sites and complexes in the region, two of them are within the Complex acquisition boundary.

Our Irreplaceable Heritage - Protecting Biodiversity in Massachusetts, 1998. Massachusetts Division of Fisheries and Wildlife, and the Massachusetts Chapter of the Nature Conservancy.



This report recommends that the state develop a Biodiversity Protection Strategy that outlines how all native biodiversity will be conserved. It also identifies and describes eight types of natural communities that may require immediate conservation attention because of their potential vulnerability and large number of rare species they contain. Seven of the eight communities listed in the report occur within the Complex boundary.

The Comprehensive Conservation Planning Process and Public Involvement

Given the mandate in the Refuge Improvement Act to develop a CCP for each national wildlife refuge, the Complex began the planning process in 1998. We started by forming a core planning team of refuge staff and regional office planners. We placed a Notice of Intent to prepare an EIS in the January 1999 Federal Register to officially kick-off our planning effort.

First, we collected information on our biological and habitat resources. While in the process of collecting information, we initiated the public scoping and involvement part of the process. We held meetings with each town's Board of Selectmen and State and Federal agencies. Many of these partners provided information on natural resources and public uses on refuges in the Complex. In February of 1999 we held open houses in each town to provide an opportunity for public comment on different issues including current and future management strategies, land protection and public uses (See Chapter V for the schedule of public meetings). We were pleased with the participation at many of our meetings, which ranged from 30 people to over 100.

We recognized that attending our Open Houses would be difficult for many and designed an Issues Workbook to encourage additional comment. Over 8,000 people, representing a variety of interests received workbooks. Workbooks were also available at open houses and at the refuge headquarters. We received over 660 responses.

Using the information collected from our partners and through public comment we identified significant issues to be addressed in the plan. In August of 1999, we distributed a planning update to everyone on our mailing list describing the key issues identified for each refuge.

Once key issues were firmed up, we developed alternative strategies to resolve each one. We derived the strategies from public comment, follow-up contacts with partners and refuge staff. After a

reasonable range of alternatives was identified (see Chapter 2), we evaluated the environmental consequences of each alternative (see Chapter 4).

In February of 2001 we recognized that producing a CCP/EIS for the entire Complex would be far too cumbersome to be efficient. At that time, we published a Notice of Intent to prepare a CCP/EA for five of the refuges in the Complex, Assabet River, Great Meadows, Oxbow, Mashpee and Massasoit refuges. Additional issues and a need for more information prompted us to later split Mashpee and Massasoit refuges from this draft as well.

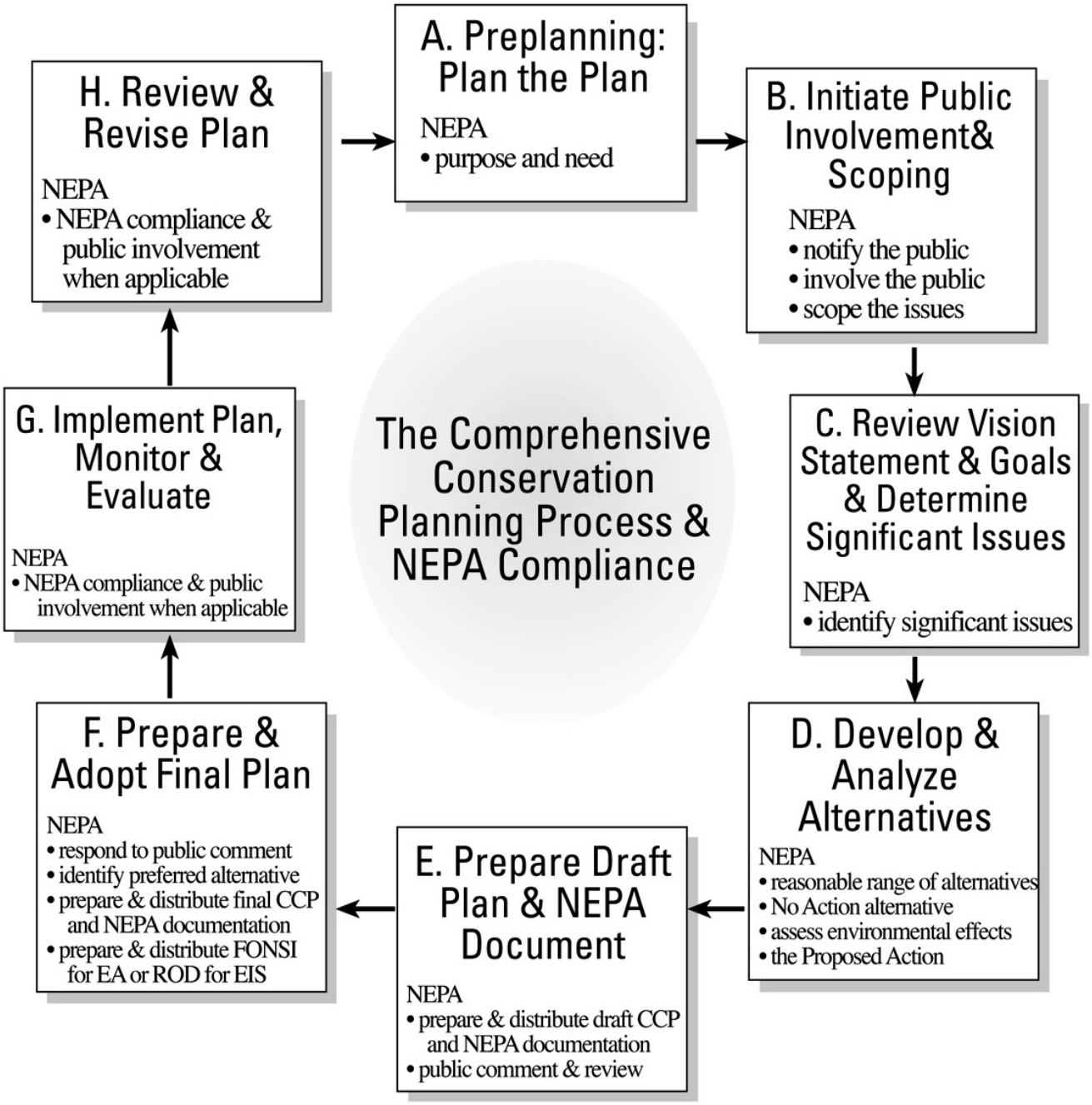
Following a public 45-day review of this draft CCP/EA, we will compile and respond to public comments in an Appendix to a final CCP/EA. The final CCP/EA will be submitted to the Regional Director for concurrence and approval of the preferred alternative. The Regional Director will then issue a decision in the Decision Memorandum. The final product of the process is three stand-alone CCPs, one for each refuge. We will publish a Notice of Availability of the final documents in the *Federal Register*. Implementation of the decision can occur once the FONSI is signed. We will then distribute final documents to interested parties.

Each year we will evaluate our accomplishments under the CCPs. Monitoring or new information may indicate the need to change our strategies. The collection of additional data at Assabet River, Great Meadows and Oxbow refuges will likely require modification and specification of the wildlife and habitat management strategies. We will modify the CCP documents and associated management activities as needed, following the procedures outlined in Service policy and NEPA requirements. The CCPs will be fully revised every 15 years, or sooner if necessary. Figure 1-1 displays the steps of the planning process and how it incorporates NEPA requirements.

Wilderness Review

The planning team conducted a Wilderness Review, as required under the Refuge Planning Policy, to determine if any lands and waters in fee title ownership were suitable to be proposed for designation as a Wilderness Area. During the inventory stage, we determined that none of the three refuges studied in this document fulfill the eligibility requirements for a Wilderness Study Area as defined by the Wilderness Act. All three refuges and their surrounding areas have been altered in some way by man, with the imprint of man's work generally noticeable. None of the areas inventoried have 5,000 contiguous acres, or are of sufficient size as to make practicable its preservation and use in an unimpaired condition. Furthermore, permanent roads are contained within most of the areas studied (See Maps 1-2 -1-5). Therefore, suitability of the lands for wilderness designation is not analyzed further in this document.

Figure 1-1. *The Comprehensive Conservation Planning Process and NEPA Compliance*



Step-Down Management Plans

The Refuge Manual (Part 4, Chapter 3) lists more than 25 step-down management plans generally required on most refuges. These plans describe specific management actions refuges will follow to achieve objectives or implement management strategies. Some require annual revisions, such as hunt plans, while others are revised on a 5-to-10 year schedule. Some of these plans require NEPA analysis before they can be implemented.

We consider the following plans up-to-date. We are not proposing revision or drafting these in this CCP.

- Fire Management Plan 2003
- Spill Prevention and Counter Measure Plan (new draft 2003, should be final soon)
- Water Management Plan 2002
- Integrated Pest Management and Housekeeping Plan 2002

These plans exist, but we consider them out of date and needing revision:

- Animal Control Plan
- Energy Contingency Plan
- Fishing Plan
- Fur Management Plan
- Immediate Response Action Plan-Maintenance Building
- Law Enforcement Management Plan
- Migratory Bird Disease Contingency Plan
- Public Use Plan
- Safety Management Plan
- Sign Plan
- Wildlife Inventory Management Plan

These step-down plans need to be initiated on all three refuges. Additional management plans may be required as future Service policy dictates.

- Wildlife Inventory Plan
- Habitat Management Plan
- Integrated Pest Management Plan
- Visitor Services Plan
- Refuge Hunt Plan
- Refuge Fishing Plan
- Cultural Resources Management Plan
- Pesticide Use Plan

Issues Identified Through Public Scoping

Issues, concerns, and opportunities were brought to the attention of the refuge planning team through early planning discussions with local governments, State, and Federal representatives, and through the public scoping process. We received comments from the public both verbally at open houses and in writing, through Issues Workbooks and individual letters. In addition issues were also identified by the Service. Many issues that are very important to the public often fall outside the scope of the decision to be made within this planning process. In some instances, the Service cannot resolve issues some people have communicated to us. For instance, water quality is a concern that was raised by many people. Proposed refuge management actions will work to improve water quality on the refuge, yet many sources of water pollution originate beyond refuge boundaries and are outside refuge staff ability to affect or change. For this reason, general water quality off-refuge is not analyzed in detail but is listed as a concern raised by the public. We have considered all issues throughout our planning process, and have developed alternative plans that attempt to address the significant issues in different ways where possible.

Water chestnut harvesting. *In the past, Great Meadows Refuge has harvested water chestnut to help control the spread of this invasive species. USFWS Photo*

Habitat and wildlife management.

Many people were interested in our management programs. The Complex has begun additional surveys and inventories to collect baseline information on the all refuges in the Complex. Our efforts at these refuges will help us develop a Habitat Management Plan which will provide a detailed description of our goals and objectives for habitat management on these refuges.

There is a lot of interest in how we manage the freshwater impoundments at Concord, Blanding's turtles at Oxbow and migratory birds and upland habitats on Assabet River, Oxbow and Great Meadows. Additionally, interest was expressed in creating an additional wildlife passage under Route 2 at Oxbow Refuge.

The public is concerned about what will happen with fencing that currently surrounds Assabet River Refuge and how it impacts wildlife movement. The fencing was not removed when the property was transferred to the Service.

Control of invasive, injurious, and overabundant plant and animal species.

Invasive species, including water chestnut, common reed, and purple loosestrife are a concern at Assabet River, Great Meadows and Oxbow refuges. These species limit the productivity of wildlife habitat. Management to control invasive species was mentioned as a watershed-wide priority to some conservation associations.

The refuges continue their efforts to control known invasives on the refuge. At Great Meadows Refuge, we are experimenting with different control techniques.

Hunting

Requests were made at public meetings and through written comments both to allow and not to allow deer hunting on the refuges. We received a petition requesting consideration of bow hunting at Assabet River Refuge. Currently, Oxbow Refuge is the only refuge in the Complex where hunting is allowed. Poaching is a problem on the Sudbury Unit of Great Meadows Refuge. There have been suggestions to provide lawful hunting opportunities on the refuge to control deer populations and deter poaching. Some would like to see waterfowl hunting on the Concord Unit of the Great Meadows Refuge. Cooperation with local towns and hunting groups was a suggestion. Others oppose hunting of any kind on the refuge. Again, there were suggestions both for and against hunting.

Management of public use and access.

The Eastern Massachusetts Refuge Complex Headquarters and interpretive and environmental education center is located in Sudbury, MA. Residents near Oxbow Refuge are anxious to have a visitor center/ education center closer to their refuge. Many people requested a visitor center at Fort Devens in an effort not to build on the refuge itself. Also, the need for environmental educational programs in local schools as well as additional interpretive opportunities where the public can learn about the refuges was also raised.

Public Use. *Many identified the need for additional environmental education opportunities on all three refuges. USFWS Photo*

Both Great Meadows and Oxbow refuges have high visitation numbers. We estimate use at Great Meadows Refuge to be around 500,000 visitors per year, with the majority of visitors at the Concord impoundments. Oxbow visitation is around 70,000 per year. These numbers are estimates. We do not have a consistent process for collecting and documenting visitation at all sites.

Several non-wildlife dependent recreational activities occur on the all three refuges. Trespass is occurring at Assabet River Refuge. Many visitors use trails at Oxbow and Great Meadows refuges for dog walking, jogging and bike riding.

Resource protection and visitor safety

Many people voiced concern for additional protection for cultural and historical resources, particularly at Assabet and Oxbow. Other concerns included the need to control poaching, trespassing and other refuge regulations violations. We need to address use of structures, especially at Assabet River Refuge, where a number of buildings need to be removed.

Infrastructure and Operations and Maintenance

We heard from some people that the Complex doesn't have the resources and staff needed to support programs and maintenance of the refuge.

Issues and Concerns Considered Outside the Scope of This Analysis

Some external threats to the refuges such as water quality and contamination were identified by the public.

Poor water quality in the Concord, Sudbury and Assabet Rivers prompted concern among citizens. The Concord and Sudbury Rivers both are reported to have high levels of contamination. In these watersheds, the Service is currently involved in watershed-wide efforts and partnerships to review and reduce impacts to the communities and to refuge resources. Service contaminants specialists represent wildlife interests in contaminants cleanup efforts that directly affect refuge lands, such as lands transferred to the Service or rivers that flow into the refuges. The clean up of Assabet River Refuge is being monitored by the Service. Some cleanup efforts are the responsibility of other agencies, such as contaminants cleanup from Otis/Edwards Air Force Base on the Cape. Nutrient loading in Waquoit Bay, in Mashpee, is a larger area problem created primarily from sewage management that is beyond the ability of Service employees to solve. Refuge staff or Service specialists are not often involved in such regional efforts.

Before the Army transferred the property to the Service, site contamination surveys were completed. The surveyed areas of the Fort Devens property that contained dangerous levels of arsenic were found and cleaned. However, many people are still concerned with possible contamination in bunkers and other sites on the refuge that have not been surveyed and/or cleaned. Both refuge and Army personnel are examining any possible impacts on the health of the visiting public. The Army has responsibility for the clean-up should additional measures be warranted.

Potential impacts to the local economy and quality of life due to Army base closures.

Portions of two refuges, Oxbow and Assabet River, are lands formerly under Army administration. In towns surrounding these two refuges, people questioned if the surrounding towns would be better off having a refuge as a neighbor or the continued presence of the Army with its population of Fort Devens. There was concern over the potential impact the Army's departure will have on the local community, including the economic effect on stores, restaurants, and other community services. The decision to close Fort Devens has already been made. As a redevelopment site, the population of the Army base is slowly, but not completely, being replaced by employees of the offices and businesses being established in the Devens facilities.

Those lands now administered by the Service will generate revenue sharing payments for the towns in which refuge land is located (see Chapter 2: Introduction, Refuge Revenue Sharing). Under Army administration, the lands comprising Assabet River Refuge were closed to any public access. As a national wildlife refuge, the area may be opened up in part to public access, as safety permits and if compatible with wildlife needs.

Some Towns wish to develop water supply wells on refuge property.

Some towns requested access for the purpose of drilling water supply wells. Wells have been shown to draw down the surrounding water table. A 1994 study by the Massachusetts Office of Water Resources identified that "wells can have a significant impact on nearby (surface) water bodies and may affect specific biological resources." Concerns were raised by the public during CCP scoping that disturbance to wildlife, and other impacts due to the wells, or access to the wells, could occur.

There is a proposal to expand use of Hanscom Air Field.

MassPort operates Hanscom Air Field, sited in Bedford, Concord, Lincoln, and Lexington. The proposal is to use the airstrip as an auxiliary airport for the Boston Airport, as well as increasing the number of flights per day. The Concord impoundments of Great Meadows Refuge lie directly west of Hanscom's east-west runway. The MassPort plans for expansion of Hanscom may affect wildlife conditions and visitor experience on Great Meadows Refuge. At issue are noise, overflights above a national wildlife refuge, fuel dumping that occurs on landing, water quality, and the concentration of storm water runoff from runways and impervious surfaces. Although the refuge isn't analyzing in detail various alternatives for resolving these issues with Hanscom Field, we support a restriction on volume of air travel to and from Hanscom.

Chemical control of mosquitoes on National Wildlife Refuges nationwide is being evaluated by the Service.

The Service is in the process of developing an EIS for mosquito control on refuges. In 2000, 2001, and 2002 mosquito spraying did not take place on any refuges in the Complex. Great Meadows Refuge is no longer involved in the East Middlesex Mosquito Control Project . Any future Service policy will be applied to Assabet River, Great Meadows and Oxbow refuges.

Jet Skis on the Concord River

Many residents and the National Park Service spoke against jet skis on the Concord River, particularly with its Wild and Scenic River status. The Massachusetts Department of Environmental Management prohibits the operation of watercraft "in excess of five miles per hour" when the craft is within 150 feet of any channel, tunnel, pier, mooring, wharf, or other floating structure or swimming beach." (MA State Forests and Parks regulation 304 CMR 12.34). The width of the rivers that flow through the refuges are rarely, if ever, in excess of 150 feet. It is therefore illegal to operate water craft, including jet skis, under State regulations, over five miles per hour within refuge boundaries. Jet skis interfere with wildlife-dependent recreation such as fishing, hunting, and wildlife observation from canoes. Fishing recreationists have frequently complained of jet ski disturbance during their use of the refuge. Some have suggested that this problem could be countered with better patrolling by the refuge.

Chapter 2

Eastern bluebird. *Photo by Bruce Flaig*

Alternatives

- Formulating Alternatives
- Features Common to All Alternatives
- Features Common to All Action Alternatives (B & C)
- Alternatives or Actions Considered, but Eliminated From Further Evaluation

- Part 1: Assabet River National Wildlife Refuge
- Alternative A: Current Management
- Alternative B: Proposed Action
- Alternative C
- Alternative Matrix

- Part 2: Great Meadows National Wildlife Refuge
- Alternative A: Current Management
- Alternative B: Proposed Action
- Alternative C
- Alternative Matrix

- Part 3: Oxbow National Wildlife Refuge
- Alternative A: Current Management
- Alternative B: Proposed Action
- Alternative C
- Alternative Matrix

Formulating Alternatives

This chapter describes and fully evaluates three alternatives spanning a reasonable range of actions for managing Assabet River, Great Meadows and Oxbow refuges and addressing the key issues identified in Chapter 1.

One of our primary objectives is to clearly define the differences among the alternatives. At the end of each part of this chapter, you will find a matrix that compares and contrasts the alternatives by their specific management actions and strategies in tabular format (Tables 2-4, 2-6 and 2-8). We organized the matrix to associate actions and strategies with their function in addressing key issues.

Alternatives are packages of complementary management strategies and specific actions for achieving the missions of the Refuge System and the Service, the vision and goals of the Complex, and the purpose for establishing each refuge. Primarily, they propose different ways of responding to key issues, and secondarily, different ways of dealing with the other issues, management concerns, and opportunities identified during the planning process. While those elements underlie every alternative, each is distinguished by its intensity and timing in committing the resources necessary to achieve desired future conditions.

Features Common to All Alternatives for All Refuges

This chapter describes current management and two alternatives for each issue identified in Chapter 1. We describe refuge specific actions in Parts 1, 2 and 3 of this chapter. In order to be concise and eliminate repetition, we have described actions that are common to all alternatives, including the Current Management Alternative, for all refuges in this beginning section. These issues are not reevaluated in later sections of the document.

Fire Management

U. S. Department of the Interior and Service policy state that Refuge System lands with vegetation capable of sustaining fire will develop a Fire Management Plan (FMP) (620 DM 1.4B; 621 FW 1.1.1). The FMP, which includes Great Meadows, Assabet River, and Oxbow refuges, provides direction and continuity in establishing operational procedures to guide all fire management objectives as identified in the plan. This plan was finalized in March of 2003. The FMP includes descriptions of the refuges and addresses wildland and prescribed fire events. The FMP also defines levels of protection needed to ensure safety, protect facilities and resources, and restore and perpetuate natural processes, given current understanding of the complex relationships in natural ecosystems. It is written to comply with a service-wide requirement that refuges with burnable vegetation develop a FMP (620 DM 1).

The associated EA was prepared in compliance with NEPA and the Council on Environmental Quality (CEQ) Regulations (40 CFR Parts1500 -1508). It provides a description of the purpose and need for the project, a brief background, the features of each alternative, the affected environment, and resulting effects and consequences of each alternative. The selected alternative, "prescribed fire and wildland fire suppression" is discussed in detail in the EA. Alternatives which were considered, but not selected, include differing combinations of: allowing naturally ignited fires to burn in some instances; use of prescribed burning to achieve wildlife resource and habitat objectives; and, wildland fire suppression. A "no-action" alternative of allowing all fires to burn at all times was initially considered, but dismissed as not suitable for further consideration in the development of this proposal. The no-action alternative was rejected because it fails to meet Service policy in regards to potential liability for losses of life and property, as well as its unacceptable environmental, social, and economic costs.

The mission of the Complex is to protect and provide quality habitat for fish and wildlife resources and for the development, advancement, management, and conservation thereof. By defining an appropriate level of wildland fire protection, and integrating a prescribed fire program based on biological needs, the FMP and EA are fully supportive and sensitive to the purpose of the Complex, and of benefit to the Service, in performing its activities and services.

If you would like a copy of the FMP, or the EA, please contact the Refuge Headquarters in Sudbury.

Land Protection

The Service is currently working on a new national land conservation policy and strategic growth initiative. This policy will develop a vision and process for growth of the Refuge System, helping individual refuges better evaluate lands suitable for inclusion in the Refuge System. The process will help insure that lands the Service protects are of national and regional importance and meet certain nationwide standards and goals. Also, some of the focus of reevaluating Refuge System growth has come from the need to address nationwide operations and maintenance (O&M) backlogs on existing properties. Many refuges, including Assabet River, Great Meadows and Oxbow, are not fully staffed under current budgets and have significant O&M backlogs. Expanding boundaries creates a need for additional staff, O&M funds, as well as additional dollars for the land protection itself. Our Director has asked that we focus, in the interim, on acquiring inholdings within already approved boundaries, which is our proposal under all alternatives for these three refuges.

Cattails at Assabet River Refuge.
Photo by Marijke Holtrop

In the future, we may look at wetland, upland and river systems near Assabet River, Oxbow and Great Meadows refuges which are of interest for possible private-lands habitat improvement projects, easements, and/or acquisition. In particular, we believe protection of lands associated with the Sudbury, Assabet and Concord River watershed are important for the health of fish and wildlife on the refuge. We will continue to protect and acquire lands within the present acquisition boundary at Great Meadows. All lands within the Assabet River and Oxbow refuge acquisition boundaries are already acquired. See Maps 1-3, 1-4 and 1-5 for the acquisition boundaries and refuge owned lands.

The Service's land acquisition policy is to obtain the minimum interest necessary to satisfy refuge objectives. Conservation easements can sometimes be used in this context, when they can be shown to be a cost-effective method of protection. In general, conservation easements must preclude destruction or degradation of habitat, and allow refuge staff to adequately manage uses of the area for the benefit of wildlife. Because development rights must be included, the cost of purchasing conservation easements often approaches that of fee title purchase, thus rendering this method less practical. Nevertheless, donations of easements or voluntary deed restrictions prohibiting habitat destruction would be encouraged. In addition, the Service could negotiate management agreements with local and State agencies, and accept conservation easements on upland tracts.

Funding for land acquisition comes from the Land and Water Conservation Fund and the Migratory Bird Conservation Fund under the Migratory Bird Conservation Act.

Property Taxes, Refuge Revenue Sharing, Relocation, and Landowner Rights

The Refuge Revenue Sharing Act of June 15, 1935, as amended, provides annual payments to taxing authorities, based on acreage and value of refuge lands located within their jurisdiction. Money for these payments comes from the sale of oil and gas leases, timber sales, grazing fees, the sale of other Refuge System resources, and from Congressional appropriations. The Congressional appropriations are intended to make up the difference between the net receipts from the Refuge Revenue Sharing Fund and the total amount due to local taxing authorities. The actual Refuge Revenue Sharing Payment does vary from year to year, because Congress may or may not appropriate sufficient funds to make full payment.

The Refuge Revenue Sharing Payments are based on one of three different formulas, whichever results in the highest payment to the local taxing authority. In Massachusetts, the payments are based on three-quarters of one percent of the appraised market value. The purchase price of a property is considered its market value until the property is reappraised. The Service reappraises the value of refuge

Table 2-1. ***Revenue Sharing Payments for Towns Associated with Assabet River, Great Meadows and Oxbow National Wildlife Refuges***

Assabet River		**Hudson**	**Maynard**	**Stow**	**Sudbury**
	2001	$863	$15,395	$21,286	$10,179
	2000	$846	$15,083	$20,854	$9,972
	1999	N/A	N/A	N/A	N/A
Great Meadows		**Bedford**	**Billerica**	**Carlisle**	**Concord**
	2001	$10,181	$2,988	$10,839	$5,853
	2000	$7,796	$1,743	$1,804	$11,283
	1999	$8,887	$622	$2,056	$12,862
		Lincoln	**Sudbury**	**Wayland**	
	2001	$174	$29,331	$26,806	
	2000	$134	$23,421	$18,196	
	1999	$153	$26,699	$20,641	
Oxbow		**Ayer**	**Harvard**	**Lancaster**	**Shirley**
	2001	$1,023	$17,328	$7	$833
	2000	$1,002	$5,193	$7	$816
	1999	$1,136	$5,939	N/A	$927

lands every five years, and the appraisals are based on the land's "highest and best use". On wetlands and formerly farmland-assessed properties, the full entitlement Refuge Revenue Sharing Payments sometimes exceed the real estate tax. In other cases, Refuge Revenue Sharing payments may be less than the local real estate tax.

The fact that refuges put little demand on the infrastructure of a municipality, must be considered in assessing the financial impact on the municipality. For example, there is no extra demand placed on the school system, roads, utilities, police and fire protection, etc. The owner of land adjacent to refuge land, or with acquisition boundary, retains any and all the rights, privileges, and responsibilities of private land ownership. The refuge controls uses only on the properties it owns.

Accessibility

Each refuge will operate its programs or activities so that when viewed in its entirety, it is accessible and usable by disabled persons. The Rehabilitation Act of 1973, as amended, requires that programs and facilities be, to the highest degree feasible, readily accessible to, and usable by, all persons who have a disability.

Protection and Management of Cultural Resources

The Service has a legal responsibility to consider the effects its actions have on archeological and historic resources. Under all alternatives, we will comply with Section 106 of the National Historic Preservation Act before conducting any ground disturbing activities. Compliance may require any or all of the following: State Historic Preservation Records survey, literature survey, or field survey.

Special Use Permits and Memorandum of Understanding and Agreement

Guided tours, by outside groups, are permitted on the refuges if the activity is determined to be appropriate and compatible with the refuge(s) purpose. Permitting will be divided into four categories by the type of use and the regularity of the activity requested. Where appropriate one Permit or Agreement will be developed for all three northern refuges in the Complex including Oxbow, Assabet River and Great Meadows.

Special Use Permits may be issued to user groups or individuals for annual or single events. These organizations or individuals are those who want to use the refuges for a special purpose (e.g. commercial photographer, special event or research study), or to gain access to an area otherwise closed to the public (e.g. one time entrance to closed areas to film/photograph special event or hold special wildlife celebration day on refuge). Groups will be given specific requirements and educational guidelines on materials to present to the public. The specific charge and specific requirements will be determined on a case by case basis.

A Memorandum of Understanding (MOU) or Memorandum of Agreement (MOA) may be issued to user groups/individuals who want to use the refuges for a special purpose or gain access to an area otherwise closed to the public, on a regular basis or annually. Those issued a MOU do not make a profit from the event/program/ study (e.g., a group providing educational tours to the public for minimal or no fee, or a researcher conducting a multi-year project on the refuges.), while those obtaining a MOA charge a fee to all participants above and beyond the cost of the program. Groups will be given specific requirements and educational guidelines on materials to present to the public. The specific charge and specific requirements will be determined on a case-by-case basis.

A concession may be developed if a business operated by private enterprise is providing a public service (recreational, educational and interpretive enjoyment of our lands and waters for the visiting public), and generally requires some sort of capital investment.

Concessionaires will generally gross a minimum of $1,000 and the concession will be charged either a fixed franchise fee or a percent of gross income. Groups will also be given specific requirements and educational guidelines on materials to present to the public.

Volunteer Opportunities and Educational Programs

As the Assabet River, Great Meadows and Oxbow refuges continue to contribute to the quality of life in east-central Massachusetts, strong support in the community and the region will also continue to contribute to its success. Helping hands are needed for program development, data gathering, and other opportunities discussed in these alternatives. Only with this type of assistance can the refuge fully achieve its goals and objectives, support the missions of the Refuge System and the Service, and help meet the needs of the community.

Volunteers participate in a wide variety of activities. These include wildlife and wildlands photography, assisting with or conducting educational and interpretative programs, providing information to visitors, conducting observations and surveys of wildlife species, botanical surveys, fabrication of wood duck and bluebird boxes, litter pick-up, trail clearing and maintenance, sign rehabilitation, and other maintenance projects.

The volunteer program at the Complex has been growing steadily. In 1990, volunteers provided more than 3,435 hours of assistance to the Refuge Complex. In 2000, volunteers provided 20,675 hours of service. The total for 2001 was 25,432. Six thousand of those hours were at Assabet River, 5,870 at Oxbow and 2,641 at Great Meadows. Much of this volunteer work was done by core volunteers and active Friends Group members. In 2002, we again received incredible support from volunteers. We are deeply indebted to all of our volunteers for their dedication and services rendered for the betterment of our nation's natural resources.

Research

The Service encourages and supports research and management studies on refuge lands that improve and strengthen natural resource management decisions. The refuge manager encourages and seeks research relative to approved refuge objectives that clearly improves land management, promotes adaptive management, addresses important management issues or demonstrates techniques for management of species and/or habitats. Priority research addresses information that will better manage the Nation's biological resources and is generally considered important to: Agencies of the Department of Interior; the U.S. Fish and Wildlife Service; the National Wildlife Refuge System; and State Fish and Game Agencies, or important management issues for the refuge.

We will consider research for other purposes, which may not directly relate to refuge specific objectives, but may contribute to the broader enhancement, protection, use, preservation and management of native populations of fish, wildlife and plants, and their natural diversity within the region or flyway. These proposals must still pass the Service's compatibility policy.

We will maintain a list of research needs that will be provided to prospective researchers or organizations upon request. Our support of research directly relates to refuge objectives and may take the form of: funding, in-kind services such as housing or use of other facilities, direct staff assistance with the project in the form of data collection, provision of historical records, conducting of management treatments, or other assistance as appropriate.

All researchers on refuges, current and future, will be required to submit research proposals which include a detailed research proposal following Service Policy FWS Refuge Manual Chapter 4 Section 6. All proposals must be submitted at least three months prior to the requested initiation date of the project. Special Use Permits must also identify a schedule for annual progress reports. The Regional Refuge biologists, other Service Divisions and State agencies may be asked to review and comment on proposals.

Monitoring and Adaptive Management

The Final CCP will cover a 15-year period. Periodic review of the CCP will be required to ensure that established goals and objectives are being met, and that the plan is being implemented as scheduled. To assist this review process, a monitoring and evaluation program would be implemented, focusing on issues involving public use activities, and wildlife habitat and population management.

Monitoring of public use programs would involve the continued collection and compilation of visitation figures and activity levels. In addition, research and monitoring programs would be established to assess the impacts of public use activities on wildlife and wildlife habitat, assess conflicts between types of refuge uses, and to identify compatible levels of public use activities. We will reduce these public use activities if we determine that incompatible levels were occurring.

Collection of baseline data on wildlife populations and habitats will be implemented. This data would update often limited existing records of wildlife species using the refuge, their habitat requirements, and seasonal use patterns. This data would also be used in the evaluation of the effects of public use and habitat management programs on wildlife populations.

Refuge habitat management programs would be monitored for positive and negative impacts on wildlife habitat and populations and the ecological integrity of the ecosystem. The monitoring will be of assistance in determining if these management activities are helping to meet refuge goals and objectives. Information resulting from monitoring would allow staff to set more specific and better management objectives, more rigorously evaluate management objectives, and ultimately, make better management decisions. This process of evaluation, implementation and reevaluation is known simply as “adaptive resource management”.

Features Common to All Action Alternatives (B and C) for All Refuges

These are actions common to all action alternatives (B and C). While some of these actions occur under current refuge management, we have described additional steps or actions we would take under Alternative B or C in this section.

The Compatibility Determination

Federal law and Service policy provide the direction and planning framework to protect the System from incompatible or harmful human activities, and to insure that Americans can enjoy Refuge System lands and waters. The National Wildlife Refuge System Administration Act of 1966, as amended by the National Wildlife Refuge System Improvement Act of 1997 (Public Law 105-57), is the key legislation regarding management of public uses and compatibility. The compatibility requirements of the Refuge Improvement Act were adopted in the Service's Final Compatibility Regulations and Final Compatibility Policy published October 18, 2000 (Federal Register, Vol. 65, No. 202, pp 62458-62496). This Compatibility Rule changed or modified Service Regulations contained in Chapter 50, Parts 25, 26 and 29 of the Code of Federal Regulations (USFWS 2000c). To view the policy and regulations online, go to http://policy.fws.gov/library/00fr62483.pdf.

The Act and Regulations require that an affirmative finding be made of an activity's "compatibility" before such activity or use is allowed on a national wildlife refuge. A compatible use is one, "...that will not materially interfere with or detract from the fulfillment of the mission of the Refuge System or the purposes of the refuge" (Refuge Improvement Act). Six priority, wildlife-dependent uses that are to be considered at each refuge are defined in the Act and Regulation. These are: hunting, fishing, wildlife observation and photography, environmental education and interpretation. These priority, wildlife-dependent uses may be authorized on a refuge when they are compatible (as defined above), and not inconsistent with public safety. Not all uses that are determined compatible may be allowed. The refuge has the discretion to allow or disallow any use based on other considerations such as public safety, policy and available funding. However, all uses that are allowed must be determined compatible. Except for consideration of consistency with State laws and regulations as provided for in subsection (m) of the Act, no other determinations or findings are required to be made by the refuge official under this Act or the Refuge Recreation Act for wildlife-dependent recreation to occur. (Refuge Improvement Act).

The Complex completed compatibility determinations for these six priority public uses for Assabet River, Great Meadows, and Oxbow Refuges under existing Service regulations and policy, the Act and the recent revisions of our Compatibility Regulations (Appendix B).

Each (with some restrictions) was found to be compatible with both the mission of the System and the purposes for which the refuges were established. We are issuing these compatibility determinations, for the these activities, as part of this CCP.

We have also determined several modes of travel to be compatible. These are: walking or hiking, snowshoeing, canoeing, and cross-country skiing. All of these means of locomotion are subject to compatibility determinations for these activities as part of this CCP. The compatible uses for Assabet River, Great Meadows, and Oxbow refuges are summarized in Table 2-1.

In addition, we have evaluated several other methods of locomotion (specifically, use of motor-vehicles in general, all-terrain vehicles, dirt bikes, gasoline-powered motor boats, snowmobiles, dogsleds, bicycles, and horses). Each of these has been determined to be incompatible with the purpose for which the refuges were established (additional information regarding these uses is provided in this chapter under section Alternatives or Actions Considered, but Eliminated from Further Consideration).

Wildlife and Habitat Management

Assabet River, Great Meadows and Oxbow refuges are currently managing their lands for wetland species, forest dwellers and those species requiring grassland, wetland and old field habitat. However, due to the relatively small land base we have, it is important for us to consider how we can best contribute to the overall picture of trust species of the Atlantic flyway. The Northeast Region of the Refuge System is currently working on a region-wide strategic plan to establish management goals for refuges which address landscape concerns and needs. We are currently gathering data, as described in Alternative A, to better understand the role these refuges for these species and under Alternative B we propose additional surveying, monitoring and researching of our lands. This information is essential for determining our management focus. Using this information and guidance from the regional strategic plan we will draft a Habitat Management Plan for each refuge which outlines the direction and details of refuge management. The Habitat Management Plan will include information required under the Service's Biological Integrity, Diversity and Environmental Health Policy, including discussion of historic conditions and restoration of those conditions if possible (see http://policy.fws.gov/601fw3.html to view this policy).

Table 2-2. *Summary of Compatible Uses on Assabet River, Oxbow, and Great Meadows National Wildlife Refuges.*

Wildlife Dependent Recreational Activities and Other Compatible Uses	Assabet River National Wildlife Refuge		Great Meadows National Wildlife Refuge		Oxbow National Wildlife Refuge	
	Existing Activity	Allowed Under Alt. B	Existing Activity	Allowed Under Alt. B	Existing Activity	Allowed Under Alt. B
Wildlife Observation	No	Yes	Yes	Yes	Yes	Yes
Wildlife Photography	No	Yes	Yes	Yes	Yes	Yes
Environmental Education	No	Yes	Yes	Yes	Yes	Yes
Environmental Interpretation	No	Yes	Yes	Yes	Yes	Yes
Hunting- Small game and upland birds	No	Yes*	No	No	Yes	Yes*
Hunting - woodcock and waterfowl	No	Only after surveys	No	Yes*	woodcock only	Yes* (waterfowl on river only)
Hunting-deer	No	Yes*	No	Yes* (archery only)	No	Yes*
Fishing-pond	No	Yes*	No	No	N/A	N/A
Fishing -river	N/A	N/A	Yes	Yes	Yes (from boat & bank)	Yes
Natural history tours	Yes	Yes	Yes	Yes	Yes	Yes
Cultural history tours	Yes	Yes	N/A	N/A	N/A	N/A
Snowshoeing and cross country skiing (to facilitate wildlife dependent uses)	No	Yes	Yes	Yes	Yes	Yes
canoeing (to facilitate wildlife dependent uses)	No	Yes	Yes (on the river only)	Yes (on the river only)	Yes	Yes

*Please refer to the maps for Alternative B for specific locations where these activities are proposed.

New Recreational Fees

Under Alternatives B and C, the Complex would charge an entrance fee at Assabet River and Oxbow refuges and at the Concord impoundments at Great Meadows Refuge, and a user fee for hunting on the Complex. Our fee program would be established under the Recreation Fee Demonstration Program, a program which Congress initiated in 1997 to encourage Department of Interior agencies who provide recreational opportunities to recover costs for their public use facilities, improve visitor facilities, promote activities for visitors and address the maintenance backlog of visitor service projects (USFWS 1997a). The Program is authorized through 2004 at which time Congress will evaluate its success and either make it a permanent part of the Recreation Fee Program on our National lands or revise the Program. The Program requires at least 70% of revenue remain at the collection site. Currently, 80% of the funds raised from user fees on a particular refuge in this region stay at the refuge. The other 20% is sent to the region to be distributed to other refuges. Great Meadows Refuge has received money from these regional funds in previous years for public use facilities. If the program does become permanent, the percent of revenue remaining on site could change, however it would never be less than 70% and could be as much as 100%. Visitors with a current duck stamp, Golden Eagle Pass, Golden Age Pass or Golden Access Pass do not have to pay entrance fees. For more information on the Recreation Fee Demonstration Program visit http://www.ios.doi.gov/nrl/Recfees/RECFEE.HTM.

Refuge staff assist students with environmental education project.
USFWS Photo

The following fee program would be initiated at Great Meadows and Oxbow refuges and at Assabet River Refuge after it is opened.

- A one day access fee will be charged by car or per group if arriving via foot or bicycle. Our proposed fee would be $4 per day.
- An annual pass for three refuges in the Complex (Assabet River, Great Meadows and Oxbow) would be available for $20.
- All entrance fees will be collected by refuge staff stationed on site or at self-service fee collection stations.
- An annual fee of $10 for small game and upland game bird hunting, $15 for deer hunting or a combined $20 fee for all hunting seasons open on the refuge would be charged. One permit would be valid for any of the refuges in the Complex that are open to hunting. Hunting fees will be paid when the permit is issued. A hunter, with a valid hunt permit, would not have to pay an entrance fee.

We may adjust fees over the 15 year period addressed in this plan to reflect changes in administrative costs or management goals.

Hunting and Fishing

The following discussion is applicable to all alternatives proposing hunting. For the description of the proposed hunting areas, see Parts 1, 2, and 3 of this chapter.

A Hunt Plan will be completed following the final NEPA decision and approval of this CCP. NEPA compliance will be met with this document, however any necessary, refuge-specific regulations or restrictions will be described in the Hunting or Fishing Plan, disseminated through refuge hunting brochures, news releases, and on-refuge informational signing and published in the Federal Register for additional comment and review.

The refuge weighs a number of factors in opening an area to hunting or fishing, including visitor safety considerations. Under the Proposed Action and Alternative C, the Refuge Manager may, upon annual review of the hunting program, impose further restrictions on hunting and fishing activity, recommend that the refuge be closed to hunting or fishing, or further liberalize hunting or fishing regulations within the limits of State law. Restrictions would occur if hunting or fishing becomes inconsistent with other higher priority refuge programs or endangers refuge resources or public safety.

Annual permits would be required for hunting on the refuge. The permits will facilitate managing numbers of hunters and harvest. Fees charged for these permits would offset costs associated with managing hunting programs. For additional information on the fee program, see previous section on New Recreational Fees.

Providing hunting and fishing opportunities addresses the mandates of Executive Order 12996 and the Refuge System Improvement Act of 1997 by providing the public with an opportunity to engage in wildlife-dependent recreation. Hunting and fishing are recognized by the Service as traditional forms of wildlife related outdoor recreation. We anticipate a low to moderate degree of hunting and fishing pressure to occur as a result of opening the refuge for these activities. The plan to permit hunting and fishing on the refuge should not significantly affect the wildlife populations in Massachusetts, as the refuges represent only a very small portion of the overall habitat available in Eastern Massachusetts.

Enforcement of federal and state hunting and fishing regulations will be accomplished through patrols by refuge law enforcement officers. Enforcement patrols may also be conducted by State Conservation Officers. The frequency of patrols will be determined by hunter use, the level of compliance observed during patrols, and information obtained from participants, visitors and other sources. Refuge brochures and hunter orientation prior to the hunting

seasons will emphasize refuge specific regulations, safety considerations and the protection of wildlife species found on the refuge.

Examples of refuge regulations that would apply to hunting include: access to closed areas of the refuge will be strictly enforced; permanent blinds are not permitted on the refuge; (50 CFR, 27.92) all hunting materials, deer stands, and flagging must be removed at the end of each hunting day; no one shall insert a nail, screw, spike, wire, or other ceramic, metal, or other tree-damaging object into a tree, or may hunt from a tree into which such an object has been inserted. (50 CFR 32.2 (i)); no discharge of a projectile from any bow within 150 feet of any public road or 500 feet of any building; "the unauthorized distribution of bait and the hunting over bait is prohibited on wildlife refuge areas" (50 CFR, 32.2 (h)); the use or possession of toxic shot is prohibited except when hunting deer or turkey; hunters are permitted on the refuge from one half hour before legal sunrise to one half hour after legal sunset; no night hunting will be allowed on the refuge; all firearms must be unloaded outside of legal State hunting hours; the use of all terrain vehicles (ATV's) on refuge land is prohibited; training of dogs on the refuge is not permitted (50 CFR, 27.91); no open fires are permitted in accordance with 50 CFR 27.95; pre-hunt scouting of the refuge is allowed, however carrying of loaded guns is not permissible during pre-hunt scouts; hunters must wear in a conspicuous manner on head, chest, and back, a minimum of 500 square inches of solid-colored hunter orange clothing or material (per State regulations), except when hunting waterfowl or turkey; the use or possession of alcoholic beverages while hunting is prohibited; (50 CFR, 32.2 (j)); in accordance with State regulations, all hunters are required to hold valid Massachusetts State hunting licenses, permits, and stamps (50 CFR, 32.2 (a)); hunters will be required to obtain permits to hunt on the refuge; check stations will not be established on the refuge at this time but reporting requirements will be instituted. Refuge staff can provide information about reporting forms when permits are issued.

For the range of alternatives on hunting on each refuge, see the hunting sections in Parts 1, 2, and 3.

Alternatives or Actions Considered, but Eliminated From Further Evaluation

Proposals for new, non-wildlife-dependent public uses

During our scoping process, we received requests for a number of recreational opportunities that are not wildlife dependent. These activities include horseback riding, biking, model airplane flying, snowmobiles, all-terrain vehicles, dog sled pulling, ice skating, picnicking, jogging and dog walking. Biking and ice skating were previously allowed, but were eliminated in the late 1990's. Service policy, as well as the Refuge Improvement Act, states that incompatible or non-wildlife dependent recreation will be eliminated as expeditiously as practical, with few exceptions. Our Refuge Manual specifically states that, with few exceptions, these uses will be de-emphasized and gradually phased out. Following public review and comment, the Service published our Final Compatibility Policy in *Federal Register* Volume 65. No. 202, pp 62484-62496 (603 FWM2) on October 18, 2002. This final rule provides additional detail on our process for determining which activities are compatible with a refuge's establishment purpose and management goals. This draft does not evaluate new proposals for these uses because their establishment would contradict Service policy, the purposes for which the refuges were established (see previous section, The Compatibility Determination).

Non-wildlife dependent recreational uses currently allowed at Great Meadows and Oxbow refuges, such as dog walking, jogging and picnicking, are addressed in Parts 2 and 3 of this chapter. Assabet River Refuge, which is currently closed, is not evaluating opening the refuge to non-wildlife dependent public uses for reasons stated above.

Deer Management Options

Reproductive Intervention (birth control)

Reproductive intervention or birth control is the general category for a number of fertility control methods available, each with varying rates of success. Immunocontraception with porcine zona pellucida (PZP) vaccine injection, is probably the best known and most widely applied. Steroid implantation has been available since the 1970s. Remote prostaglandin injection (Denicola 1997), oral vaccination with a live vector (Miller et al. 1999a), and vaccines are more recent and lack long-term evaluation of effectiveness. Sterilization is a permanent option, although not widely applicable.

Effectiveness and efficiency of any of the above forms of reproductive intervention is affected by a number of factors including; method of application or delivery, need or ability to capture the animal, the number of treatments needed to ensure effectiveness, size of the population, status of the population (confined or free ranging), and longevity of treatment.

Immunocontraception

Immunocontraception (PZP injection) is most effective at preventing pregnancy when hand injected and combined with subsequent boosts. The PZP vaccination produces reversible infertility lasting 1-4 years (Miller et al. 1999b), however, it requires two injections, four weeks apart, to be effective for at least two years (McShea et al.1997). Effectiveness at reducing population number and growth rate is greatly reduced when dealing with large and open populations due to the need to treat a large percentage of the females over a large area. For a large population, contraception rates of less than 50% of does will curb growth in 30 years, but will not reduce the size. Even rates of greater than 50% require at least a 5-10 year planning horizon to see significant population declines (Seagle and Close1996). Therefore, the cost, effort, expertise, manpower, and handling time will continue for years before achieving any results.

Another obstacle to PZP immunocontraception is the adjuvant used for the initial injection (an adjuvant is a microbial aid necessary for boosting the vaccine once inside the animal's bloodstream). Complete Froine's, the most commonly used, contains heat-killed tuberculin cells, which causes subjects to test false positive for TB. The FDA, which has jurisdiction over its commercial use, currently does not permit use of this adjuvant on other than tightly controlled or isolated populations and in combination with ear-tagging (in order to prevent the public from consuming escaped deer). There are two other adjuvants undergoing field tests but both are not yet effective as boosters and still pending FDA approval (Rick Naugle, Humane Society of the U.S., August 28, 2000, personal communication).

Steroidal implants

Subcutaneous steroidal implants have been used during the past 25 years with varying rates of effectiveness in reducing deer pregnancy (and now remote delivery of this treatment is possible) but the long-term effectiveness is uncertain. In addition, the same factors that confound the PZP method at the population level apply (Connecticut Department. of Environmental Protection, Wildlife Bureau, 1988). Because of the uncertainty of long-term health effects on deer and subsequent impacts on the food-web (including human consumption of treated deer), the FDA will not approve application on free-ranging deer at this time (DeNicola et al. 2000).

Oral Delivery of Contraceptives

Oral delivery of contraceptives has a number of concerns that make this method ill-advised and impractical: it is not species-specific (risks ingestion by non-target species), bait and supplies are wasted on non-target species, deer sometimes reject treated bait, and it is difficult to manage dosage control. Currently, the method is not working at the field or captive level. Oral vaccinations through live-vector delivery is a relatively new method, and is species-specific, but is not long-acting and so must be delivered on a frequent and regular basis (Alan Rutberg, Humane Society of the U.S., 2000).

GNRH Vaccine

Another field method currently being tested is the GNRH vaccine. This shuts down the whole reproductive hormone system of both sexes and its effects are dramatic, even on behavior and antler development. This is a new method and the affect on deer and their behavior needs further evaluation prior to application in the field (Ibid.).

Sterilization

Sterilizations must be done annually, the number of which must be calculated based on the number of fertile females in the herd. Great care must be taken to reduce the number of sterilizations in time to prevent a population crash and bottleneck (Boone and Wiegert 1994). Again, this option is not effective for open populations unless performed at a landscape level.

No matter which birth control method is used, more than 50% of the females will need to remain infertile to effect a reduction in population size (Hobbs et al. 2000, Seagle and Close 1996). All of the above described techniques are compromised at the individual and population levels due to the openness of the population. Because these operations entail multiple captures, considerable handling time, facilities for holding captured animals or conducting surgery, risk to personnel and animals, trauma losses, and constant or recurring expense means that at this stage of development they are not viable methods in the field. This situation may change in a few years as applications of these techniques are improved upon.

Live Trapping and Relocation

The live trapping and relocation approach entails transporting captured animals to a new location outside the impacted area. Disadvantages, however, far outweigh the advantages. Capture and handling of deer involves risk to deer and handlers. Deer are susceptible to capture myopathy, a form of muscle dysfunction that is stress-related and can result in delayed mortality. Trauma losses can amount to about 4% of capture and transfer efforts (Wildlife Information Publication, Virginia Department of Game and Inland Fisheries, 1999). The mortality potential attendant to handling is amplified by placing individuals in unfamiliar surroundings (Cypher and Cypher 1988).

Finding suitable release sites is increasingly more difficult as most locations cannot accommodate more deer and are experiencing their own population management problems. A further complication to this alternative is the recent increase in Lyme-Disease associated with the Northern Virginia deer population. Northern Virginia deer are infested with a type of Lyme Disease-bearing ticks not found in more distant populations (Dan Lovelace, Virginia Department of Game and Inland Fisheries July 2000, personal communication).

Habitat Management

This approach manipulates the existing habitat to induce behavioral changes in deer and reduce human/deer conflicts. An example would be to lower the biological carrying capacity by removing forage species, and/or changing landscape elements such as water features or forest edge. This alternative has an appeal for its humane and nonlethal approach but is incompatible with one of the primary management goals for the refuge, which is to promote and maintain its grassland habitat and vegetation cover.

Part 1: Assabet River National Wildlife Refuge

Alternative A - Current Management

Under the Current Management Alternative, there would be very little or no change in our current anticipated baseline management programs at Assabet River Refuge. The Current Managment Alternative presents the current range of public recreation opportunities, which are severely restricted due to a number of physical safety hazards(see Chapter 3: Part 1 Physical Safety Hazards). The refuge would continue operations and maintenance activities within its current staffing and funding levels and the refuge boundary would remain at 2,230 acres.

Habitat and Wildlife Populations

We would continue current population baseline surveys (woodcock, marsh birds, breeding birds, whip-poor-will, hawk and anuran surveys) as long as funding for these activities is available through the Region's Biological program. See Table 2-3 for a complete list and description of current wildlife surveys at Assabet River Refuge.

Table 2-3. *Wildlife Surveys at Assabet River National Wildlife Refuge*

Survey	Purpose	Points	Observation	Other Information
Landbird Breeding Survey	• occurrence of species • occurrence within habitats • relative abundance • changes in populations	51 points refuge-wide	late May to mid-June for 10 days 1 time/season observation made in 5 minute intervals	began in 2000 habitat is classified at each point birds are identified by sight and sound
Marsh Bird Callback Survey	• identify species presence • monitor change in abundance • evaluate species response to habitat modifications	13 points in ponds, marshes and emergent vegetation	early May - mid July 3 times/season	began in 2000 birds are identified by sight and sound callback tapes are used
American Woodcock Survey	• presence and abundance	22 points in fields, clear cuts, meadows, etc.	mid-April to mid-May 1 time/season observations made in 2 min intervals	began in 2000
Anuran Call Counts	• occurrence, abundance, and presence	at least 14 points in wet meadows, pools, and along river	mid-March- mid-July 4 times/season 5 minute observation period	began spring of 2000
Whip-poor-wil	• presence and abundance	~10 points	1 time/season	began in 2002
Migrating Hawks	• presence and abundance	fixed location	daily during spring and fall migration	began in 2001

We would continue cooperating in current, partner-based, monitoring programs for contaminants (USFWS Ecological Services, EPA, MADEP) and water quality/flow levels (USGS, MADEP, the Organization for the Assabet River, and the SUASCO Watershed Association). We would also continue to seek any information compiled by others related to habitat and wildlife populations within the refuge and surrounding ecosystem.

Assabet NWR. *Puffer Pond. USFWS Photo*

We would protect nesting, wintering and migration habitat for the Federal trust resources, in particular, migratory bird species. Approximately 60-70 acres of presently existing old-field grass/shrub habitat would be maintained by mowing. Maintenance of this grassland/ old-field habitat by use of fire would be evaluated (Map 2-1).

The existing wetlands on the Refuge (approximately 500 acres) would continue to be protected. At some time prior to its transfer to the Service, beaver colonies and dams were removed from the Taylor Brook wetland complex down-gradient from Puffer Pond. The wetland hydrology has been compromised with the removal of the beavers. In addition, water flow through the wetland area up-gradient of Puffer Pond has been restricted by existing culverts and long-term sedimentation. Approximately 40-50 acres of the wetland complex's wildlife values have been degraded as the result of these actions. We would work toward installing a water-control structure on the Taylor Brook culvert at Patrol Road, and completing engineering evaluations of the up-gradient wetland hydrology in order to restore these portions of the wetland. Map 2-1 depicts the general areas within the refuge where these activities would occur. The remaining current mix of wetland and upland habitats would be protected, but allowed to mature under natural successional processes.

We have evaluated the suitability of bunkers as bat habitat. Three bunkers (318, 320, and 321) adjacent to the Taylor Brook wetland have been evaluated. Bunker doors have been removed or secured in the open position, and temperature and humidity data is measured. Grating or fencing has been installed on bunker openings where parameters are within the range suitable for bats, to prevent human intrusion, and bunkers are monitored for bat use (presence/absence, species and numbers). Under this alternative we would continue these efforts.

We would identify other research needs to the Service's Regional Research Coordinator, and to other potential research partners (e.g., USGS, Biological Resources Division and universities).

We would selectively remove existing fencing, roads and dirt trails that are not needed for refuge management, visitor use or fire-control purposes.

Invasive and Overabundant Species

If they are funded from outside sources or available from a small-scale rearing program we would initiate use of host-specific beetles (*Galerucella calmariensis* or *G. pusilla*) in a program to control purple loosestrife (*Lythrum salicaria*) within approximately 20 acres of wetland on the refuge. Under Alternative A, unless project-specific funding becomes available, the effects of treatment with the beetles would be evaluated only by simple year-to-year photographic recording of the release site(s) on the refuge.

Existing stands of spotted knapweed (*Centaurea maculosa*), glossy buckthorn (*Rhamnus frangula*), Japanese knotweed (*Polygonum cuspidatum*), Oriental bittersweet (*Celastrus orbiculatus*), cattail (*Typha sp.*) and common reed (*Phragmites australis*) would be identified and monitored to determine changes in areal extent. Limited treatment of these invasive plant species would occur only if project-specific funding was made available.

A beaver's work on the refuge.
USFWS Photo

In recent years, overabundant beaver caused flooding of roads on the property. We would control such situations by manually clearing culverts, installing grates on culverts and water-control structures, and by installing beaver exclosures and "deceivers" in dams or on culverts.

Priority Public Uses

The refuge is currently closed to public access due to a number of unmitigated saftey hazards. Please see Chapter 3: Part 1 Physical Safety Hazards for a list of these hazards.

Hunting

Big and Upland Game Hunting

The refuge is closed to big and upland game hunting due to a number of unmitigated physical safety concerns.

Migratory Bird Hunting

The refuge is closed to migratory bird hunting due to a number of unmitigated physical safety concerns.

Fishing

The refuge is closed to fishing due to a number of unmitigated physical safety concerns.

Wildlife Observation and Photography

The refuge is closed to general public access and use due to a number of unmitigated safety hazards that exist on the property. A limited number of special escorted tours/events would be organized to allow limited access to the refuge (e.g., birding field trips, Christmas bird counts, etc).

Environmental Education and Interpretation

The refuge is closed to general public access and use due to a number of unmitigated safety hazards that exist on the property. Special guided tours/events would be organized to allow limited access to the refuge (e.g., interpretive walks featuring differing habitat types, tours discussing refuge history or geology, etc.).

We would provide environmental education oriented teacher workshops on an "as-requested" basis (primarily at the Complex Headquarters in Sudbury, MA).

We would continue to provide support to educational and interpretative programs organized and led by the Friends of the Refuge and other groups.

Public and Community Outreach

Monthly news releases would be issued (on a Complex-wide basis) to provide information on refuge management activities and upcoming events or programs. A monthly electronic newsletter would also be available. Articles in the newsletter inform the public of ongoing management and upcoming activities. The Complex website would also provide information about refuge activities and presentations on Assabet River Refuge.

We would continue to provide presentations related to the refuge and its resources to local schools, clubs, and community organizations as time and staff resources allow. We would also continue to work closely with the Friends of the Assabet River Refuge, to assist them in membership and program development, and to assist in the organization and leadership of volunteer programs and work activities on the refuge.

Resource Protection and Visitor Safety

The current law enforcement staffing of one full-time and one collateral-duty Park Ranger who share responsibilities at a number of the Complex refuges would be maintained. These officers would continue to enforce the Service's refuge protection regulations, State and federal wildlife protection and hunting laws and regulations, and federal cultural resource protection laws and regulations.

Assabet River NWR. *USFWS Photo*

Cultural Resource Protection

Cultural resource (archeological and historical) evaluations or surveys would continue on a project-specific basis. Soil disturbance requires resource evaluation and clearance. Federal cultrual resource laws would be enforced.

Refuge Buildings

There currently are 24 buildings and 50 bunkers remaining on the refuge as transferred from the U.S. Army (see Chapter II, Affected Environment and Map 2-1. All the buildings are in poor condition due to past lack of maintenance, use for military/police training, or past vandalism. Few, if any, appear to be habitable. None of the buildings or bunkers are currently in use.

Refuge Staffing

Currently the Assabet River Refuge shares a refuge manager position with the Oxbow Refuge The refuge also currently shares the support of a refuge biologist, a biological technician, an outdoor recreation planner, a visitor services park ranger, two law enforcement rangers, two maintenance workers, two administrative technicians and seasonal employees with the Complex. The Assabet River Refuge minimum staffing needs have been determined to include:

- refuge operations specialist/manager
- one outdoor recreation planner
- two maintenance workers
- one park ranger (law enforcement);
- two refuge biologists.

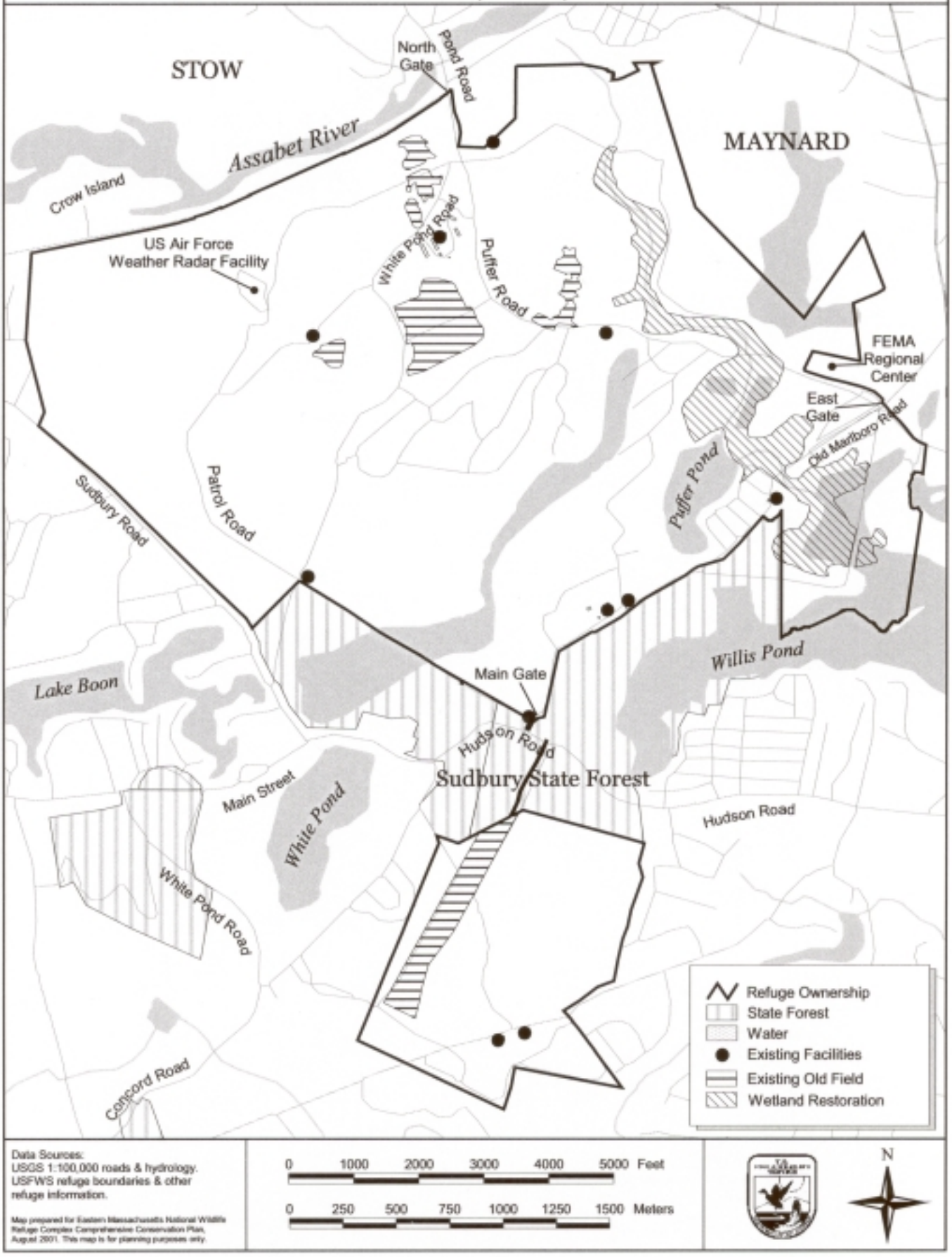
Under Alternative A, the Service would work toward filling these minimum staffing needs for the Assabet River Refuge. See Appendix D for staffing charts.

Alternative A: Current Management

Existing Habitat Management and Facilities

Assabet National Wildlife Refuge

Eastern Massachusetts NWR Complex Comprehensive Conservation Plan



Data Sources:
USGS 1:100,000 roads & hydrology.
USFWS refuge boundaries & other refuge information.

Map prepared for Eastern Massachusetts National Wildlife Refuge Complex Comprehensive Conservation Plan, August 2001. This map is for planning purposes only.

0 1000 2000 3000 4000 5000 Feet

0 250 500 750 1000 1250 1500 Meters

N

Alternative B - The Service's Proposed Action

Under the Service's Proposed Action, refuge staffing and funding levels would be increased. We would initiate new wildlife population, habitat and invasive/overabundant species management activities; and, provide new compatible wildlife-dependent recreational opportunities. We would also work with State, Federal and non-governmental partners to secure funding for the construction of new visitor facilities and a Visitor Contact Station to support the goals and objectives of the Refuge System and the Assabet River Refuge.

Special emphasis would be placed on obtaining baseline data of wildlife populations and habitat conditions required to develop the detailed step-down plans under this CCP. Wildlife population and habitat monitoring surveys and inventories would be continued to provide the data needed to assess the effectiveness of management programs and practices, and to make mid-course adaptations to these practices to ensure they meet long-range refuge goals and objectives.

Special emphasis would also be placed on providing enhanced, but sustainable opportunities for the six priority, wildlife-dependent public uses defined in the Refuge Improvement Act of 1997. Public use evaluations, along with wildlife and habitat monitoring programs, would assist us in both assessing the intensity of public use and adapting our management strategies and practices for those uses.

Brief explanations of the Service's Proposed Action follow. The Proposed Action(s) are also summarized under Alternative B in **Table 2-4.** *Actions and Strategies Matrix for the Assabet River NWR.*

Habitat and Wildlife Populations

In addition to the activities described previously under Alternative A, the increased staff and funding resources associated with our proposed action would enable us to take a number of actions that would lead to the completion of two key step-down plans under this CCP: a Habitat Management Plan and a Habitat and Wildlife Inventory and Monitoring Plan.

First, we would expand our inventory of wildlife species utilizing the Assabet River Refuge species lists (See Chapter III: Part 1 Affected Environment and Appendix F, Species Lists). Our current inventories would be updated or expanded upon to close data gaps including: seasonality of use; habitat-type preferences; and, where practicable, estimates of population numbers. Under Alternative B, surveys and inventories of both the Service's Trust Resources (migratory birds and federally listed threatened and endangered species) and resident wildlife, including State listed threatened and endangered species, are expected to be accomplished concurrently. If necessary, surveys and inventories related to the

Service's Trust Resources may receive priority. These additional surveys would include, such activities as:

n In addition to collecting information on nesting species, migrating neotropicals would be censused for two seasons by 2007 by the refuge and partners.

n Small mammals would be surveyed by 2010 using small live box traps, snap traps, and pitfall traps. Traps would be arranged in a grid, and trapping would be done during the spring, summer, or fall. If any threatened or endangered species are found, mark recapture studies may be initiated to determine a population estimate. The refuge does not have any known populations of Federal-listed endangered or threatened species.

Our Proposed Action for habitat and wildlife management includes four parts:

1. Collect information for all species on the refuge,
2. Determine resources of concern based on national and regional Service plans,
3. Using information gathered in Steps 1 and 2, develop a Habitat Management Plan,
4. Develop a Habitat and Wildlife Inventory and Monitoring Plan to insure objectives in the Habitat Management Plan are reached.

n Freshwater fish would be sampled in all the "substantial" ponds by 2010 using passive and active capture gear and electro fishing. Passive gear includes, but is not limited to, gill nets, trammel nets, and fyke nets. Active gear includes, but is not limited to, seines, nets, and hooks. Depending on the diversity and abundance of fish that are found in the ponds, mark recapture studies may be initiated.

n Amphibian and reptiles would be surveyed by 2007 using a combination of pitfall traps, fyke nets, and audio cues. Aquatic turtles would be surveyed using fyke nets during the summer and fall. Terrestrial turtles, snakes, and amphibians would be sampled using pitfall traps.

n Working with partners and local naturalists, we would conduct a comprehensive survey of invertebrates in the spring and summer by 2008. "Sticky" sticks (paint stirrers dipped in Tanglefoot Insect Trap Coating and placed horizontally on and vertically in the substrate) would be used to sample ground based invertebrates. Collecting nets would be used to sample winged invertebrates. Endangered and threatened species would be noted and the possibility of increasing populations of these species (particularly ground based invertebrates) on the island would be investigated.

Second, we would determine resources of concern, including focus species or species-groups and their habitat needs. Focus species and habitats are most likely to be selected based on a combination of factors such as: endangerment (federal and State-listed species); priority, national and regional Service plans (such as the North American Waterfowl Management Plan, the Partner's in Flight, etc; developing Service Policies/regulations such as those related to Habitat Management Planning and Maintenance of Ecological Integrity; the purpose for which Assabet River Refuge was established (its value for the conservation of migratory bird species); current/historical species and habitat presence; and recommendations from the Massachusetts State Division of Fisheries and Wildlife or other partners.

Baby redwing blackbirds. *USFWS Photo*

Third, we would develop a long-range Habitat Management Plan (HMP) by 2006. The HMP would contain information for all habitats and species on the refuge, with a focus on resources of regional and national concern (based on regional and Service plans). It would provide quantitative and measuable objectives and strategies for habitat management to enhance resources of concern.

Fourth, our Habitat and Wildlife Inventory and Monitoring Plan would be completed by 2007. This plan would include an on-going monitoring component designed to measure progress toward those objectives outlined in the HMP, and to allow mid-course corrections or alterations as they may be needed. Depending on specific habitat management techniques or practices that may be recommended in the plans including chemical, mechanical or fire, several additional step-down plans may be required (e.g., a pesticide (or herbicide) use plan, specific wetland restoration plans, etc). Protocal developed in this plan would be statistically sound and peer reviewed.

A considerable amount of work would be needed to obtain the detailed species and habitat data in order to complete steps 2, 3, and 4. Until our management plans are completed, the refuge would continue with the status quo of grassland, old field, upland and wetland habitat management described in Alternative A.

The refuge would also continue to seek opportunities to develop cooperative management agreements with neighboring conservation organizations and individuals.

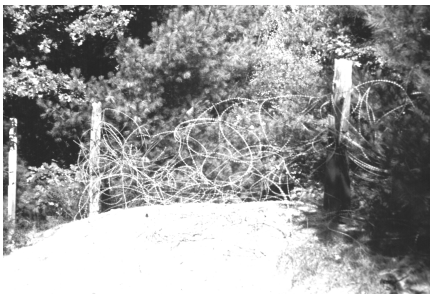
As described later in section "Opening the Refuge to Public Uses" and "Refuge Buildings", safety hazards would be removed before opening the refuge. Removal of these hazards, including some existing buildings, and some roads would require habitat restoration. Restoration goals and objectives will be outlined in the HMP.

Invasive and Overabundant Species

Under Alternative B, a comprehensive invasive plant inventory would be developed and implemented by 2007. In addition to determining aerial extent of those species currently of concern,

additional or incipient problems would be documented, and baseline measurements of key condition indices such as species diversity, density, height, percent cover, etc. would be made. An Integrated Pest Management Plan would be developed, which would provide a full range of potential and alternative mechanical, biological and chemical control strategies. The plan would also include preparation of on-going monitoring survey methods to assess rate of change of invasive species stands, with or without treatment.
Control strategies to be developed will be species and condition specific. Control practices may employ biological vectors such as the use of Galerucella beetles for purple loosestrife control, water level manipulation, mechanical methods (e.g., hand-pulling, mowing, or discing), use of fire, or use of herbicides (see section Fire Management at the beginning of this chapter). The least intrusive, but most efficient, control practice will be preferred. As previously discussed, use of herbicides will require action-specific step-down plans, and in some situations, proposed control methodologies may also require wetland permitting review and approval.

There are no currently identified problems related to overabundant or invasive animal species on the Assabet River Refuge. Beaver have occasionally caused localized flooding of on-refuge trails and maintenance roads. To date, these problems have been controllable by use of perforated pipe and wire mesh fence "beaver exclosures" installed on culverts, water-control structures or beaver dams. If more serious threats to habitat, refuge facilities, adjacent property or endangerment of health arise, we would work, in coordination with the Massachusetts Division of Fisheries and Wildlife, to either trap and relocate individual animals from problem sites, permit licensed sports trappers or hunters to reduce population numbers, remove individual beavers through trapping or shooting by refuge staff, or to permit a licensed animal damage control firm to reduce population numbers by trapping. If needed, we would issue a special use permit and complete a compatibility determination (see Chapter 2: Introduction, Actions Common to All Action Alternatives) outlining specific requirements and conditions for beaver removal.



Wire. *Wire such is this must be removed before the refuge can be opened to the public. USFWS Photo*

Under this alternative, the refuge would monitor mute swans on the refuge. In an effort to keep this aggressive, non-native species from becoming a resident on the refuge, territorial or nesting swans on the refuge would be lethally removed after obtaining appropriate permitting from our migratory bird office. Currently mute swans only occasionally use the refuge and do not pose a problem.

The refuge would also participate in appropriate, experimental invasive species control research programs, if such programs have been reviewed and approved by Service Regional or national biological staff and the Department of Interior's wildlife research arm, the Biological Resources Division, now located within the U.S. Geologic Survey.

Opening the Refuge To Public Uses

We would mitigate existing physical safety hazards, complete necessary public use plans and regulations, and open portions of the refuge in phases under Alternative B. We anticipate assistance from the Friends of the Refuge with the first three efforts described below.

To correct the currently known safety hazards we would:

- Complete removal of concertina wire, razor wire, unneeded barbed wire and old Army communications wire from the refuge.

- Either secure the buildings by boarding windows and doors or by demolishing and removing buildings (if architectural/ engineering condition and historical significance assessments indicate that to be appropriate).

- Secure the large diameter, open hand-dug wells by filling in accordance with Massachusetts Department of Environmental Protection requirements. Most or all of these wells pre-date the Army's acquisition of the property in 1942. If any of the wells are determined to be of historical significance, we would coordinate with the State Historic Preservation Office to determine the appropriate closure method (filling, capping with concrete or wood closures, etc).

- Install refuge "Closed Area" signs to deter entrance into or around sites, where needed.

The sequencing of the portions to be opened may vary depending on availability of funding, completion of building condition and historical assessments, and continuation of support from the Friends of the Refuge and volunteers who have been assisting with this work. Before any of these trails can be opened, we will remove safety hazards such as military wire and old wells. All opened trails are existing roads and will not require clearing of additional land. Our current conceptual plan (Map 2-2) is to clear the safety hazards and open portions of the refuge in the following sequence:

All trails proposed under Alternative B would be on existing roads. These existing roads provide opportunities for wildlife dependent recreation without disturbing additional vegetation.

(1) the portion of the refuge running along Patrol Road from the former Main Gate on Hudson Road, past the Air Force Weather Radar Facility and ending at the former North Gate on White Pond Road. At least rudimentary parking areas would be provided at the North and Main Gate entry points. Access on the refuge would initially be limited to foot traffic use of the Patrol Road through this area. General use of areas of the Refuge off Patrol Road would be limited to educational and interpretive programs, wildlife observation and photography opportunities and hunting season use.

(2) the portion of the refuge running along Old Marlboro Road (also known as Craven Lane) running from the former Main Gate to the former East Gate at the FEMA Regional Center, and continuing

Milkweek. *Photo by Marijke Holtrop*

along Patrol Road to the former North Gate. At least a rudimentary parking area would be provided at the East Gate entry point. Limited access to the easterly side of Puffer Pond could be provided in this phase. General use of areas of the refuge off these former roads would be limited to fishing at Puffer Pond, educational and interpretive programs and hunting season use.

(3) a walking trail within the portion of the refuge located south of Hudson Road. A rudimentary parking area would be provided inside the refuge along the access road from Hudson Road. General use of areas of the refuge off the trail would be limited to educational and interpretive programs and hunting season use.

(4) a trail along the former railroad bed road network through the old bunker complex beginning at Old Marlboro Road and running northerly along the westerly side of Puffer Pond to old Puffer Road, and then easterly to Patrol Road. General use of areas of the refuge off the trail would be limited to educational and interpretive programs and hunting season use.

(5) two additional foot trails through the former bunker complex would be opened for public use. These would begin near the former Main Gate, with the first running along the southerly and westerly edge of the complex to Puffer Road. The second would run northerly through the mid portion of the complex to Puffer Road. Puffer Road would be opened for foot traffic from White Pond Road and easterly to its junction with Patrol Road. General use of areas of the refuge off the trails would be limited to educational and interpretive programs and hunting season use.

(6) White Pond Road would be opened for foot traffic from the former North Gate to its southerly juncture with Patrol Road. General use of areas of the refuge off White Pond Road would be limited to educational and interpretive programs and hunting season use. The current, proposed locations of these phases and roads/ trails are depicted on Map 2-2.

Minimally intrusive parking areas would be provided as funding and staff allow.

Priority Public Uses

Refuge Access

Special emphasis would be placed on providing enhanced, and sustainable, opportunities for the six priority, wildlife-dependent public uses defined in the Refuge Improvement Act of 1997 (environmental education, fishing, hunting, interpretation, photography and wildlife observation). This alternative proposes developing a Visitor Services Plan which would include a monitoring program to evaluate intensity and potential impact of all the wildlife-dependent public uses on the refuge. Public use activities in general, may be modified in the future if adverse impacts on wildlife or habitat are identified. Public use evaluations, along with wildlife and

habitat monitoring programs, would assist the refuge in both assessing the intensity of public use and adapting our management strategies and practices for those uses. Again, the refuge would only be opened after safety hazards are removed.

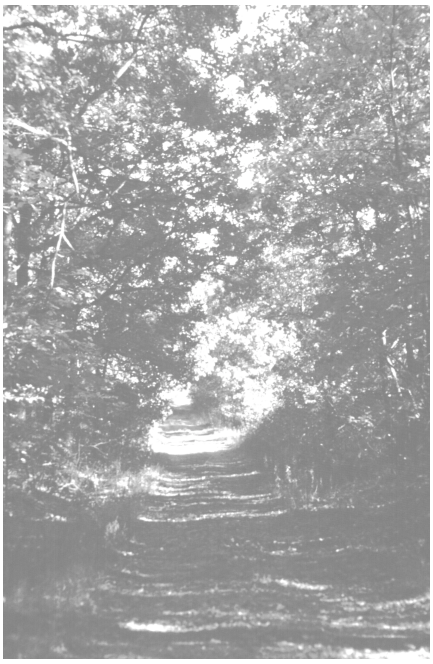
Hunting and Fishing

We have described the regulations and permit program for the hunting programs on all three refuges at the beginning of this chapter (see section New Recreational Fees). Below we outline specific details of the proposed action for hunting at Assabet River Refuge.

As soon as possible after the existing physical safety hazards are mitigated refuge would be opened for hunting according to the earlier discussion on opening the refuge. Any necessary, refuge-specific regulations or restrictions would be described in the hunt plan and distributed through the Federal Register as a notice on hunting on refuges in the Northeast Region, refuge hunting brochures, news releases and on-refuge informational signing.

Big and Upland Game Hunting

Archery, shotgun and primitive firearm deer hunting opportunities would be provided on the refuge in accordance with Massachusetts State regulations and requirements. Among other restrictions, these regulations prohibit the discharge of any firearm or arrow upon or across any State or hard-surfaced highway or within 150 feet of any such highway, and the possession or discharge of any firearm within 500 feet of any dwelling or building in use, except as authorized by the owner of occupant thereof. For a complete discussion of hunting, see the previous section in this chapter's introduction, "Hunting".



Proposed trail at Assabet River NWR.
USFWS Photo

A limited special season will be provided for physically handicapped hunters. Selected roads on the refuge would be open for vehicle traffic during this season. We believe the physical configuration of trails and roads on the refuge will allow us to provide handicapped accessible deer hunting opportunities from several of these access routes.

Shotgun hunting of upland game birds (ruffed grouse), turkey (spring season only per current State season restrictions), and small game (rabbit, gray squirrel) will be allowed on the Assabet River Refuge. All State regulations and restrictions would apply and be enforced, including the safety related restrictions discussed above. In addition, the use of non-toxic shot (non-lead) would be required for all seasons, with a current exception for turkey hunting (see map 2-2).

There were several options to deer hunting that were analyzed and considered during the CCP process but were eliminated as non-viable management options. These include immunocontraception, steroidal implants, oral delivery of contraceptives, GNRH vaccine,

sterilization, live trapping and relocation, and habitat management. Please refer to the section at the beginning of Chapter 2, Alternatives Addressed but not Considered, for their description and discussion.

Migratory Bird Hunting

Woodcock hunting on the refuge would be opened. Waterfowl hunting on the refuge (or portions of the refuge) may be opened in the future, if the wildlife and habitat inventories and plans previously discussed indicate such action will not have detrimental effect on waterfowl habitat or use of such habitat by migrating or over-wintering populations. We are particularly concerned since most of the waterfowl may be concentrated in areas that would be difficult for hunters to access without impacting vegetation, including some rare State-listed plant species. We would continue to gather information to assess waterfowl use on the refuge, specifically habitats being used and seasonality of that use.

Fishing

We propose to provide fishing opportunities at Puffer Pond on the refuge. Fishing would be restricted to "catch-and-release" and "no live-bait" use. After additional fisheries surveys are completed and we assess sustainable harvest, we may consider elminating the "catch-and-release" restriction. However, until that data is collected, only "catch-and-release" fishing would be allowed. We would provide limited shoreline fishing from up to four areas along the pond perimeter and fishing from canoes would be allowed. Ice fishing would not be permitted. The current, proposed locations of these facilities are depicted on Map 2-2. These shoreline fishing areas may need to receive stabilization or be provided with erosion control measures prior to being opened, and they may be closed as needed to prevent or repair bank erosion if such should develop. At least one of these locations will be made handicapped accessible.

Wildlife Observation and Photography

The phased opening of the refuge would ultimately provide approximately 15 miles of trails for public use. A wildlife observation platform and a photography blind would be constructed. The current, proposed locations of these facilities are depicted on Map 2-2.

Environmental Education and Interpretation

We would initiate a very active program of participation in local and regional environmental education and interpretive programs in conjunction with the Assabet River Refuge. Our Urban Education Program is currently in its second year of development at Great Meadows and Oxbow Refuges in cooperation with the Boston and Worcester Public School Systems and the Friends of the Refuge. This program would be expanded to include the Assabet River

Existing facilities such as this one are being evaluated for historical significance. *USFWS Photo*

Refuge and an additional elementary-middle-high school system within the region. We would also endeavor to work with other school systems to provide instructional materials and presentations related to refuge resources and management programs that are occurring at Assabet River. We would provide teacher workshops when requested. In addition, we would work with our Friends of the refuge and other partners to expand our current staff and volunteer-led interpretive and educational programs on Assabet River Refuge.

Three informational kiosks would be constructed at entrances to refuge foot trails, and a self-guided interpretive trail with signage and explanatory pamphlets would be developed for a refuge trail. The current, proposed locations of these facilities are depicted on Map 2-2.

Public and Community Outreach

We would organize and host one or more annual events (such as National Fishing Day, National Wildlife Refuge Week or Earth Day) designed to promote wildlife-dependent recreation and natural resource education. In cooperation with area teachers, we would assess the needs for, and work toward development of a refuge-specific environmental education curriculum for grades between kindergarten and the senior year of high school. We will provide an annual teacher workshop either at Assabet River or at the Complex Headquarters in Sudbury to cooperatively share experience and ideas related to these curricula.

We would also initiate programs to provide local communities and landowners educational and informational material and strategies related to natural resource protection and restoration. On-going refuge resource management practices and habitat restoration areas would be incorporated in all of these programs to serve as illustrations or demonstrations of resource management concepts and techniques.

A refuge-specific informational brochure would be developed for the Assabet River Refuge. We would also work with partners and local communities to place informational kiosks related to the refuge and resource management at three off-refuge locations.

Resource Protection and Visitor Safety

Refuge staff would complete a fire suppression contract or agreement with State or local fire suppression agencies for wildfires occurring on the refuge (see section Fire Management at the beginning of this chapter).

Cultural Resource Protection

We would initiate and complete archeological and historical resource surveys and inventories on a refuge-wide basis (in comparison the current, more limited project-specific evaluations described under

Alternative A). The archeological survey portion of this work would be designed to develop predictive models that could be applied refuge-wide in evaluating the potential of future projects to impact cultural resources.

Refuge Buildings

We would complete our architectural/engineering condition assessment and historical significance review of the 24 structures remaining on the refuge. All buildings with historical significance would be appropriately documented. All 24 structures would be removed following review and documentation.

We would work with State, private and other federal partners to obtain authorization and funding that would enable the construction of a visitor-contact center at the Assabet River Refuge. The siting of these facilities will be determined at a later date, and will be based on the wildlife and habitat management plans to be developed as well as the historical and condition assessments of existing facilities. A location close to the former Main or North Gates would be the most likely to be chosen for the center. The visitor contact station would be no more than 4000 square feet in size. It would provide space for interpretative exhibits, a meeting room and administrative offices for refuge staff. The current, proposed locations of these facilities are depicted on Map 2-2.

Refuge Staffing

We would seek to fully staff the minimum requirement identified under Alternative A, the "No-Action" alternative. The Assabet River Refuge would continue to share a refuge manager with Oxbow, and fill the minimum staffing needs as described in Alternative A. Those positions include:

- refuge operations specialist/manager
- outdoor recreation planner
- two maintenance workers
- park ranger (law enforcement);
- two refuge biologists.

In addition, several new staff positions would be required to enable us to implement the full range of programs, facilities and activities identified in this Alternative (B), our Proposed Action. The additional required staffing includes:

- forester (who will share responsibilities at several units of the Complex)
- administrative technician.

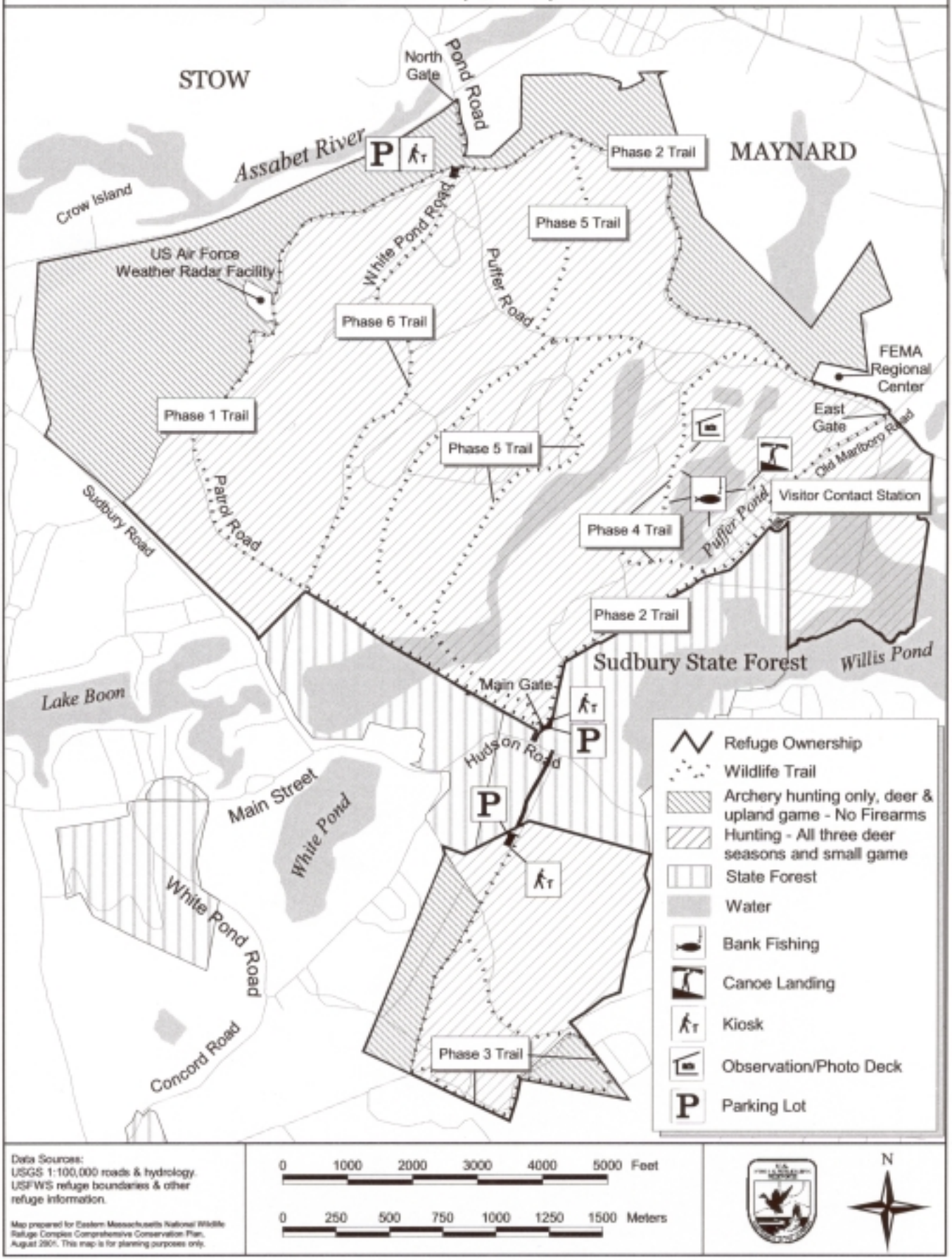
See Appendix D for staffing charts.

Alternative B: Proposed Action

Proposed Public Use, Habitat Management and Facilities

Assabet River National Wildlife Refuge

Eastern Massachusetts NWR Complex Comprehensive Conservation Plan



Data Sources:
USGS 1:100,000 roads & hydrology.
USFWS refuge boundaries & other refuge information.

Map prepared for Eastern Massachusetts National Wildlife Refuge Complex Comprehensive Conservation Plan, August 2001. This map is for planning purposes only.

0 1000 2000 3000 4000 5000 Feet

0 250 500 750 1000 1250 1500 Meters

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Alternative C

Under this alternative the refuge management strategy would be oriented towards a "hands-off, let nature take its course approach." We would curtail or forego most, active wildlife and habitat management planning and implementation. Natural succession of habitats would be the selected strategy across the refuge. The refuge would be opened to public use only after all safety-related concerns were corrected. Additional opportunities for wildlife-dependent recreational activities would be reduced or eliminated within portions of the refuge. Fewer public-use trails would be developed.

Habitat and Wildlife Populations

We would limit wildlife and habitat planning to only basic survey work, compiling inventory lists of species presence, and the development of a current habitat cover-type map. These activities would be repeated at five-year intervals to measure changes and to reassess refuge management objectives. Detailed wildlife and habitat management plans would not be required, nor would they be prepared. No management activities would be undertaken that would impede or slow natural successional processes, and no habitat restoration projects would be planned or implemented.

Invasive and Overabundant Species

An inventory and mapping of the current extent of invasive plant species would be completed. These activities would be repeated at five-year intervals to measure changes and to reassess refuge management objectives. No active management would be undertaken except in the event of a threat to property or human health.

Priority Public Uses

Hunting

Big and Upland Game Hunting

Under this alternative, the hunt plan would be the same as Alternative B except the white-tailed deer hunting would be opened on the refuge, but would be limited to archery and the primitive firearm seasons established by the Massachusetts Division of Fisheries and Wildlife (See Map 2-3).

Migratory Bird Hunting

Same as Alternative B.

Fishing

Alternative C would limit fishing to shoreline use from two locations/ areas. The current, proposed locations of these facilities are depicted on Map 2-3.

Wildlife Observation and Photography

Alternative B would be modified by eliminating all trails interior of the former Patrol Road on the northern portion of the refuge.

Environmental Education and Interpretation

Same as Alternative B.

Public and Community Outreach

Same as Alternative B, however use of on-refuge wildlife or habitat management demonstrations areas described under Alternative B would be reduced or eliminated.

Resource Protection and Visitor Safety

Same as Alternative B

Cultural Resource Protection

Same as Alternative B, except the refuge-wide archeological survey would be less intensive as the development of predictive modeling to evaluate refuge management actions would not be necessary.

Refuge Buildings

Same as Alternative B.

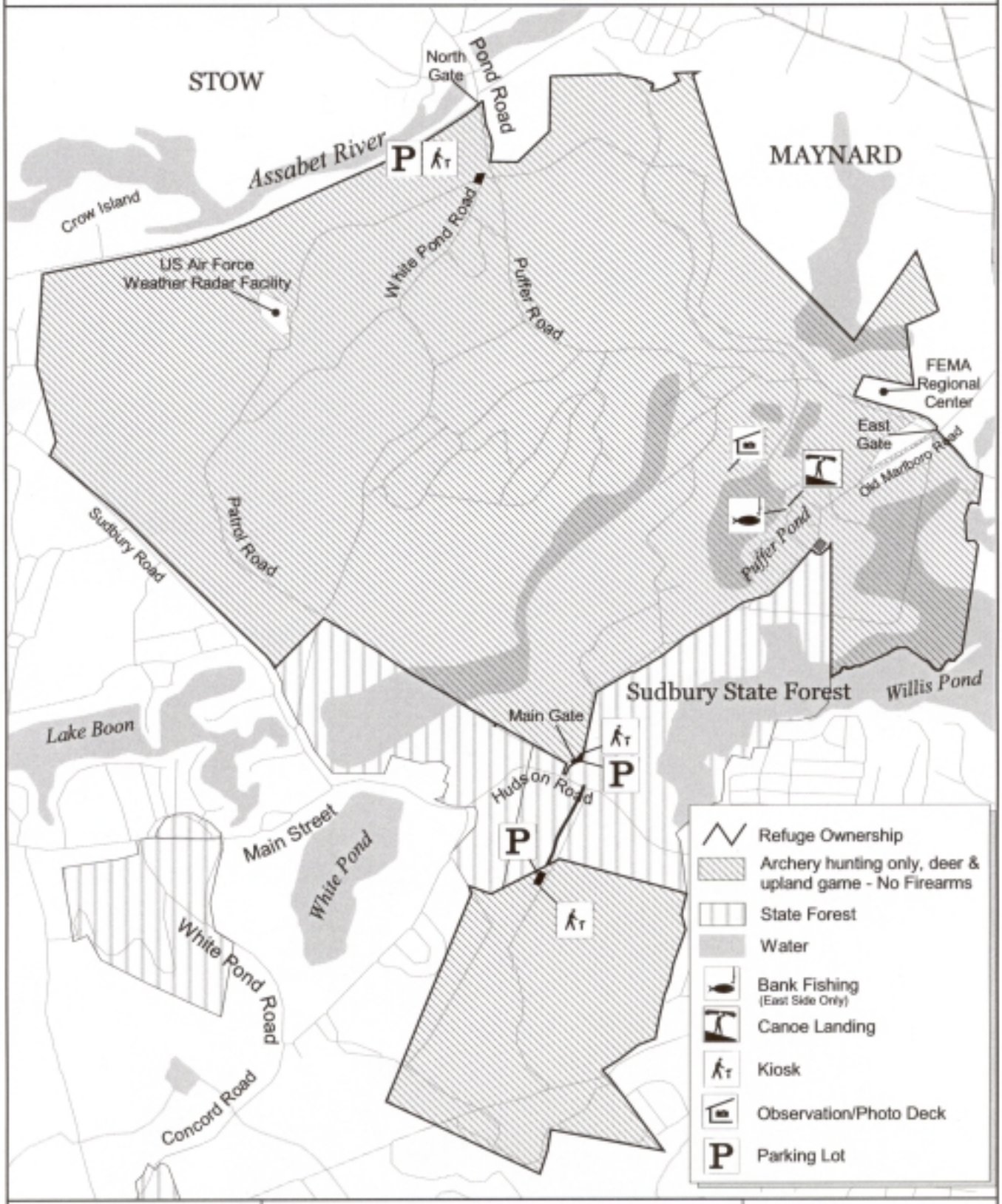
Refuge Staffing

The reduced levels of wildlife and habitat management activities and som public use opportunities included in Alternative C would result in fewer required staff. We propose the following staff under Alternative C:

- refuge operations specialist/manager
- outdoor recreation planner
- two maintenance workers
- park ranger (law enforcement);
- refuge biologist
- administrative technician

See Appendix D for Staffing Charts.

Alternative C
Public Use Habitat Management and Facilities
Assabet River National Wildlife Refuge
Eastern Massachusetts NWR Complex Comprehensive Conservation Plan



Data Sources:
USGS 1:100,000 roads & hydrology
USFWS refuge boundaries & other refuge information.

Map prepared for Eastern Massachusetts National Wildlife Refuge Complex Comprehensive Conservation Plan, August 2001. This map is for planning purposes only.

0 1000 2000 3000 4000 5000 Feet

0 250 500 750 1000 1250 1500 Meters

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Table 2-4. Actions and Strategies Matrix, Assabet River National Wildlife Refuge

Issue	Alternative A Current Management	Alternative B Service's Proposed Action	Alternative C
How would we manage habitats and wildlife populations?	Conduct annual surveys for woodcock, marsh birds, breeding birds, whip-poor-wills, migrating hawks and anurans. Obtain supplemental wildlife and habitat information from partners. Participate in partner-based monitoring contaminants program. Maintain existing old field habitat (approximately 60-70 acres) by mechanical means or fire management techniques. Maintain approximately 500 acres of existing wetland habitat. Restore approximately 40-50 acres of currently degraded wetlands. Allow existing mix of hardwood and pine forest to mature under natural succession processes. Selectively remove existing roads and trails not required for refuge maintenance, visitor use, or fire control purposes. Evaluate and re-ues ammunition bunkers which provide suitable for bat habitat. Selectively remove portions of the exterior fence which will allow for wildlife movement. Identify research needs.	In addition to Alternative A: Develop inventory list of migratory bird and federally listed threatened and endangered species. Inventory and evaluate population statuses of key, resident vertebrate and invertebrate species, including State listed threatened/ endangered species, deer, small mammals, frogs, and others on the refuge. Inventory refuge habitats surface hydrology, soils and topography Develop and update cover type map Identify focus species Develop species management objectives Develop & implement a Habitat Management Plan and a Habitat and Wildlife Inventory and Montioring Plan which may utilize mechanical, chemical and fire management techniques to accomplish potential habitat plan recommendations Seek opportunities to develop cooperative management agreements with neighboring conservation agencies, organizations and individuals Restore those habitats which were severely impacted or destroyed as a result of military activities, including building and road removal where appropriate	Active management practices would be severely curtailed or eliminated. Planning and monitoring would be limited. Inventory migratory bird and Federal listed threatened and endangered species, resident vertebrate (e.g. deer, small mammals, anuran, etc.) and invertebrate species, including State listed threatened/ endangered species, on the refuge. Develop an updated cover type map Repeat inventory surveys at five year intervals to evaluate successional changes.

Table 2-4. Actions and Strategies Matrix, Assabet River National Wildlife Refuge

Issue	Alternative A Current Management	Alternative B Service's Proposed Action	Alternative C
How would we manage invasive and overabundant species?	Monitor known stands of invasive species, and implement control if project- specific funding becomes available. Continue to rely on partners to identify invasive species problems. Continue beaver management program which currently relies primarily on non-lethal methods of control.	Inventory and document all invasive, pest or overabundant species locations and extent. Monitor and evaluate rate of spread of invasive, pest or overabundant species. Develop and implement an Integrated Pest Management Plan (IPM) for invasive plant, pest or overabundant species which utilizes biological, mechanical, chemical and fire management or other control techniques. Manage overabundant/invasive animal populations identifed in surveys using hunting, trapping and relocation, and lethal controls as may be necessary. Specifically, remove nuisance beaver where other control methods fail and remove territorial exotic mute swans from the refuge. Conduct/participate in experimental control technique research.	Active management practices would be severely curtailed or eliminated. Planning and monitoring would be limited. Inventory and document all invasive species locations and pest or overabundant animal species. Monitor and evaluate rate of spread of invasive pest or overabundant species at five-year intervals.

Table 2-4. Actions and Strategies Matrix, Assabet River National Wildlife Refuge

Issue	Alternative A Current Management	Alternative B Service's Proposed Action	Alternative C
How will the Refuge be opened to wildlife-dependent public uses?	Currently the refuge is closed to general public access and use due to a number of unmitigated safety hazards that exist on the property. Special guided tours/events are organized to allow limited access to the refuge.	A Visitor Services Plan for the refuge will be prepared. The refuge will be opened in sections, along specific designated trails, as current safety problems are resolved within those sections. Potential strategies for a sequenced opening of the refuge include: 1. Section from Hudson Road Gate along Patrol Rd. to North Gate. 2. Section from North Gate along Patrol and Old Marlboro Roads back to Hudson Road Gate. 3. Portion South of the Hudson Road. 4&5 Designated trails to be established in and through the ""bunkers"". 6. Section from North gate along White Pond Road back to Patrol Road. When safety-related concerns have been eliminated, the two gates on either side of Hudson (State) Road (The old ""Main"" opened for public access to the Refuge. The former ""North Gate"" on White Pond Road will also be made available for public access. Minimally intrusive parking areas will be provided as funding and staff allow. An entrance fee will be collected. .	The refuge will be opened only after all safety issues are corrected on a site-wide basis, and along a limited subset of designated trails.

Table 2-4. Actions and Strategies Matrix, Assabet River National Wildlife Refuge

Issue	Alternative A Current Management	Alternative B Service's Proposed Action	Alternative C
What upland and big game hunting opportunities would we provide?	Currently the refuge is closed to general public access and use due to a number of unmitigated safety hazards that exist on the property.	A Refuge Hunting Plan will be prepared using the analysis from Alternative B and, if needed, refuge-specific regulations will be prepared. The refuge will be open to archery, shotgun and black powder deer hunting, if State mandated safety distances can be maintained Handicapped accessible hunting opportunities will be provided refuge-specific regulations will be prepared. Shotgun hunting of upland game birds, turkey and small game mammals will be permitted. Use of non-toxic shot would be required. Annual fee permits will be required for hunting on the refuge.	Same as Alternative B, except: The refuge will be open to archery and black powder deer hunting only.
What migratory game bird hunting opportunities would we provide?	Currently the refuge is closed to general public access and use due to a number of unmitigated safety hazards that exist on the property.	Woodcock hunting on the refuge would be open. If supported by refuge specific wildlife and habitat inventories, portions of the refuge will be open to waterfowl. A Refuge Hunting Plan will be prepared using the analysis from Alternative B and, if needed, refuge-specific regulations will be prepared. Annual fee permits will be required for hunting on the refuge.	Same as Alternative B.

Table 2-4. Actions and Strategies Matrix, Assabet River National Wildlife Refuge

Issue	Alternative A Current Management	Alternative B Service's Proposed Action	Alternative C
What fishing opportunities would we provide?	Currently the refuge is closed to general public access and use due to a number of unmitigated safety hazards that exist on the property.	Catch and release fishing will be provided on Puffer Pond. Use of live bait and motorized water craft will not be permitted. Canoes are allowed. Ice fishing will not be permitted. Portions of the Pond perimeter may be closed from time to time to minimize bank vegetation damage. Handicapped accessible fishing opportunities will be provided.	Same as Alternative B, except the westerly shoreline of the pond would not be opened for fishing.
What wildlife observation and photography opporutnities would be provided?	Currently the refuge is closed to general public access and use due to a number of unmitigated safety hazards that exist on the property.	Approximatley 5-6 miles of designated trails/roads will be opened for wildlife-dependent uses such as wildlife observation and photography. One wildlife viewing platform and photography deck will be constructed. Monitor programs for impacts to wildlife, modify as needed.	Alternative B would be modified to limit foot trails to only Patrol and Old Marlboro Road routes.
What environmental education and interpretation opporutnities would we provide?	Currently the refuge is closed to general public access and use due to a number of unmitigated safety hazards that exist on the property. Very limited interpretive programs occur, primarily organized and lead by partners, volunteers and the Refuge Friends group.	Provide on and off site environmental education programs. Coordinate with area environmental educators to integrate refuge programs with local environmental education programs. Provide assistance with teacher workshops, as requested. Construct three on-site informational kiosks in the vicinity of the Main, South and North gate entrances. Develop, construct and implement a self-guided interpretive trail or trails. Develop volunteer-led interpretive and education programs. Provide Service-led interpretive and education programs on the refuge. Review non-Service sponsored uses of the refuge for compatibility. Regulate these uses through Special Use Permits, Memoranda or Understanding or Agreement, or Concessions, as appropriate.	Same as Alternative B

Table 2-4. Actions and Strategies Matrix, Assabet River National Wildlife Refuge

Issue	Alternative A Current Management	Alternative B Service's Proposed Action	Alternative C
How will the refuge provide outreach to increase the public's awareness of the refuge?	A very active Refuge Friends group is engaged in outreach programs. A electronic newsletter is distributed. A refuge Web-site and monthly news releases are used to provide information on refuge management activities and upcoming events.	Same as Alternative A plus: With partners, provide refuge related presentations to schools, clubs, and civic organizations when requested. One or more annual events (such as National Fishing Day, Refuge Week, etc.), which promote wildlife dependent uses and natural resource education will be held on the refuge. An Assabet River Refuge Brochure would be developed. Work with partners towards funding construction of a visitor contact station on the refuge. Work with partners to place information kiosks with refuge oriented materials at 3 off-refuge locations in the local communities. Develop programs to education local communities and landowners about existing opportunities and strategies for resource protection and restoration. Utilize on-going refuge management areas to illustrate beneficial wildlife and habitat practices.	Same as Alternative B, except on-refuge wildlife and habitat management demonstration areas would not be available.
How would we ensure resource protection and visitor safety?	Law enforcement would be provided by one full-time and one collateral-duty staff shared with other Complex refuges. Federal cultural resource protection laws and regulations are enforced. Soil disturbance requires cultural resource evaluations and clearance.	In addition to Alternative A: Survey sites proposed for construction of all facilities, roads, trails, buildings, etc. Modify construction as necessary to minimize impacts to cultural resources.	Same as Alternative B, except the refuge-wide archeological survey would be reduced in scope, eliminating studies needed to develop predictive models. Complete an overview survey of cultural resources of the refuge. Develop predictive model for probable archeological and historic sites.

Table 2-4. Actions and Strategies Matrix, Assabet River National Wildlife Refuge

Issue	Alternative A Current Management	Alternative B Service's Proposed Action	Alternative C
What buildings and facilities would be used or constructed for refuge operations?	No buildings are in use.	Using information provided in assessment of the condition and historical significance of buildings existing structures will be demolished. Work with partners towards funding construction of a visitor contact station on the refuge.	Same as Alternative B.
What would be the future staffing needs at Assabet River Refuge?	Current Minimum Staffing: 1 Refuge Operation Specialist (vacant) 1 Biologist (vacant) 1 Park Ranger (LE) (vacant) 1 Outdoor Recreation Planner (vacant) 1 Biologist (vacant) 2 Maintenance Workers (vacant) Total FTEs 7	In addition to Alternative A: 1 Administrative Technician 1 Forester (shared with other Complex Refuges) Total FTEs (A+B) 9	Same as Alternative A (except the biologist), plus : 1 Administrative Technician Total FTEs 7

Part 2: Great Meadows National Wildlife Refuge

Actions Common to All Alternatives for Great Meadows Refuge

Wild and Scenic River Designation

Great Meadows National Wildlife Refuge protects 12 miles of the Concord and Sudbury Rivers, which are designated under the Wild and Scenic Rivers Act. For a complete description of the designation see Chapter 3: Part 2 Great Meadows National Wildlife Refuge.

Under all alternatives, we would continue to work with our partners to develop a Wild and Scenic River Plan, as required by the establishing act. We have also identified funding needs in our Refuge Operations Needs System (RONS), Appendix E, for both biological and interpretive programs to enhance our management and conservation of these two rivers where they flow thru/by the refuge. None of the actions proposed in any of the alternatives violate the guidelines for Wild and Scenic river designations. For additional information on this designation, see Chapter 3: Part 2 or log onto http://www.nps.gov/rivers/wsr-suasco.html.

Alternative A: Current Management

This alternative assumes no change from current and ongoing management. This is considered to be the baseline against which all other alternatives are compared. No changes would be made to the major current activities, such as current and ongoing management activities and partnerships, public access and currently approved staffing levels.

Habitat and Wildlife Populations

Great Meadows Refuge would continue to participate in several region-wide and Service-wide surveys and studies. Ongoing inventories of frogs, shorebirds, marsh birds, and American woodcock would proceed as funding allows. Breeding bird surveys and participation in the national frog deformity project would continue as staff and funding allow.

Beginning in 2000, water levels in the Concord Impoundments have been actively managed by drawdowns to continuously expose the appropriate amount of new mudflat habitat during the entire shorebird migration period. Weekly water gauge readings are recorded from existing measurement structures in the pools. Surveys are conducted weekly year round. Water control structures at the Strand property (Sudbury) and Concord impoundments (Concord) would be maintained to allow refuge staff

to manage water levels in the pools. Flooding areas dominated by seed-producing annuals provide carbohydrates and fat for the higher maintenance requirements of dabbling ducks during the winter and migration. To obtain the desired feeding habitat, water levels are drawn-down in alternating pools in Concord during the summer to promote germination of wetland plants. These pools are then slowly flooded during the fall and early winter, ensuring that water depths in areas with annual plants do not exceed eight inches. Slow staging of water levels provides a continual supply of new habitat at optimal levels. During the late winter and spring, these units could be drawn-down, which creates a concentration of invertebrates at a time when waterbirds are actively attempting to acquire protein.

Great blue heron with fish. *Many different marsh birds find food at the Concord Impoundments. Photo by Bruce Flaig*

Refuge staff would obtain data from Massachusetts Division of Fisheries and Wildlife for fall waterfowl banding efforts on the Concord impoundments and wood duck box production and success occurring throughout the refuge. The State biologist and volunteers maintain more than 30 wood duck boxes on both the Sudbury and Concord Unit and band waterfowl one to two times each fall at the Concord Unit. The refuge relies on partners for this waterfowl production information. Information collected by partners through wildlife surveys conducted on the refuge is gathered annually.

Volunteers and staff would continue to monitor and record bluebird production from approximately 40 boxes found at four sites on the Sudbury Unit. The refuge has been involved in this program since the mid-1980s. Boxes are checked once a week from late March to mid-July. Boxes are checked for the presence/absence of birds, species identification, and number of young. Success of the boxes varies greatly from year to year. Chickadees, tree swallows, house wrens, and bluebirds have all been documented as successfully using the boxes.

Refuge staff would participate in an alewife stocking program begun in 2000, when funds are available. The goal of the project is to restore historical runs of fish in the herring family to the Concord River. The Central New England Fishery Resources Office in Nashua, New Hampshire applied for a three-year permit to transfer a total of 7,500 alewife to the Concord River from the Nemasket River. Each year 1,000 fish are stocked into four separate locations on the Main stem of the river, and the remaining 1,000 fish are stocked in the Assabet and Sudbury Rivers. Refuge staff would continue to help locate release sites, release stocked fish, and monitor rivers for fish passage as time and funds allow.

Refuge staff continue to rely on partners such as CREST (Concord River Environmental Stream Team), OAR (Organization for the Assabet River) and SVT (Sudbury Valley Trustees) to monitor water quality.

Refuge staff would continue to actively maintain and restore early successional grasslands and shrublands on approximately 100 acres of the refuge through hydro-axing and mowing, for birds that

Table 2-5. *Wildlife Surveys at Great Meadows National Wildlife Refuge*

Survey	Purpose	Points	Observation	Other Information
Landbird Breeding Survey	• occurrence of species • occurrence within habitats • relative abundance • changes in populations	Sudbury 21 Concord 22, refuge wide	late May to mid-June for 10 days 1time/season observation made in 10 minute intervals	survey points visited once during survey period, habitat is classified at each point began in 2000 birds are identified by sight and sound
Marsh Bird Callback Survey	• identify species presence • monitor change in abundance • evaluate species response to habitat modifications	20 points/ unit in ponds, marshes and emergent vegetation	early May-mid July 3 times/season	began in 2000 birds are identified by sight and sound callback tapes are used
American Woodcock Survey	• presence and abundance	10 points in fields, clear cuts, meadows, etc.	mid-April to mid-May, observations conducted in 2 minute intervals 1 time/season	re-established in 2000
Anuran Call Counts	• presence and abundance	11 points at Great Meadows	mid-March- mid-July 5 minute observation period 4 times/season	began Spring of 2000
State-wide Annual Midwinter Bald Eagle Survey	• presence and abundance	3 survey routes through refuge	January 1-15	refuge participation since 1980
Waterbird counts at Concord Impoundments	• determine efficiency/success of water level manipulation	Concord Impound-ments	weekly, year round	began 2000 4 year study in Concord Impoundments
Rare Plant Surveys	• presence/abundance of rare plants	----	----	surveys conducted by New England Wildflower Society, MassWildlife, and State Natural Heritage and Endangered Species Program

depend on this habitat. Refuge staff mow approximately 30-50 acres of fields each year in mid- to late-August on a three to five year rotating schedule in order to maintain grasses without disturbing ground-nesting birds. Refuge fields exist in Carlisle, Sudbury, and Wayland (Map 2-4).

Great Meadows Refuge would continue the Cooperative Farming program on a single six acre field. Currently, six acres of refuge lands are enrolled the Cooperative Farming program. A private farmer grows summer crops and contributes money in return for the ability to farm the field. The farmer also plants and leaves an overwinter standing crop. This total is currently down from about 27 acres in 1998. One 20-acre field was removed from this program in 1999. The current participator plants non-wildlife-compatible crops and uses no herbicides or pesticides on this property.

Invasive and Over Abundant Species

Purple loosestrife. *USFWS Photo*

The refuge would actively continue to control water chestnut (*Trapa natans*), purple loosestrife (*Lythrum salicaria*) and cattail (*Typha latifolia*). The refuge uses biological control to combat purple loosestrife via the release of beetles and weevils. Depending on staffing levels, the refuge would continue to raise beetles in a rearing facility and release up to 10,000 *Galerucella pusilla* and *G. calmariens*is beetles annually in Sudbury, Concord, and Carlisle in an effort to cut costs. In addition, refuge staff would occasionally release weevils (*Hylobius transversovittatus*) when available. Affects of beetles and weevils on loosestrife on the refuge would be quantitatively documented. The refuge would also continue to use herbicides on loosestrife.

Refuge staff would control water chestnut in the Concord impoundments, using a 2002 Water Management Plan as a guide. The impoundments are alternately drained in the summer months to control seed viability (survival). Ditches are maintained in the pools as needed, using an amphibious excavator, to insure proper drainage of the pools. In addition, an aquatic weed harvester is occasionally used to remove whole plants from the impoundments. The weed harvester is also used by local and State partners in rivers and pools were water levels can not be managed.

Large, monotypic stands of cattails would be managed through mowing, flooding and herbicides where appropriate. Stands of cattail in the Concord impoundments are mowed in the late fall/early winter and the stems are kept flooded in at least 6 inches of water through spring.

Other invasive species occurring on the refuge would not be vigorously controlled.

The refuge would continue to install and maintain beaver control devices on refuge wetlands and beaver meadows. In recent years, beavers have caused flooding of refuge trails and maintenance roads. Control of such situations includes manually clearing culverts, installing grates on culverts and water-control structures, and installing beaver deceivers in dams or on culverts. Devices range from a simple PVC pipe inserted into dams to reduce water levels, to fencing constructed in a semicircle around a culvert with drain pipes inserted through the fence.

Priority Public Uses

The refuge public use areas would be open to the public year round from one half-hour before sunrise to one half-hour after sunset, 365 days a year.

Hunting

Big and Upland Game Hunting

Refuge lands would remain closed to all types of hunting.

Migratory Game Bird Hunting

Refuge lands would remain closed to all types of hunting.

Fishing

The refuge would continue to allow fishing on the Concord and Sudbury rivers. Boat or canoe fishing opportunities, in compliance with State regulations and restrictions, are provided on the 12 miles of the Sudbury and Concord Rivers, which flow through the refuge. Fishing within refuge ponds, pools and wetlands is prohibited for wildlife nesting and habitat protection reasons. Fishing from the banks of the Concord and Sudbury Rivers within the refuge is closed to the shoreline, to prevent disturbance to migratory birds, destruction of habitat, including the marshes along the shoreline, bank erosion, litter and due to limited accessibility.

Wildlife Observation and Photography

Public use trails would remain open. Refuge visitors can access trails on both the Concord and Sudbury Units (see Map 2-4., 2-5, 2-6, 2-7).

Sudbury trails
Weir Hill (Sudbury)-1.1 miles
Heard Pond (Wayland) -1/4 mile

Concord trails
Concord impoundment (Concord)- 2.7 miles
O'Rourke Farm (Carlisle)- 3 miles
Route 4 Bridge (Billerica)- new trail partially developed
Two Brothers Rock (Bedford) 2 miles

The Concord and Sudbury rivers are open to canoeing and fishing. Two canoe landings on the refuge, one at Weir Hill and one at the Concord impoundments, are maintained. The State and towns maintain several other launches and landings as well (see Maps 2-4., 2-5, 2-6, and 2-7).

Visitors can access refuge trails by foot, snowshoes and cross-country skis. Dogs on leashes are allowed on the trails. Bicycles and

motorized vehicles are allowed in refuge parking lots only. Bike racks are provided at the Concord impoundment and at Weir Hill Trails. Jogging is currently allowed on refuge trails. No picnic tables are provided.

We would continue to sponsor an annual photo contest. Since 1998 the refuge has hosted this photography contest. Entries fall into three categories: wildlife, recreation, and landscape. Photos must be taken on one of the refuges in Massachusetts. Local sponsors supply prizes for winning entries. An unveiling of winning photos and slides takes place during National Wildlife Refuge Week each October. Winning entries are displayed in the Sudbury Visitor Center for several months. The refuge uses entries in educational and promotional programing.

Environmental Education, Interpretation, and Outreach

We would continue to provide assistance to all scheduled school groups who use the refuge. Currently over 100 classes receive a minimum of a welcome talk and introduction to the Refuge System. Refuge staff lead programs for some groups focusing on habitat types, pond study, and refuge management. When requested staff and volunteers assist teachers at their schools, as time and funds allow. The Concord Unit would continue to be the heaviest used Outdoor Classroom site on the refuge by schools. The Weir Hill Outdoor Classroom is used to a lesser degree by schools.

We sponsor several teacher workshops annually. One-day workshops include Project Wild activities and activities teachers can use at the refuge during a visit. The workshops also discuss planning a field trip to the refuge.

The refuge would continue to sponsor the Urban Education Program. The program began in 1999 and focuses on working with inner city, multi-cultural students in the Worcester and Boston area. Students in the program visit a refuge three time and have staff from the refuge visit their classroom three times in each of the 4th, 8th and 12th grades. This long-term relationship with the Service fosters an understanding and appreciation for the refuge and creates an avenue for career opportunities with the Service. The program would increase only slightly in size to two schools from Worcester and two from Boston participating. Interns from the program are encouraged to enter the Student Career Experience Program, a program that offers college students the opportunity to gain professional experience with the Service during school with possible job placement after graduation.

Refuge staff and volunteers would continue to offer on- and off-site interpretive programs to visitors at all public use areas. As time and funds allow, staff and volunteers provide offsite interpretive programs when requested. Programs focus on refuge management, mission of the Service and species that can be found on the refuges. All programs are free and open to the public. Programs to scouts are offered as requested. Eagle Scouts help to maintain trails and build boardwalks.

Informational and educational kiosks are located at the Concord impoundments, Weir Hill, and Heard Pond. Interpretive signs and self-guided trails with fact sheets (Map 2-5, 2-6, 2-7) are maintained at the Concord impoundments and Weir Hill trails. Interpretive signs about refuge management and species' natural history can be found along the Weir Hill and Concord Dike trails. The observation tower at Concord is maintained as a wildlife observation tool for visitors (see Map 2-5). The refuge produces general Complex brochures, refuge-specific brochures, and a bird guide for Great Meadows, Oxbow, and Assabet River refuges. The refuge also provides two self-guided trail brochures: one is found at The Sudbury Unit- Weir Hill, the other at the Concord Unit- Dike Trail. These brochures can be obtained at the Visitor Center or at trail-heads.

Between two and four special event days would continue to be hosted by the refuge annually. Each event is a minimum of four hours and revolves around a single theme. Special celebrations include Bluebird Day, National Hunting and Fishing Day, and Wildlife Art Festival.

Guided tours by outside groups would be permitted on the refuge through annually renewed Special Use Permits. Each group is required to give basic Refuge information to the participating public. The refuge receives information on each program offered on its lands including type of program, number of participants, and number of programs offered.

Volunteers assist refuge staff with interpretive and education programs.
USFWS Photo

A monthly electronic newsletter is distributed to an increasing number of local citizens. This newsletter replaces the previous, Meadows Messenger which began in the early 1980's. In January, 2001, Great Meadows Refuge developed a refuge-specific web page which provides information on refuge activities, and reproduces The Messenger. Articles in the newsletter inform the public of ongoing management and upcoming activities. The refuge distributes monthly news releases to more then 20 local papers and radio stations on upcoming events and ongoing management activities.

The Refuge Visitor Center and Headquarters would continue to be open Monday through Friday 8:00 a.m. - 4:00 p.m. The Visitor Center is open on weekends from May to October. The conference room/auditorium is open to conservation and/or educational organizations to conduct meetings and workshops. Refuge staff are also conducting roving interpretation on the trails during the summer months. Simple exhibits on the Service, and local issues continue to be provided at the Visitor Center.

We would continue to build a strong volunteer program to help with public use and biological activities. The staff continue to view volunteers as an essential part of its manpower and ability to meet its mandate. Examples of projects volunteers assist with include: leading school, Scout, and interpretive programs, performing surveys, greeting visitors, staffing special events and the Visitor Center, posting boundaries, and maintaining trails. The refuge has over 100 volunteers. Some help once a year while others help once a

week. Refuge staff continue to be active participants in local community and conservation organizations. Refuge staff participate on local committees, councils, and advisory boards.

A Cooperating Association- SuAsCo Great Meadows- Education Fund, would continue to be allowed to run a small bookstore at the Refuge Headquarters. Items sold through the store focus on increasing visitors understanding and appreciation of the natural world and the refuge. Profits from the store are used to support the refuge's public use program.

Non-Wildlife Dependent Activities

The refuge public use trails would continue to be open to jogging and walking dogs on leash. Picnicking would be allowed, though no would be available. Bicycles would be allowed in parking lots and on paved entrance roads. Bike racks would be provided to visitors who wish to walk the trails. Bikes would not permitted on refuge trails.

Resource Protection Visitor Safety

The current refuge law enforcement staff consists of two full-time officers for Great Meadows Refuge and one collateral duty officer shared throughout the eight refuges in the Complex. These officers would continue to enforce the Service's refuge protection regulations, State and Federal wildlife protection and hunting laws and regulations, and Federal cultural resource protection laws and regulations.

Cultural Resource Protection

Cultural resource (archeological and historical) evaluations or surveys would continue on a refuge project-specific basis. Soil disturbance requires resource evaluation and clearance. Federal cultural resource protection laws and reguations would be enforced.

Refuge Buildings and Facilities

No new office or visitor buildings would be constructed. The existing Refuge Headquarters, Visitor Center and maintenance buildings are located at the Sudbury Unit, at the end of Weir Hill Road, and would be maintained. The comfort station (restroom facilities) at the Concord Unit would be open year round and the small shop located at the end of Monsen Road would be maintained as a storage area for heavy equipment. Visitor facilities at the Sudbury Unit would be remodeled to provide higher-quality visitor experiences, as funds allow. Two storage barns/building are located on Water Row Road in Sudbury. We would maintain two residences and one dorm facility in Sudbury and one residence in Carlisle (Map 2-8 and Map 2-9).

Refuge Administration

The current Great Meadows Refuge runs along the Concord and Sudbury Rivers from Framingham to Billerica. The refuge is managed as two separate Units. The Concord Unit encompasses lands in the towns of Billerica, Bedford, Carlisle, and Concord. The Sudbury Unit encompasses lands in Lincoln, Wayland, Sudbury, and Framingham.

Refuge Staffing

Great Meadows Refuge is one of eight refuges managed under the Complex. This refuge is one of two staffed offices within the complex and houses the Refuge Headquarters and administrative personnel at the Sudbury office (see Appendix D for complete staffing chart). By 2006, all six positions at Great Meadows Refuge would be filled. The current staff for this refuge includes:

Refuge Manager (vacant)	sets goals and objectives for the refuge and to establish and maintain partnership,
Maintenance Workers(3)	maintains refuge facilities and equipment
Administrative Staff (2)	manages office and secretarial demands on the refuge

Staff assigned to Great Meadows Refuge also perform work duties on many of the other seven refuges in the Complex.

We would continue to sponsor a Youth Conservation Corps (YCC) program each summer. A crew of five to six local high school students, between the ages of fifteen and eighteen, would assist the refuge each summer for eight weeks. The crew would help maintain trails, assist with wildlife habitat management, and participate in eight hours of environmental education programs each week.

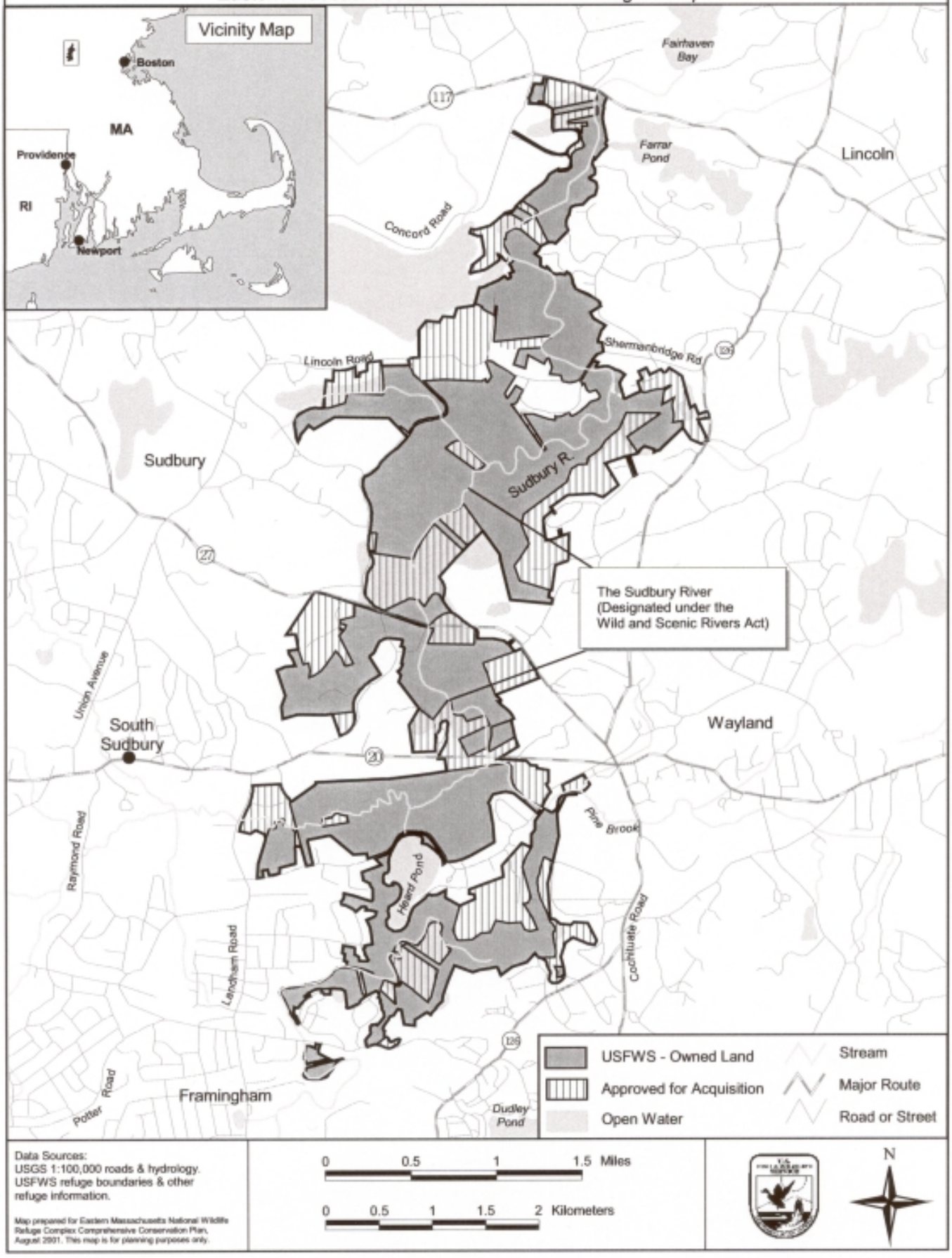
We also would continue to recruit 2-4 interns each year to assist with the education interpretation and biology programs. The interns would work between 8-12 weeks, working up to 40 hours each week. Internships could be completed for school credit. Free housing would be offered in the dorm to interns.

Great Meadows National Wildlife Refuge

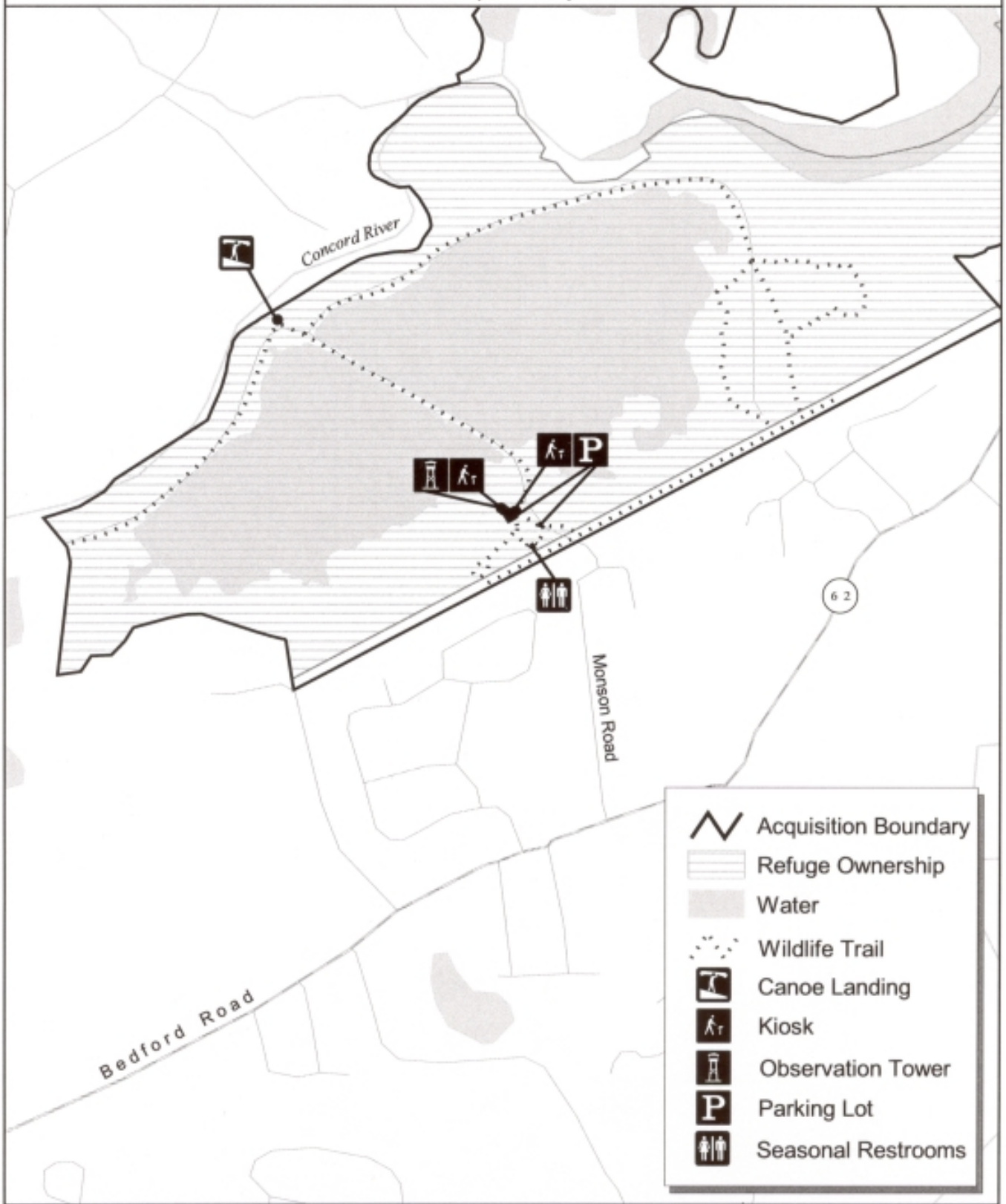
Sudbury Unit - 2,137 acres

Middlesex County, Massachusetts

Eastern Massachusetts National Wildlife Refuge Complex



Alternative A: Current Management
Existing Public Use at Concord Impoundments
Great Meadows National Wildlife Refuge
Eastern Massachusetts NWR Complex Comprehensive Conservation Plan



Data Sources:
USGS 1:100,000 roads & hydrology.
USFWS refuge boundaries & other refuge information.
MassGIS DOQQ

Map prepared for Eastern Massachusetts National Wildlife Refuge Complex Comprehensive Conservation Plan, August 2001. This map is for planning purposes only.

0 500 1000 1500 2000 Feet

0 200 400 600 Meters

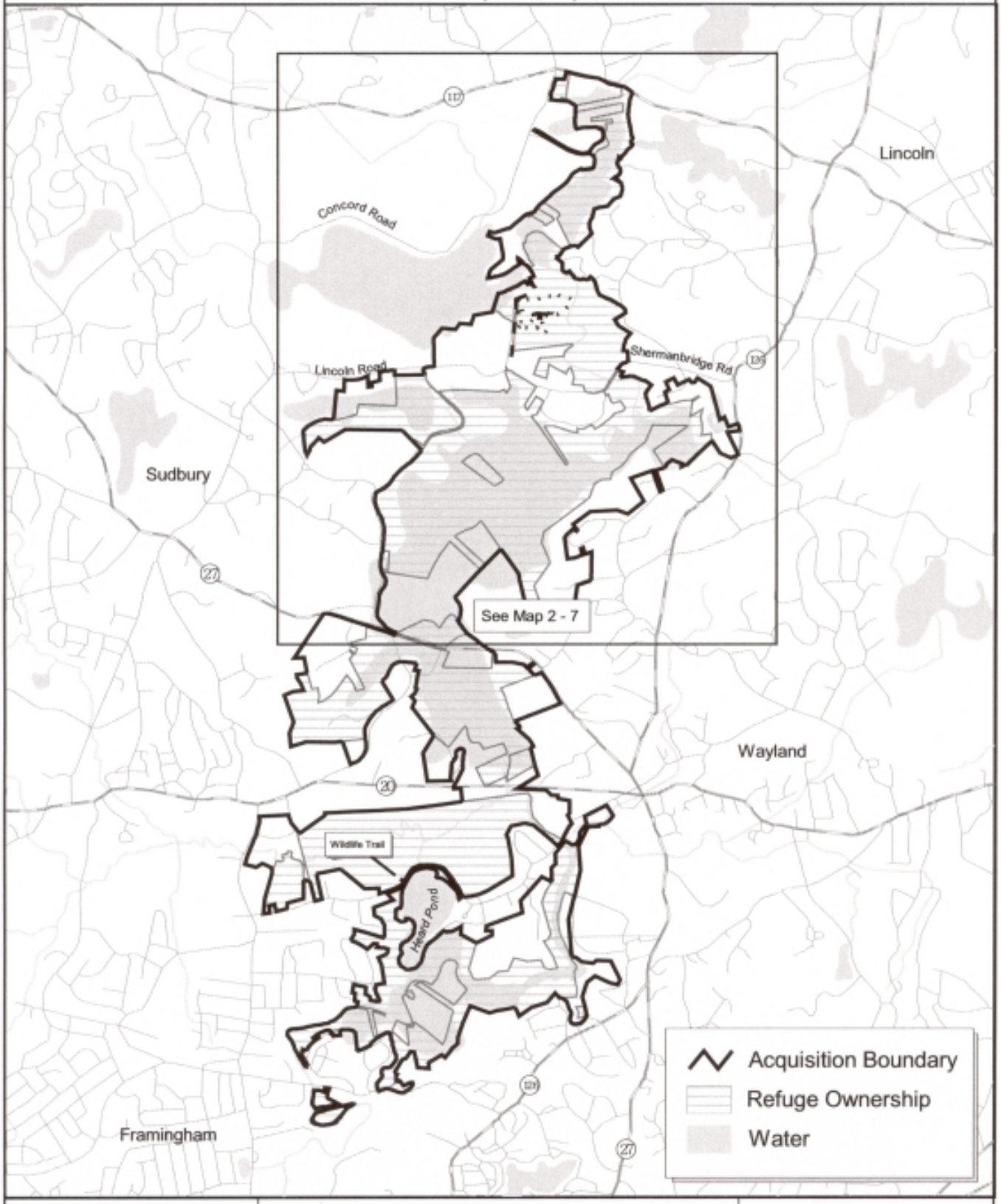
N

Alternative A: Current Management

Existing Public Use at Sudbury Unit

Great Meadows National Wildlife Refuge

Eastern Massachusetts NWR Complex Comprehensive Conservation Plan



Data Sources:
USGS 1:100,000 roads & hydrology.
USFWS refuge boundaries & other refuge information.

Map prepared for Eastern Massachusetts National Wildlife Refuge Complex Comprehensive Conservation Plan, August 2001. This map is for planning purposes only.

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0 1 2 3 Kilometers

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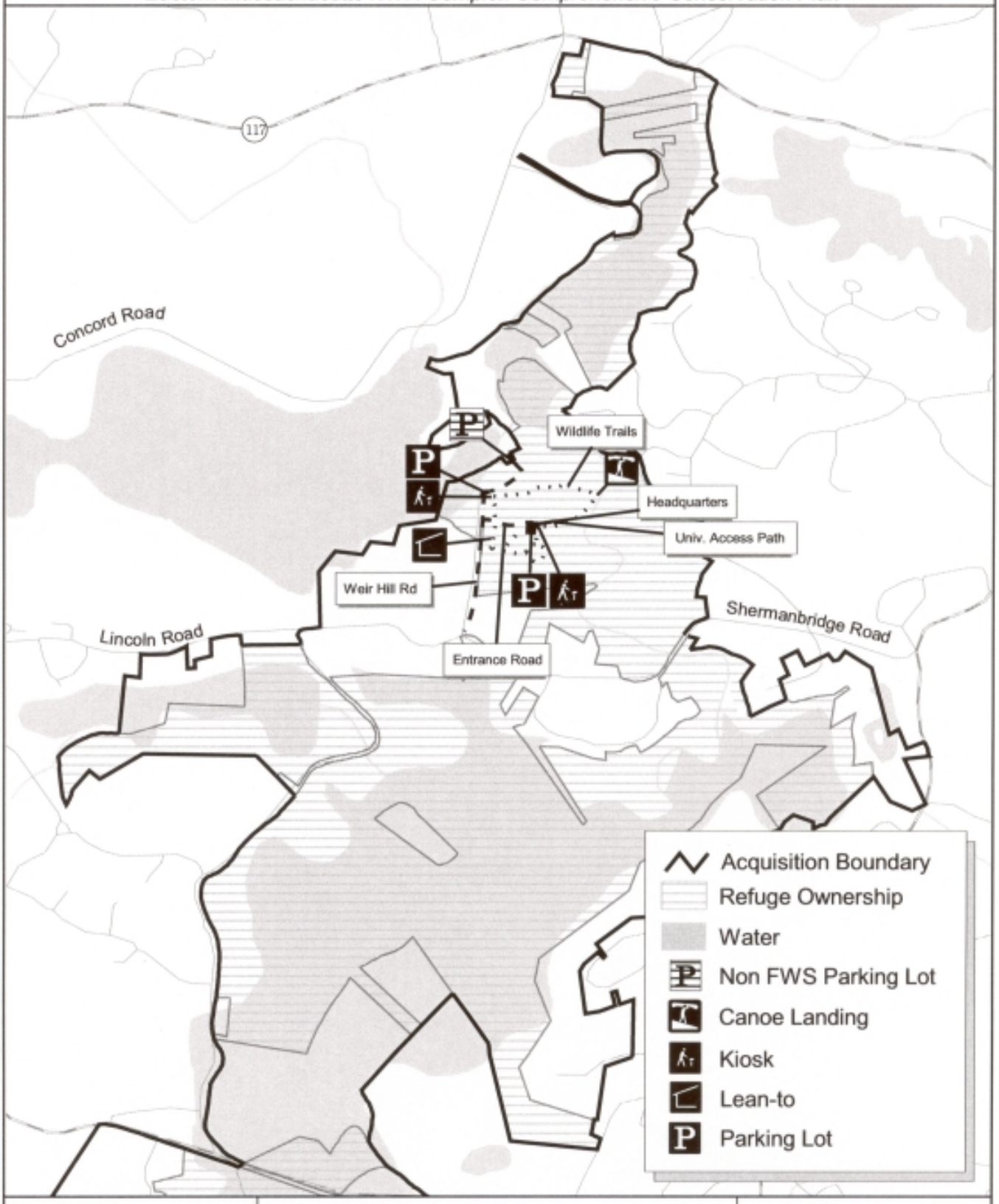
Alternative A: Current Management

Existing Public Use at Sudbury Unit

Great Meadows National Wildlife Refuge
Eastern Massachusetts NWR Complex Comprehensive Conservation Plan



Data Sources:
USGS 1:100,000 roads & hydrology.
USFWS refuge boundaries & other refuge information.

Map prepared for Eastern Massachusetts National Wildlife Refuge Complex Comprehensive Conservation Plan, August 2001. This map is for planning purposes only.

0 0.25 0.5 0.75 1 Miles

0 0.5 1 1.5 Kilometers

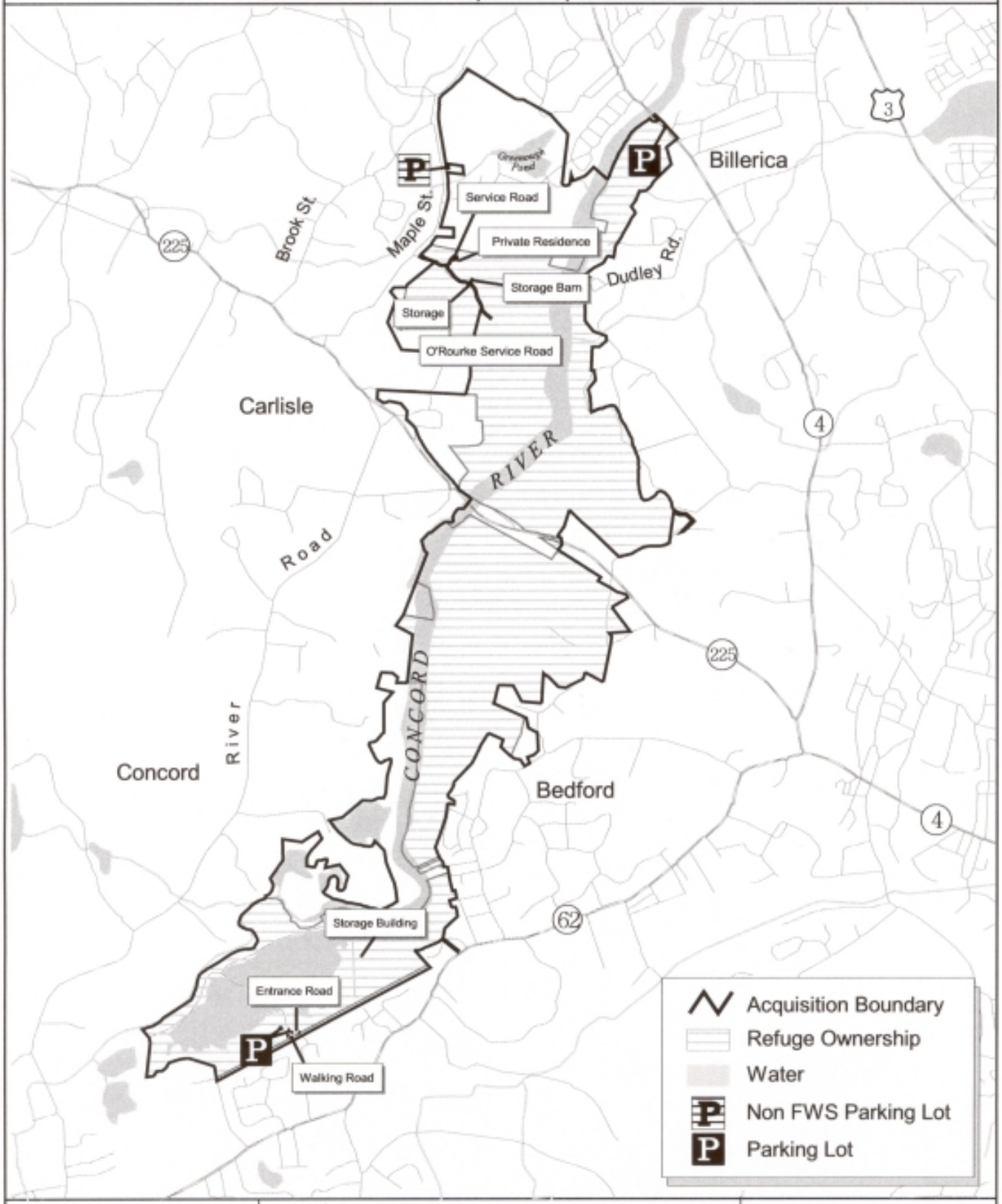
N

Alternative A: Current Management

Existing Facilities at Concord Unit

Great Meadows National Wildlife Refuge

Eastern Massachusetts NWR Complex Comprehensive Conservation Plan



Data Sources:
USGS 1:100,000 roads & hydrology.
USFWS refuge boundaries & other refuge information.

Map prepared for Eastern Massachusetts National Wildlife Refuge Complex Comprehensive Conservation Plan, August 2001. This map is for planning purposes only.

0 2000 4000 6000 8000 Feet

0 500 1000 1500 2000 Meters

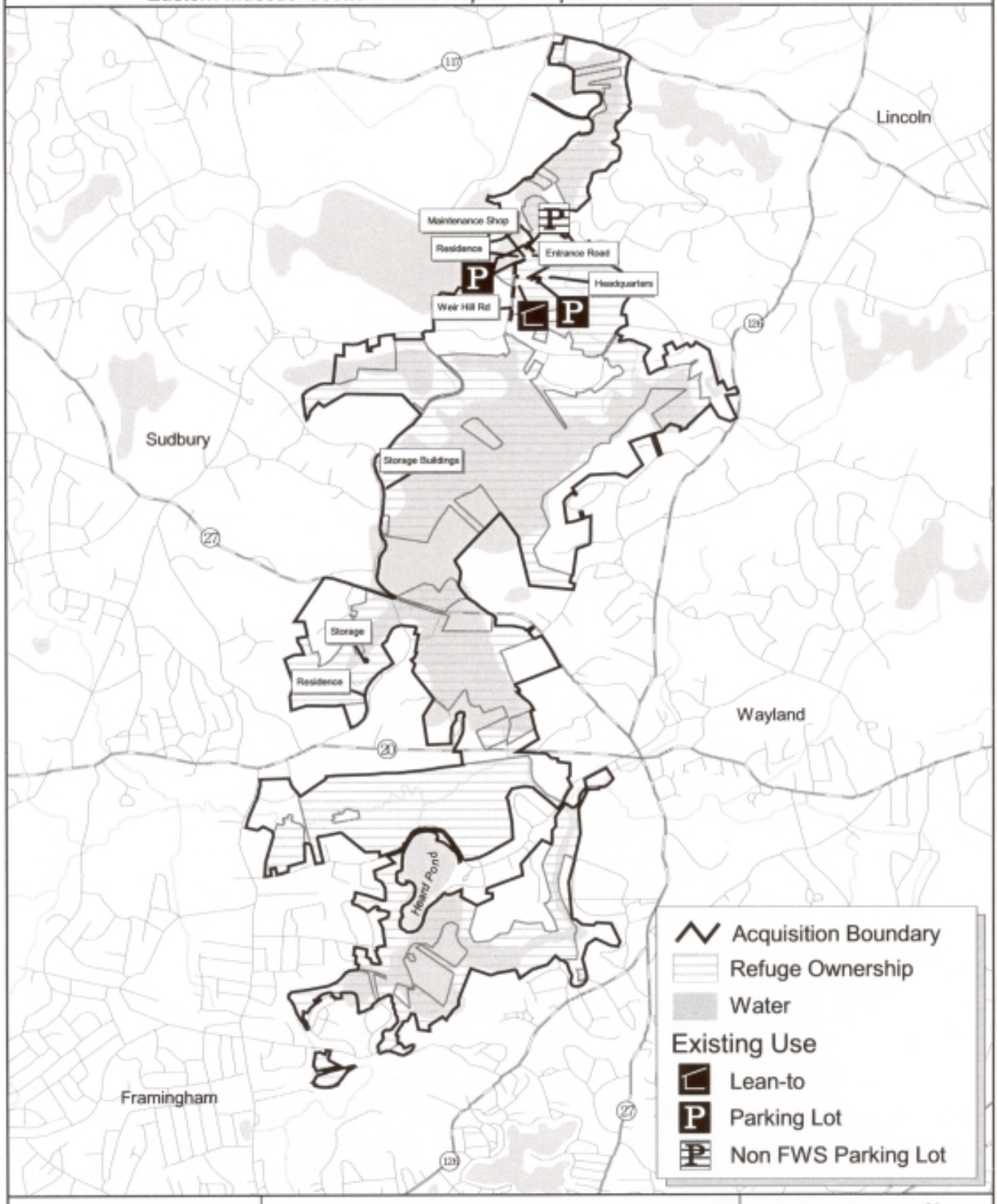
N

Alternative A: Current Management

Existing Facilities at Sudbury Unit

Great Meadows National Wildlife Refuge

Eastern Massachusetts NWR Complex Comprehensive Conservation Plan



Data Sources:
USGS 1:100,000 roads & hydrology.
USFWS refuge boundaries & other refuge information.

Map prepared for Eastern Massachusetts National Wildlife Refuge Complex Comprehensive Conservation Plan, August 2001. This map is for planning purposes only.

0 0.5 1 1.5 2 Miles

0 1 2 3 Kilometers

N

Alternative B- The Service's Proposed Action

Under Alternative B, refuge staffing and funding levels would be increased, and we would initiate new wildlife population, habitat, and invasive/overabundant pest species management activities and provide new compatible wildlife-dependent recreational opportunities. The refuge would also work with State, Federal, and non-governmental partners to secure funding for the construction of new visitor facilities including a Concord visitor contact station and a new visitor center to support the goals and objectives of the Refuge System at Great Meadows Refuge.

Special emphasis would be placed on obtaining baseline data of wildlife populations and habitat conditions required to develop detailed step-down plans. This data would be needed to provide a professional and scientifically adequate resource for future management planning. Wildlife population and habitat monitoring surveys and inventories would be continued to provide the data needed to assess the effectiveness of management programs and practices, and to make mid-course adaptations to these practices to ensure they meet long-range refuge goals and objectives.

Special emphasis would also be placed on providing enhanced, and sustainable, opportunities for the six priority, wildlife-dependent public uses defined in the Refuge Improvement Act of 1997 (environmental education, fishing, hunting, interpretation, photography and wildlife observation). The Visitor Services Plan, which is part of the Proposed Action, will include a monitoring program to evaluate intensity and potential impact of all the wildlife-dependent public uses on the refuge. Public use activities in general, may be modified in the future if adverse impacts on wildlife or habitat are identified. Public use evaluations, along with wildlife and habitat monitoring programs, would assist the refuge in both assessing the intensity of public use and adapting our management strategies and practices for those uses.

Brief explanations of the Service's Proposed Action follow. The Proposed Action is also summarized under Alternative B in **Table GRM 2-6**. *Actions and Strategies Matrix for the Great Meadows NWR.*

Habitat and Wildlife Populations

In addition to the activities described previously under Alternative A, the increased staff and funding resources associated with our proposed action would enable us to take a number of actions that would lead to the completion of two key step-down plans under this CCP: a Habitat Management Plan and a Habitat and Wildlife Inventory and Monitoring Plan.

First, our developing inventory of wildlife species utilizing the Great Meadows Refuge (See Chapter III: Part 2, Affected Environment and Appendix F., Species Lists) would be expanded upon. Our

current inventories would be updated or expanded upon to close data gaps related, in part, to: seasonality of use; habitat-type preferences; and, where practicable, estimates of population numbers. Under Alternative B, surveys and inventories of both the Service's Trust Resources (migratory birds and federally listed threatened and endangered species) and resident wildlife, including State listed threatened and endangered species, are expected to be accomplished concurrently. If necessary, surveys and inventories related to the Service's Trust Resources may receive priority. These additional surveys would include, such activities as:

- Working with partners and local naturalists, we would conduct a thorough survey on plants of the refuge by 2006. Aerial photography would be used to develop a cover type map which would be ground truthed in the field. The cover type map would show locations and acres for each habitat type. In addition, locations of federally endangered and threatened species, other priority species, and invasive species would be recorded using a global positioning system, and identified on the cover type map. The map would be updated every ten years.

- Working with partners and/or local naturalists, we would conduct a comprehensive survey of invertebrates in the spring and summer by 2007, noting Federal and State endangered and threatened species. "Sticky" sticks (paint stirrers dipped in Tanglefoot Insect Trap Coating and placed horizontally on and vertically in the substrate) would be used to sample ground-based invertebrates throughout the refuge. Collecting nets would be used to sample winged invertebrates.

- Freshwater fish would be sampled throughout the river and ponds on the refuge by 2010 using passive and active capture gear and electrofishing. Passive gear includes, but is not limited to, gill nets, trammel nets, and fyke nets. Active gear includes, but is not limited to, seines, nets, and hooks. Depending on the diversity and abundance of fish that are found in the ponds, mark/recapture studies may be initiated.

Frog. *Alternative B would include additional surveys of amphibians and reptiles on the Refuge. Photo by Bruce Flaig*

- Small mammals would be surveyed by 2010 using small live box traps, snap traps, and pitfall traps. Traps would be arranged in a grid throughout the Refuge and trapping would be done during the spring, summer, or fall. If any threatened or endangered species are found, mark/

recapture studies may be initiated to determine a population estimate.

- Additional amphibians and reptiles would be surveyed by 2007 using a combination of pitfall traps, fyke nets, and audio cues. Aquatic turtles would be surveyed using fyke nets during the summer and fall. Terrestrial turtles, snakes, and amphibians would be sampled using pitfall traps.

- In addition to collecting information on nesting species, migrating raptors, and neotropical migrants would be censussed for two seasons by 2007 by the refuge and partners. Raptor surveys would be conducted throughout the fall, using methods developed by the Hawk Migration Association of North America. Refuge staff would work with local birders and organizations to determine the best method for censussing neotropical migrants.

Our Proposed Action for habitat and wildlife management includes four parts:

1. Collect information for all species on the refuge,
2. Determine resources of concern based on national and regional Service plans,
3. Using information gathered in Steps 1 and 2, develop a Habitat Management Plan,
4. Develop a Habitat and Wildlife Inventory and Monitoring Plan to insure objectives in the Habitat Management Plan are reached.

Second, we would determine resources of concern, including focus species or species-groups and their habitat needs. Focus species and habitats are most likely to be selected based on a combination of factors such as: endangerment (federal and State-listed species); priority, national and regional Service plans (such as the North American Waterfowl Management Plan, the Partner's in Flight, etc; developing Service Policies/regulations such as those related to Habitat Management Planning and Maintenance of Ecological Integrity; the purpose for which Great MeadowsRefuge was established (its value for the conservation of migratory bird species); current/historical species and habitat presence; and recommendations from the Massachusetts State Division of Fisheries and Wildlife or other partners.

Third, we would develop a long-range Habitat Management Plan (HMP) by 2006. The HMP would contain information for all habitats and species on the refuge, with a focus on resources of regional and national concern (based on regional and Service plans). It would provide quantitative and measuable objectives and strategies for habitat management to enhance resources of concern.

Fourth, our Habitat and Wildlife Inventory and Monitoring Plan would be completed by 2007. This plan would include an on-going monitoring component designed to measure progress toward those objectives outlined in the HMP, and to allow mid-course corrections or alterations as they may be needed. Depending on specific habitat management techniques or practices that may be recommended in the plans including chemical, mechanical or fire, several additional step-down plans may be required (e.g., a pesticide (or herbicide) use plan, specific wetland restoration plans, etc). Protocal developed in this plan would be statistically sound and peer reviewed.

A considerable amount of work is needed to obtain detailed species and habitat data in order to complete the basic plans. Until our management plans are completed, the refuge would continue with the status quo or our old field, grassland, upland and wetland habitat management.

In addition to the four steps above, the refuge would continue to seek opportunities to develop cooperative management agreements with neighboring conservation organizations and individuals.

Under this alternative, the Cooperative Farming program would be discontinued refuge-wide by 2004. The six acre field located at Nice-acre Corner would be planted with the appropriate native vegetation.

Invasive and Overabundant Species

Same as Alternative A plus:

We would document presence, acreage, and location of invasive and overabundant species in conjunction with vegetation surveys and development of a cover type map. In addition, baseline measurements of key condition indices such as density, height, and percent cover would be made. An Integrated Pest Management Plan would be developed, which would provide the fullest possible range of alternative control strategies. The plan would also include a monitoring program consisting of plot sampling, estimates of cover, and responses of wildlife and other plants. This, in concert with habitat monitoring, would assess progress and the effectiveness of different techniques, and identify additional problem species. Alternative methods of controlling certain species would be researched as appropriate, based on monitoring results. Control strategies would be species specific and may employ biological vectors, mechanical methods (hand pulling), fire, or herbicides. The least intrusive, but most effective control practice would be used. As previously discussed, use of herbicides would require action specific step down plans, and in some situations proposed control methodologies may also require wetland permitting review and approval.

A small one-to-five acre patch of common reed (*Phragmites sp)* has been identified on the Concord River in Carlisle and would controlled by chemicals, mechanical removal, mowing, and flooding. Chemical application would probably be the most effective and efficient technique. Glyphosphate is the most widely used chemical and would be applied in late summer or early fall, directly to the plant, when they are in full fluorescence. Stands would probably need to be treated for two to three consecutive years for effective control.

Where autumn olive (*Eleagus umbelleta*), Asiatic bittersweet (*Celastrus orbiculata*), yellow iris (*Iris pseudacorus*), and Japanese honeysuckle (*Lonicera japonica)* are found on the refuge, hand pulling would be used where feasible. Larger plants of autumn olive and Asiatic bittersweet would be cut and herbicide would be painted on the stumps to prevent re-sprouting. Because autumn olive, Asiatic bittersweet, and yellow iris all re-sprout and grow quickly after being cut, burning could actually worsen the problems caused by these species. Fire would, therefore, not be used as a control mechanism.

Common reed. *USFWS Photo*

Under this alternative, the refuge would monitor mute swans on the refuge. In an effort to keep this aggressive, non-native species from becoming a resident on the refuge, territorial or nesting swans on the refuge would be lethally removed after obtaining appropriate permitting from our migratory bird office. Currently mute swans only occasionally use the refuge and do not pose a problem.

There are no currently identified problems related to overabundant or invasive animal species on the Great Meadows Refuge. However, beaver have occasionally caused localized flooding of on-refuge trails and maintenance roads on other Complex refuges. To date, these problems have been controllable by use of perforated pipe and wire mesh fence "beaver exclosures" installed on culverts, water-control structures or beaver dams. If a beaver causes problems at Great Meadows we would use similar methods. If more serious threats to habitat, refuge facilities, adjacent property or endangerment of health arise, we would work, in coordination with the Massachusetts Division of Fisheries and Wildlife, to either trap and relocate individual animals from problem sites, permit licensed sports trappers or hunters to reduce population numbers, remove individual beavers through trapping or shooting by refuge staff, or to permit a licensed animal damage control firm to reduce population numbers by trapping. If needed, we would issue a special use permit and complete a compatibility determination (see Chapter 2: Introduction, Actions Common to All Action Alternatives) outlining specific requirements and conditions for beaver removal.

The refuge would also participate in appropriate, experimental invasive species control research programs, if such programs have been reviewed and approved by Service regional or national biological staff and the Department of the Interior's wildlife research arm, the Biological Resources Division, now located within the U.S. Geologic Survey.

Wildlife Dependent Priority Public Use Activities

Refuge Access and Fees

Same as Alternative A, plus:

A Visitor Services Plan which describes all the planned public uses would be developed using standard regional guidelines by 2007. The plan would involve setting public use goals, determining measurable objectives, identifying strategies, and establishing criteria for all visitor services. The plan will also outline future funding and staffing needs. Serval step down plans will be required prior to opening or expanding public use plans including a fishing plan and hunting plan.

Entrance fees will be charged at the Concord Impoundments. See section New Recreational Fees at the beginning of this chapter.

Hunting

Big and Upland Game Hunting

By 2005, 2,280 acres of the refuge would be open to archery deer hunting during the State archery and shotgun seasons (the refuge will not be opened to firearm deer hunting). Areas to be opened include portions of refuge lands north of the Route 225 bridge in Bedford, and excludes the areas west of the public use trail traversing the O'Rourke tract in Carlisle, and portions of lands south of Sherman Bridge (Maps 2-9, 2-11, 2-12). Hunting opportunities would be provided on the refuge in accordance with Massachusetts State regulations and requirements. Among other restrictions, these regulations prohibit the discharge of any firearm or arrow upon or across any State or hard-surfaced highway or within 150 feet of any such highway, and the possession or discharge of any firearm within 500 feet of any dwelling or building in use, except as authorized by the owner of occupant thereof

A permit and fee would be required. See section New Recreational Fees at the beginning of this chapter.

Any necessary, refuge-specific regulations or restrictions would be disseminated through refuge hunting brochures, news releases, and on-site informational signing.

Upland game hunting will not be open at Great Meadows.

There were several options to deer hunting that were analyzed and considered during the CCP process but were eliminated as non-viable management options. These include immunocontraception, steroidal implants, oral delivery of contraceptives, GNRH vaccine, sterilization, live trapping and relocation, and habitat management. Please refer to the section at the beginning of Chapter 2, Alternatives Addressed but not Considered, for their description and discussion.

Migratory Bird Hunting

Under the Service's Proposed Action, by 2005 we would open approximately 575 acres of the refuge to waterfowl hunting in accordance with Federal and State regulations and restrictions. Refuge ownership on the Sudbury River, South of Shermans bridge, North of Pantry Brook and South of Route 117, and on the Concord River heading North from Route 225 Bridge would be opened to migratory bird hunting from watercraft only, within State seasons, after the completion of a Hunt Plan (see Maps 2-11, 2-12, 2-13).

With respect to waterfowl, these species are already regulated at the State and Federal level. We have no local data to suggest that these populations are not adequately regulated by existing hunting regulations at this time.

Fishing

Same as Alternative A

Wildlife Observation and Photography

Same as Alternative A, plus:

Trail at Great Meadows Refuge. *Proposed trails and observation platforms offer visitors additional opportunities for wildlife observation and photography. USFWS Photo*

At the Heard Pond, the refuge would reestablish a parking area, and up to two miles of trails in Wayland (Map 2-11), by 2007. The parking area would hold up to six cars, and would make access to the area safer for visitors.

At least three photo blinds would be built and placed on the refuge by 2009. One blind would be established at the Concord impoundments, and one at the Sudbury Unit. These blinds would be universally accessible to provide access and viewing opportunities to all visitors. (Map 2-11, 2-13).

We would work with individual towns to improve directional signage to all public use areas on the refuge.

We would create and open several wildlife management demonstration sites by 2015 throughout the Refuge. Potential sites of these areas are depicted on Maps 2-10, 2-11, 2-12, and 2-13 and sites would be further developed in the Visitor Services Plan. These areas are designed to demonstrate various wildlife management activities, their success and failures, and explain what things people can do at home to help wildlife. Great Meadows Refuge is seen by the public and Service as a premier destination to learn about wildlife management. Environmental education and interpretive programs, signs, and brochures will be offered to explain these demonstration sites to visitors.

One demonstration area/site would be developed at the Concord Unit impoundments. The observation tower would be replaced with a universally accessible observation platform by 2010. The new structure would be built within the footprint of the existing observation area, and would provide all visitors with equal opportunity to view the Concord impoundments and understand refuge management techniques and practices. The lower level of this structure would be designed to provide visitors hands-on experience into how these pools are managed and how water is moved. Visitors would also be exposed to various exotic species management options (see Map 2-11).

As for all wildlife-dependent public uses planned for the refuge, a monitoring program to evaluate intensity and potential impact of each use would be initiated. We would help support research projects that look at impacts of uses on wildlife areas and means of determining carrying capacity of an area. Public use activities may be modified in the future, if adverse impacts on wildlife or habitat are identified.

Environmental Education, Interpretation and Outreach

Same as Alternative A plus:

We would provide assistance to all scheduled school groups to the refuge. A refuge curriculum for grades K-12 ,would be developed that incorporates Massachusetts Curriculum Frameworks and refuge messages by 2010. All groups who use the refuge would participate in one of the programs developed. The exhibits, wildlife demonstration sites, and refuge management objectives are tied into the curriculum. An accredited teacher workshop would show teachers how to use and teach the curriculum. Refuge staff and volunteers would assist teachers at their schools, as requested. We would also work with other conservation organizations and education programs to coordinate efforts and messages provided in environmental education programs in the area. We would develop a welcome/orientation video for schools and visitors to better understand the mission and opportunities the refuge has to offer visitors.

School groups would be more evenly spread between the Concord Unit and Weir Hill Outdoor Classroom sites. A third Outdoor Classroom site would be developed at the O'Rourke Farm, Heard Pond, or Strand properties. Refuge staff would work with other conservation organizations and education programs to coordinate efforts and messages provided in environmental education programs in the area.

Environmental Education. *The existing visitor center would continue to offer office space for Refuge staff as well as exhibit space. USFWS Photo*

We would continue to participate in the Urban Education Program. The program would be expanded to include no more then six schools in Boston and six schools in Worcester by 2012. The refuge would publish papers and curriculum from this program, which is viewed as a pilot program for urban refuges across the country. Interns from the program enter the Service Student Career Education Program, a program that offers college students the opportunity to gain professional experience with the Service during school with possible job placement after graduation.

We would install four additional kiosks at areas with high public use; specific location to be determined in the Visitor Services Plan. The refuge would also work to offer visitors updated brochures including the addition of a self guided canoe trail on the Concord and Sudbury Rivers. The refuge would work with partners to provide increased hunter education through training, brochures, and news releases.

Working with partners from within and outside of the Service, we would develop interpretive materials to be placed in The Boston Metro area. Materials to be developed may include a kiosk to be placed at Logan Airport or the new National Park Service Headquarters, an exhibit in the Boston Law Enforcement Office, posters for the "MBTA" and commuter train, or Service announcements on the radio. Materials to be developed would be discussed in full in the Visitor Services Plan.

Refuge staff would continue to be active participants in local community and conservation organizations. The refuge supports a large and active Friends Group. The refuge would also initiate programs to provide local communities and landowners educational and informational material and strategies related to natural resource protection and restoration.

As for all wildlife-dependent public uses planned for the refuge, a monitoring program to evaluate intensity and potential impact of each use would be initiated. Public use activities may be modified in the future, if adverse impacts on wildlife or habitat are identified. A new visitor center for the Complex is also proposed under this alternative. See the following section, Refuge Facilities and Buildings for details.

Non-wildlife Dependent Recreation

Dog walking and picnicking, which occur now, would be eliminated from the refuge by 2004. These uses have been found to disturb wildlife and other visitors and are not considered one of the six priority uses on national wildlife refuges. Jogging would continue to be allowed, but would not be encouraged. We plan to analyze the potential impacts of jogging within the next three years on Service trust resources and priority public uses and would consider modifying or eliminating the use in the future, based on this additional analysis. The refuge would remain closed to other non-wildlife dependent activities such as bikes on trails, horseback riding, dog sledding, snowmobiling and swimming. See Alternatives or Actions Considered, but Eliminated from Further Evaluation, Proposals for new, non-wildlife-dependent public uses at the beginning of this chapter for additional information.

Resource Protection and Visitor Safety

Protection of visitors and both natural and cultural resources would be significantly improved under the Service's Proposed Action. We would increase refuge law enforcement staff (see Appendix D) to provide additional protection.

Cultural Resource Protection

Service employees would initiate and complete cultural and historical resource surveys and inventories on a refuge-wide basis (compared to the current, more limited project-specific evaluations described under Alternative A) by 2015. The archeological survey portion of this work would be designed to develop predictive models that could be applied refuge-wide in evaluating the potential of future projects to impact cultural resources.

Refuge staff would complete a fire suppression contract or agreement with State or local fire suppression agencies for wildfires occurring on the refuge (see section Fire Management at the beginning of this chapter).

Refuge Buildings and Facilities

Same as Alternative A plus:

As part of the Centennial Celebration for the National Wildlife Refuge System, the Service identified ten refuges in the country for a new visitor center. The Complex ranked number three on the Service's list. Refuges were ranked on a number of factors including their need for a facility and potential to provide opportunities for a large audience. The site for the new facility is not identified in this document. However, below are the criteria we would use to identify potential sites. Sites chosen would be evaluated in a later EA. The new facility would house exhibits focusing on a variety of environmental themes as well as refuge management activities. We would implement recommendations for interior facility design from the Complex Project Identification Document which is currently in draft.

We would evaluate each potential site with the following criteria.

- Access from a major travel route (Route 2, 128, etc.)
- Access from public transportation
- Accessibility of utilities
- Presence of trust species, habitats or other important re sources
- Opportunity for outdoor features associated with center, including interpretive trails
- Topography
- Potential disturbance to habitats
- Presence of hazardous wastes
- Potential impacts to neighbors
- Buffer from current or predicated commercial activity

In addition to the new visitor center, a visitor contact station would be built at the Concord Unit by 2015. The contact station would be a small building for a refuge staff person or volunteer to greet the public and conduct interpretive programs. It may contain a few professionally designed exhibits explaining ongoing management activities at the refuge. The existing Visitor Center and Headquarters in Sudbury would continue to provide office space for refuge staff.

Two new equipment storage areas would be built by 2017. These areas would house large equipment and provide refuge maintenance staff a safe and up to code area to repair and maintain refuge vehicles and equipment. Placement and size of these facilities is still to be determined.

Refuge Staffing

Additional staff are needed at Great Meadows Refuge to properly manage refuge lands as well as work with partners. By 2015, 14 full-time permanent employees would work at Great Meadows Refuge. The refuge staff would include filling all positions described in Alternative A plus:

Biologist	collects data and work with researchers and develops habitat and wildlife management plans
Biological technician	collects baseline data
Education Specialist	Oversight of new Visitor Center
Volunteer Coordinator/ Outreach Specialist	works with local and national partners to assist refuge meets its goals and objectives
Maintenance Worker	restores habitat as well as maintain new and old facilities and equipment
Park Rangers (3)	protects refuge resources and visitors (law enforcement person) and staff new facilities

Refuge Administration

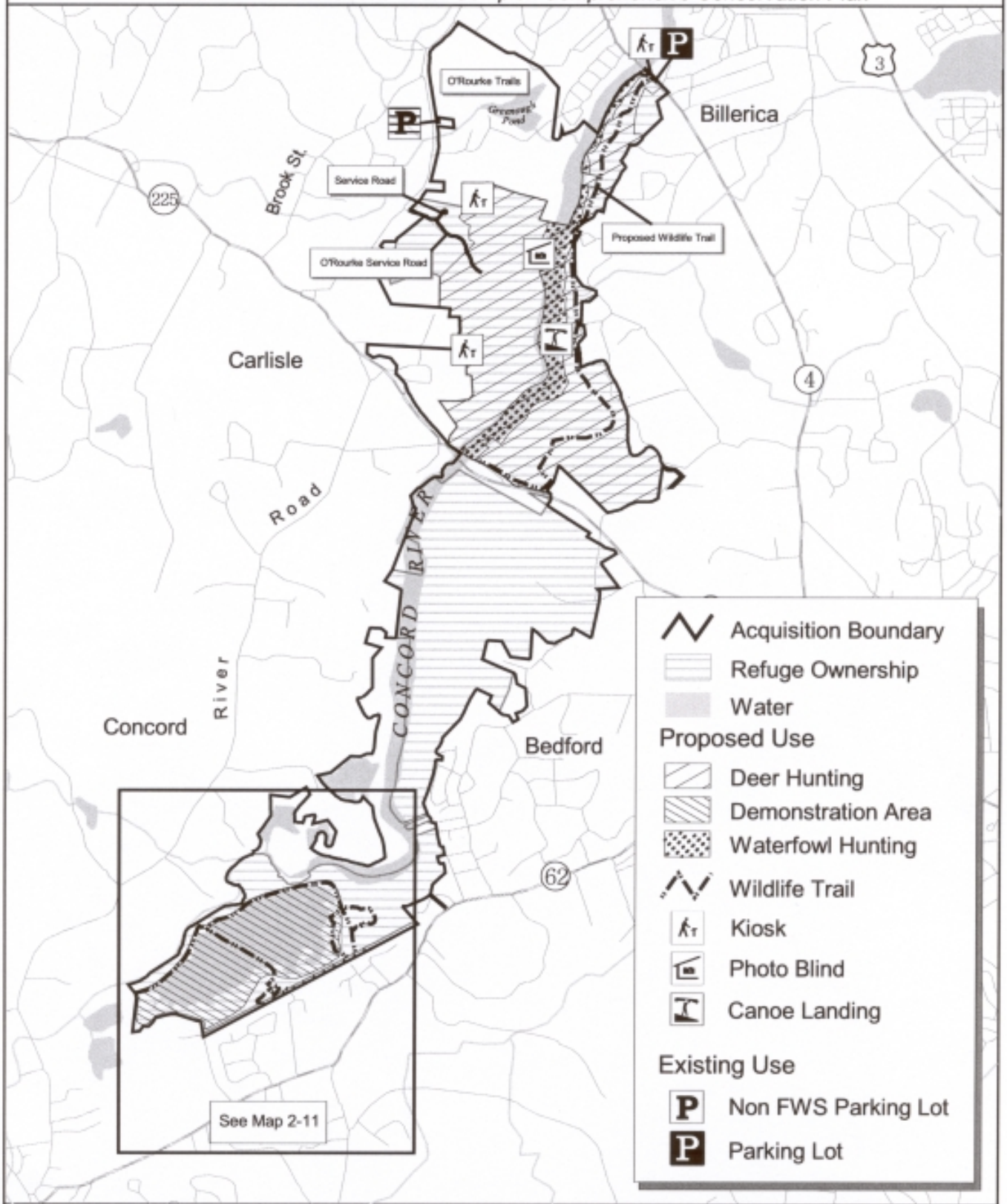
Under this alternative, the Concord Unit which includes lands from the Route 117 bridge in Lincoln and Concord to the Northern boundary, would remain Great Meadows National Wildlife Refuge. In an effort to recognize the resource and identity of the Sudbury Unit, it would become a separate refuge named the Sudbury River National Wildlife Refuge. This would include all lands from the 117 bridge in Lincoln and Concord to the southern boundary of the refuge. Map 1-4. depicts the area which would become Sudbury River National Wildlife Refuge.

Alternative B: Proposed Action

Proposed Public Use at Concord Unit

Great Meadows National Wildlife Refuge

Eastern Massachusetts NWR Complex Comprehensive Conservation Plan



Data Sources:
USGS 1:100,000 roads & hydrology.
USFWS refuge boundaries & other refuge information.

Map prepared for Eastern Massachusetts National Wildlife Refuge Complex Comprehensive Conservation Plan, August 2001. This map is for planning purposes only.

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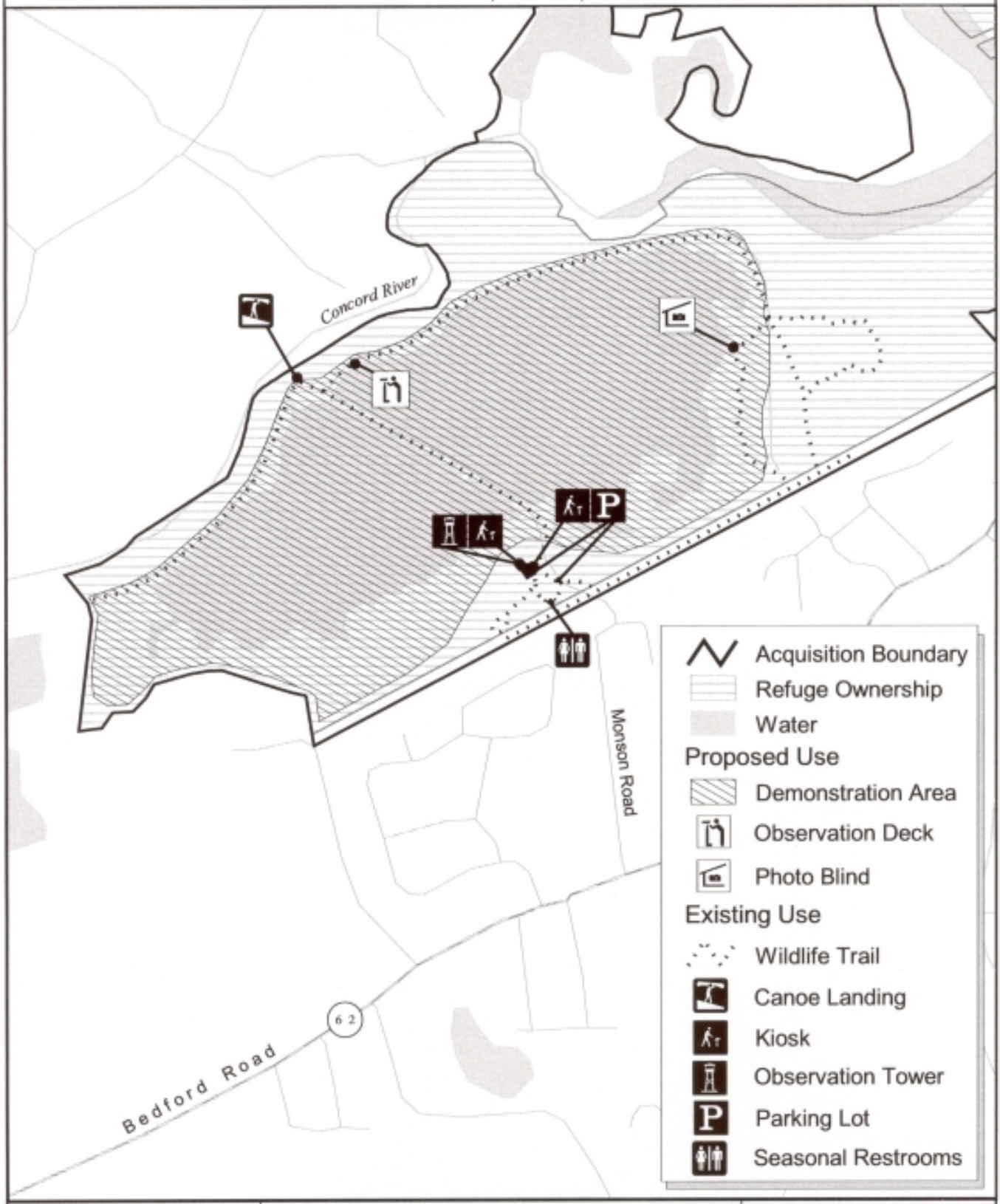
Alternative B: Proposed Action

Proposed Public Use at Concord Impoundments

Great Meadows National Wildlife Refuge

Eastern Massachusetts NWR Complex Comprehensive Conservation Plan



Data Sources:
USGS 1:100,000 roads & hydrology.
USFWS refuge boundaries & other refuge information.

Map prepared for Eastern Massachusetts National Wildlife Refuge Complex Comprehensive Conservation Plan, August 2001. This map is for planning purposes only.

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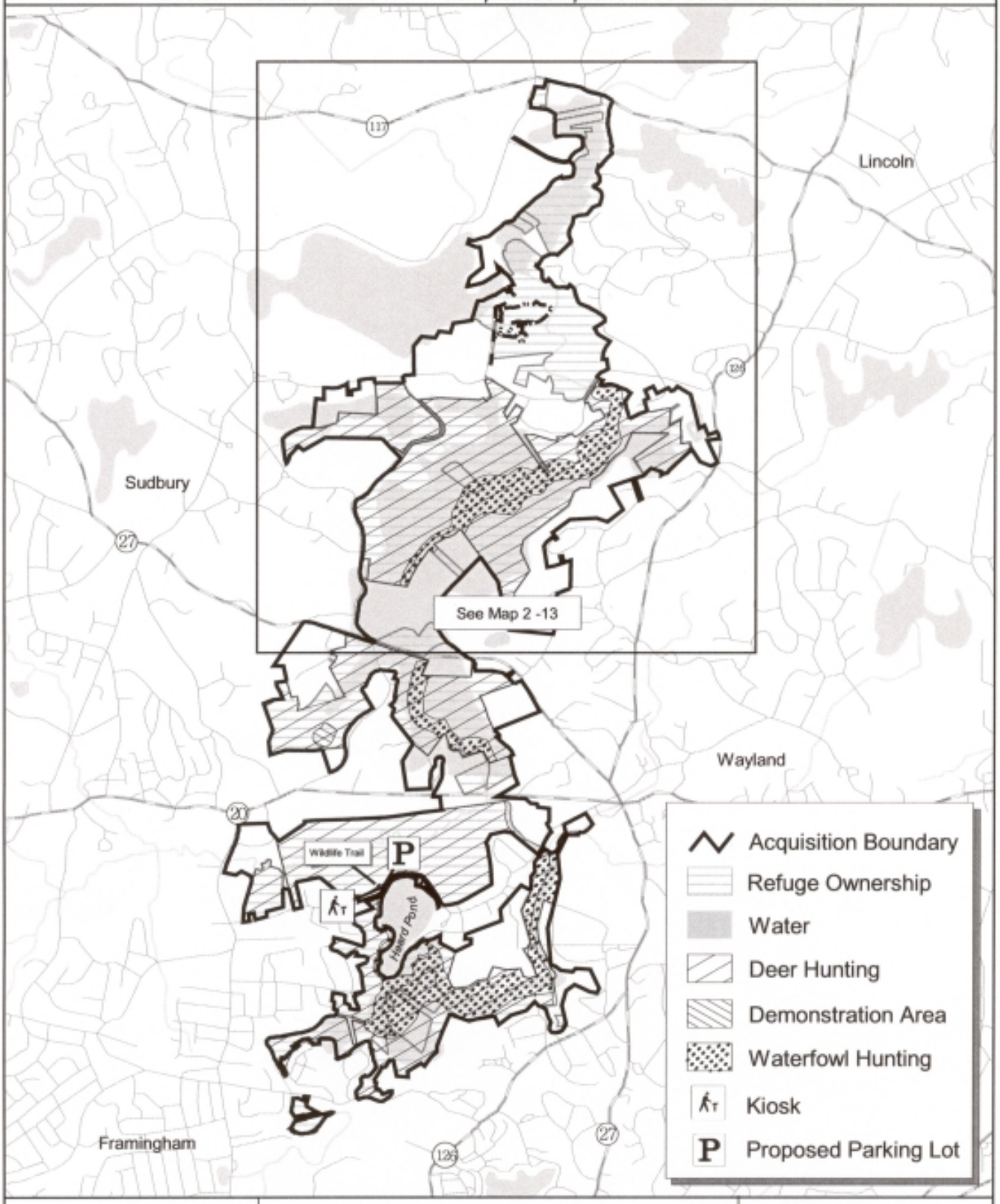
Alternative B: Proposed Action

Proposed Public Use at Sudbury Unit

Great Meadows National Wildlife Refuge

Eastern Massachusetts NWR Complex Comprehensive Conservation Plan



Data Sources:
USGS 1:100,000 roads & hydrology.
USFWS refuge boundaries & other refuge information.

Map prepared for Eastern Massachusetts National Wildlife Refuge Complex Comprehensive Conservation Plan, August 2001. This map is for planning purposes only.

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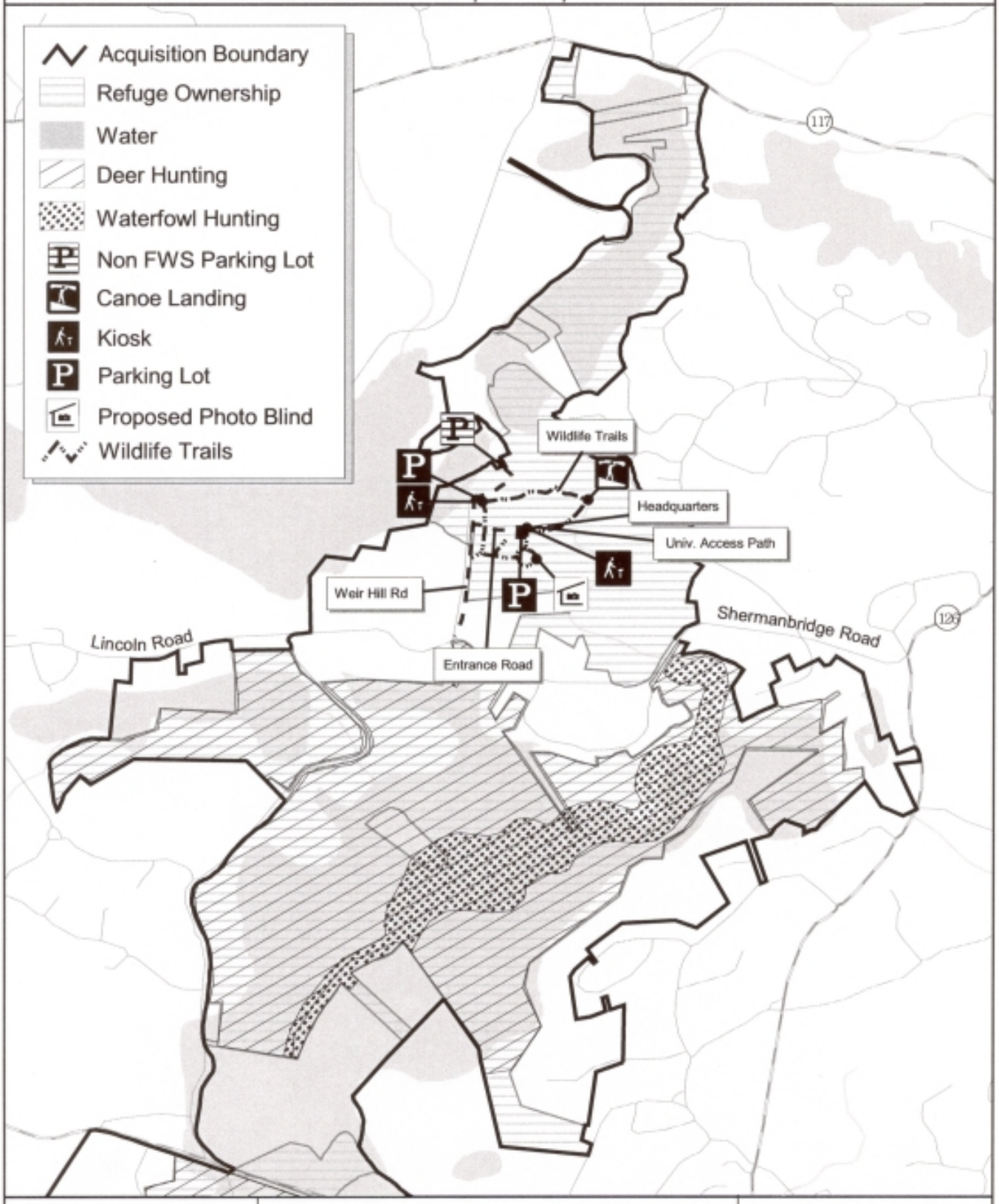
Alternative B: Proposed Action

Proposed Public Use at Sudbury Unit

Great Meadows National Wildlife Refuge
Eastern Massachusetts NWR Complex Comprehensive Conservation Plan



Data Sources:
USGS 1:100,000 roads & hydrology.
USFWS refuge boundaries & other refuge information.

Map prepared for Eastern Massachusetts National Wildlife Refuge Complex Comprehensive Conservation Plan, August 2001. This map is for planning purposes only.

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0 0.5 1 1.5 Kilometers

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Alternative C

Under this Alternative, the refuge management strategy would be oriented towards the "hands-off, let nature take its course" approach. The refuge would curtail or forego most active wildlife and habitat management planning and implementation. Natural succession of habitats would be the selected strategy across all of the refuge. Opportunities for wildlife-dependent recreational activities would be similar to activities proposed under Alternative B, except hunting and wildlife observation and photography opportunities would be expanded. The emphasis of this alternative for this refuge is on expanding the public use program at the refuge.

Wildlife Observation. *Bird watching at Great Meadows Refuge can be a rewarding experience. USFWS Photo*

Habitat and Wildlife Populations

The refuge would limit wildlife and habitat planning to only compiling inventory lists of species presence, and the development of a current habitat cover type map. Detailed wildlife and habitat management plans would not be prepared. No management activities would be undertaken that would impede or slow natural successional processes, and no habitat restoration projects would be planned or implemented.

Invasive and Overabundant Species

An inventory and mapping of the current extent of invasive plant species would be completed. These activities would be repeated at ten-year intervals to measure changes and to reassess refuge management objectives. No active management would be undertaken except in the event of a threat to property or human health (including water chestnut, purple loosestrife or cattail).

The Concord impoundments would not be managed. They would be left at full pool. The aquatic weed harvester would still be loaned out to neighboring towns and partners to control invasive species outbreaks off-refuge.

Hunting

Big and Upland Game Hunting

By 2005 approximately 2,280 acres of the refuge would be open to archery, primitive firearms, and shotgun deer hunting. Portions of refuge lands north of the Route 225 bridge in Bedford and portions of refuge lands south of Sherman Bridge in Wayland/Sudbury would be opened in accordance with Massachusetts State regulations and requirements. Among other restrictions, these regulations prohibit the discharge of any firearm or arrow upon or across any State or hard-surfaced highway or within 150 feet of any such highway, and the possession or discharge of any firearm within 500 feet of any dwelling or building (Maps 2-14 and 2-15).

The refuge would not be open to upland game hunting.

Migratory Bird Hunting

Under Alternative C, the refuge would open all refuge waters (except Concord impoundments) to waterfowl hunting in accordance with Federal and State regulations and restrictions. Refuge lands on the Sudbury and Concord Rivers would be opened within State seasons, after the completion of a hunt plan (see Map 15). As for all wildlife-dependent public uses planned for the refuge, a monitoring program to evaluate intensity and potential impact of the use would be initiated. Public use activities may be modified in the future if adverse impacts on wildlife or habitat are identified.

Fishing

Same as Alternative A

Wildlife Observation and Photography

Same as Alternative B except only one demonstration area would be developed at the Concord Unit. In addition, the refuge would explore areas to expand and connect refuge trails to neighboring conservation lands.

Environmental Education, Interpretation and Outreach

Same as Alternative B

Non-wildlife Dependent Recreation

Same as Alternative B.

Resource Protection and Visitor Safety

Same as Alternative B.

Cultural Resource Protection

Same as Alternative B, except the refuge-wide archeological survey would be less intensive as the development of predictive modeling to evaluate refuge management actions would not be necessary.

Refuge Buildings and Facilities

Same as Alternative B.

Visitors at the Concord Impoundment.
USFWS Photo

Refuge Staffing

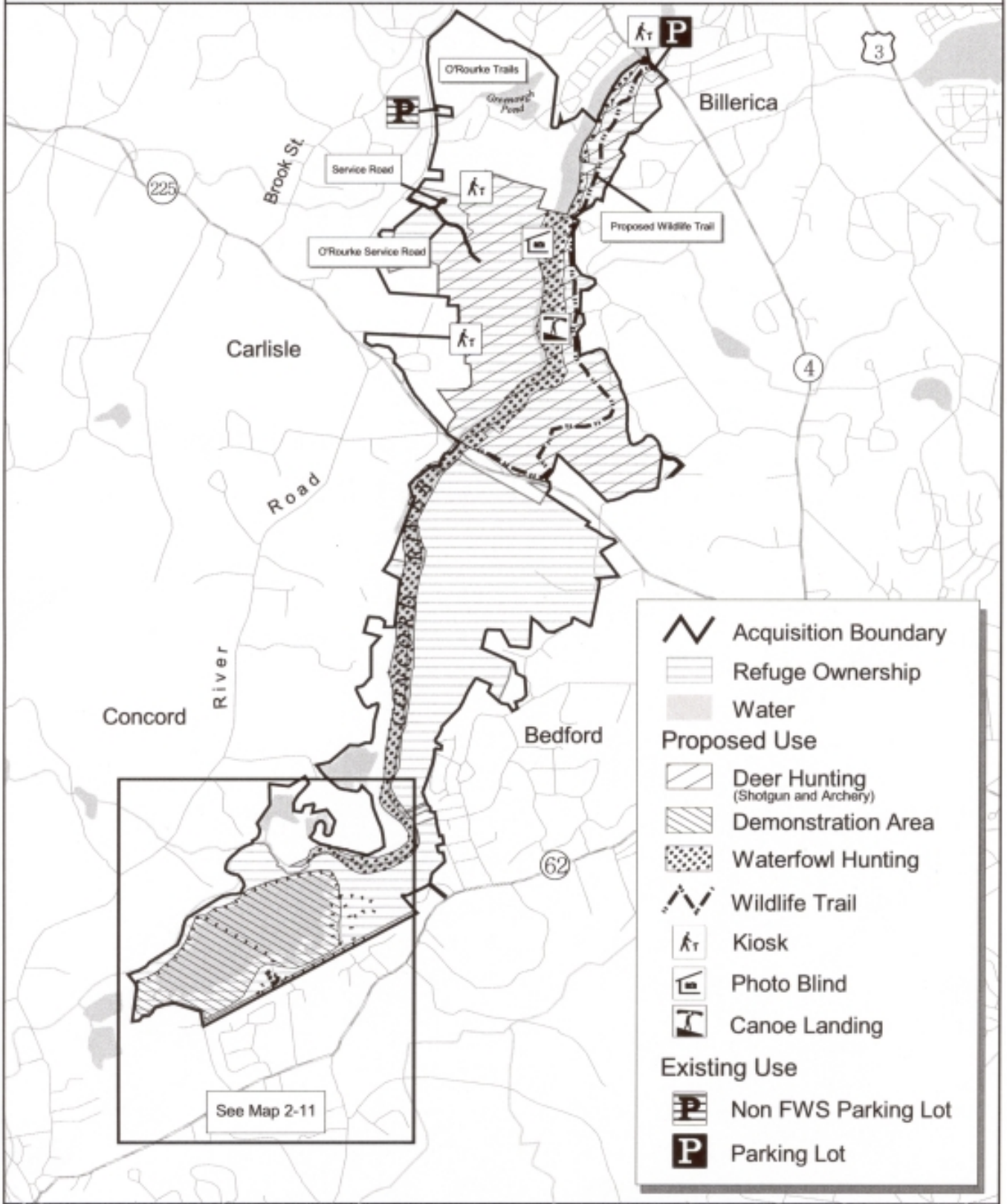
Same as Alternative A plus:
Alternative C proposes to add additional staff to properly manage refuge lands as well as work with partners. By 2015, 12 full-time permanent employees would work at Great Meadows. The refuge staff would include filling all positions listed in alternative A plus:

Education Specialist	Oversight of new Visitor Center
Volunteer Coordinator/ Outreach Specialist	Works with local and national partners to assist refuge meets its goals and objectives
Park Ranger (3)	Protects refuge resources and visitors (law enforcement person) and 3.5 to provide public programs and staff new facilities
Maintenance Worker	Maintains new facilities and exhibits

Refuge Administration

Same as Alternative B.

Alternative C
Public Use at Concord Unit
Great Meadows National Wildlife Refuge
Eastern Massachusetts NWR Complex Comprehensive Conservation Plan



Data Sources:
USGS 1:100,000 roads & hydrology.
USFWS refuge boundaries & other refuge information.

Map prepared for Greatmeadows National Wildlife Refuge Comprehensive Conservation Plan, August 2000. This map is for planning purposes only.

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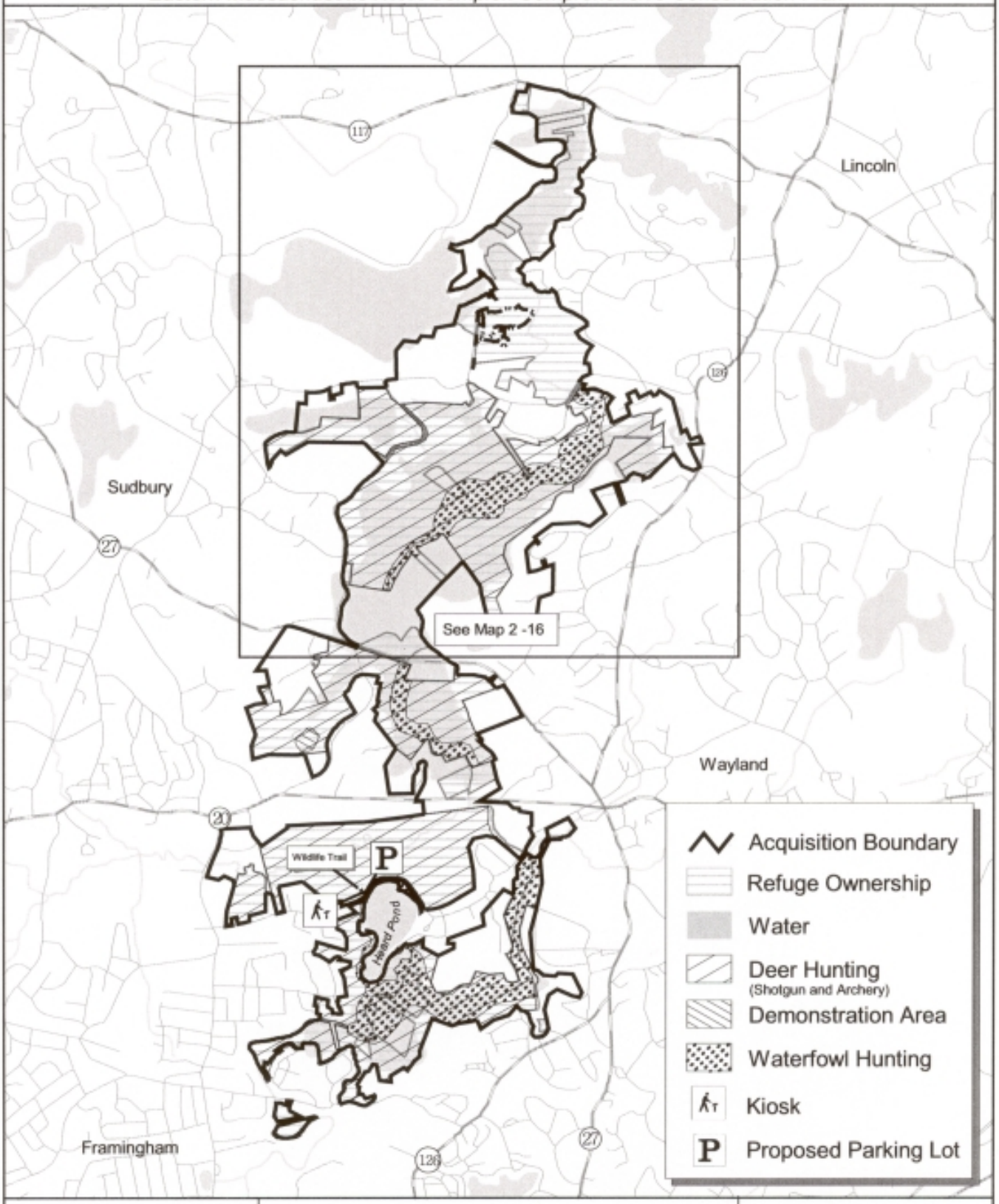
Alternative C

Public Use at Sudbury Unit

Great Meadows National Wildlife Refuge

Eastern Massachusetts NWR Complex Comprehensive Conservation Plan



Data Sources:
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USFWS refuge boundaries & other refuge information.

Map prepared for Eastern Massachusetts National Wildlife Refuge Complex Comprehensive Conservation Plan, August 2001. This map is for planning purposes only.

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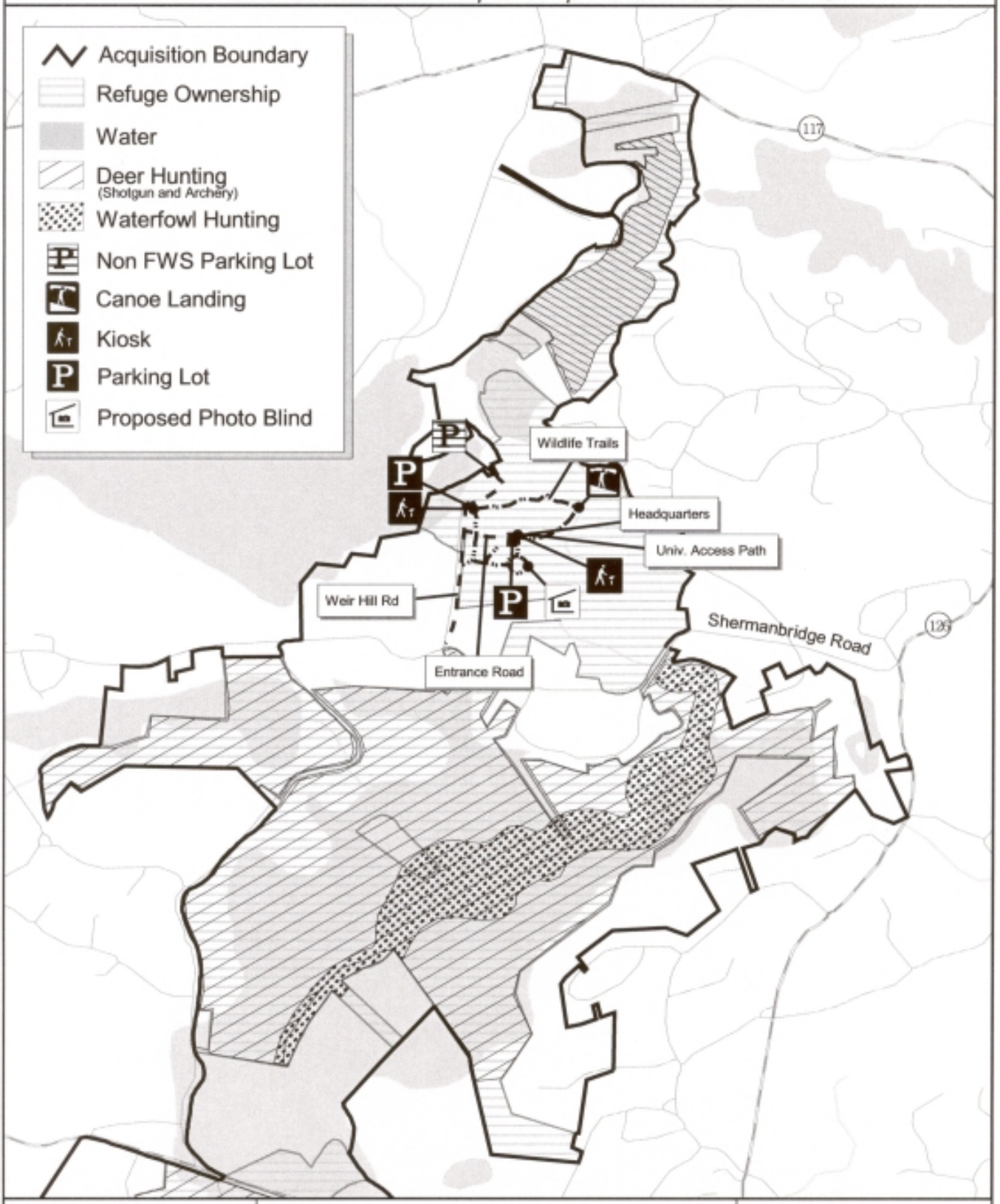
Alternative C

Public Use at Sudbury Unit

Great Meadows National Wildlife Refuge
Eastern Massachusetts NWR Complex Comprehensive Conservation Plan



Data Sources:
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USFWS refuge boundaries & other refuge information.

Map prepared for Eastern Massachusetts National Wildlife Refuge Complex Comprehensive Conservation Plan, August 2001. This map is for planning purposes only.

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Table 2-6. Actions and Strategies Matrix, Great Meadows National Wildlife Refuge

Issue	Alternative A Current Management	Alternative B Service's Proposed Action	Alternative C
How would we manage habitats and wildlife populations?	Inventory breeding birds, marsh birds, woodcock, anurans, waterfowl, shorebirds annually Manage Concord impoundments for waterfowl and shorebirds annually. Maintain current water control structures Band waterfowl annually through partners Conduct bald eagle survey annually Monitor wood duck box production annually through partners Monitor and maintain bluebird nesting boxes annually Assist USFWS Fisheries Assistance Office, as needed, with reintroduction and survey efforts of spawning habitat for interjurisdictional fish including shad, alewife, herring and Concord and Sudbury Rivers Collect information on plant species and water quality through collection of partners/volunteers data Maintain existing open fields (approximately 100 acres) through mowing every 3-5 years Allow partner to cooperatively farm 6 acres parcel in Concord	Same as Alternative A plus: Conduct baseline surveys on plants, invertebrates, mammals, amphibians, reptiles and fish, and birds to determine species presence; repeat baseline surveys every 10 years. Inventory refuge habitats and produce a cover type map every ten years which includes broad habitats (wetland, grassland, shrub) as well as specific endangered/threatened plants Using survey results, develop a list of focus species and habitats using regional standards which includes Federally-listed species Develop & implement a Habitat Management Plan and a Habitat and Wildlife Inventory and Montioring Plan which may utilize mechanical, chemical and fire management techniques to accomplish potential habitat plan recommendations Eliminate cooperative farming program within 2 years. Plant appropriate native vegetation. Initiate research on the impact of public use on wildlife and the impact of water quality and quantity on wetland resources Seek opportunities to develop cooperative management agreements with neighboring conservation agencies, organizations and individuals	Conduct baseline surveys on plants, invertebrates, fish, small mammals, amphibians and reptiles to determine species presence Develop a Wildlife Inventory Plan Inventory refuge habitats and produce a cover type map every ten years which includes broad habitats (wetland, grassland, shrub) as well as specific endangered/ threatened plants

Table 2-6. Actions and Strategies Matrix, Great Meadows National Wildlife Refuge

Issue	Alternative A Current Management	Alternative B Service's Proposed Action	Alternative C
How would we manage invasive and overabundant species?	Beetles and weevil are released in Concord, Sudbury, Wayland and Carlisle to control purple loosestrife annually Large monotypic stands of cattail at Concord unit are managed through water level manipulation, herbicide and mowing Concord impoundments are alternately flooded and drained for a growing season at least every third year to control water chestnut. Aquatic weed harvester used by refuge staff and partners to remove water chestnut in Sudbury and Concord Rivers and surrounding ponds Beaver deceivers are used as a nonlethal control methods for nuisance beaver to allow refuge to manage water levels on refuge	Same as Alternative A plus: Survey invasive and exotic species and extent of distribution Develop refuge-wide map of invasive species. Purple loosestrife beetle program expanded. Refuge raising and releases beetles annually throughout refuge Remove established common reed Develop and implement Integrated Pest Management program for controlling invasive species found on the refuge including biological, chemical, mechanical and fire management techniques Evaluate and modify control techniques for species found, each year using: plot sampling, estimates of cover, and response of wildlife and other plants Manage overabundant/invasive animal populations identifed in surveys using hunting, trapping and relocation, and lethal controls as may be necessary. Specifically, remove nuisance beaver where other control methods fail and remove territorial exotic mute swans from the refuge. Participate in appropriate experimental invasive species control programs	Survey invasive and exotic species and extent of distribution Develop refuge-wide map of invasive species
What big and upland game hunting opportunities would we provide?	No hunting opportunities exist	Open archery deer hunting within State guidelines on portion of the Refuge South of Sherman's Bridge in towns of Sudbury, Lincoln, Wayland and Framingham Open archery deer hunting within State guidelines on portions of the Refuge north of 225 bridge in the towns of Bedford, Billerica and Carlisle Complete Hunt Plan Prior to opening Refuge to hunting. Refuge charge special permit fee for hunting on refuge No upland small game hunting allowed	In addition to Alternative B: Initiate shotgun deer hunting on same areas as archery deer hunting was opened. No upland small game hunting allowed.

Table 2-6. Actions and Strategies Matrix, Great Meadows National Wildlife Refuge

Issue	Alternative A Current Management	Alternative B Service's Proposed Action	Alternative C
What migratory game bird hunting opportunities would we provide?	No hunting opportunities exist .	Open waterfowl hunting within State guidelines on the portions of the Sudbury River south of Sherman's Bridge and from Pantry Brook to Route 117 in Towns of Sudbury, Lincoln, Wayland and Framingham Open waterfowl hunting within State guidelines on portions of the refuge on the Concord River north of the Town of Concord in towns of Bedford, Billerica and Carlisle Open waterfowl hunting on the banks of Heard Pond, Wayland, from Refuge land Complete Hunt Plan Prior to opening Refuge to hunting.. Refuge charges special permit fee for hunting on Refuge	Open all refuge waters to waterfowl hunting (except Concord impoundments) according to state guidelines Complete Hunt Plan Prior to opening refuge to hunting. Refuge charges special permit fee for hunting on refuge
What fishing opportunities would we provide?	Continue to allow river fishing throughout the Refuge on Sudbury and Concord Rivers All refuge pools remain closed	Same as Alternative A	Same as Alternative A
What wildlife observation and photography opportunities would we provide?	Provide wildlife viewing opportunities at: Heard Pond- Wayland, Weir Hill trails- Sudbury, Dike trails, and observation tower- Concord, Two Brothers Rock- Bedford, O'Rourke Trails- Carlisle, Route 4 trail- Billerica/Bedford Trail Concord and Sudbury Rivers via canoe- open through all 8 towns. Maintain existing canoe landings Host Wildlife photography contest and display all entries in refuge Visitor Center	In addition to Alternative A: Develop Visitor Services Plan Re-establish parking area at Heard Pond- Wayland Create photo blinds at three sites within refuge Increase directional signage to all public use areas Create habitat demonstration areas to explain management and observe wildlife Conduct research project on impacts of public uses and carrying capacity of areas An entrance fee will be charged	Same as Alternative B

Table 2-6. Actions and Strategies Matrix, Great Meadows National Wildlife Refuge

Issue	Alternative A Current Management	Alternative B Service's Proposed Action	Alternative C
What environmental education and interpretation opporutnities would we provide?	Provide for over 100 on-site environmental education programs annually Offer teacher workshops on refuge Environmental Ed. programs at least twice a year Work with Boston and Worcester schools through the Urban Education Program Provide off-site education programs as requested at local schools and on-site interpretive programs Maintain 3 interpretive kiosks- Weir Hill, Heard Pond, Dike trails & provide brochures at existing refuge public use sites Maintain 2 self-guided interpretive trails: Concord Dike trails and Weir Hill trail Host 4 on-site special events/ celebrations annually Allow partners (via required Special Use Permit) to conduct education programs on-refuge, no charge for permit Allow cooperating association, SuAsCo Great Meadows Education Fund to run a small book store at the refuge headquarters Quarterly news letter on the "web" and viewed by over 3000 people Refuge Web-site and monthly news releases used to explain refuge management and upcoming activities Refuge visitor center with exhibits and headquarters is open year round. Provide programs within the local community as requested. Active volunteer force helps staff provide on and off site programs	Same as Alternative A plus Develop Visitor Services Plan Develop refuge specific curriculum for grades k-12. Provide accredited teacher workshops Disseminate school groups more evenly between Dike trail and other outdoor classrooms Expand Urban Education Program to more inner city schools in Boston area Allow private groups to conduct programs on refuge via required Special Use Permit, Memorandum of Understanding, Memorandum of Agreement, or concession to conduct education programs on-refuge Install 4 kiosks at areas with wildlife observation opportunities Develop self-guided canoe trail with interpretive brochures on Concord and Sudbury Rivers Increase interpretive outreach to hunters and anglers through hunter education programs Develop environmental education partnerships, introductory refuge video for all age groups, and wildlife learning materials for children Conduct outreach related to environmental education opportunities at refuge Increase interface with education community, & help develop wildlife classroom projects Reach out to local community groups, especially those that are not the refuge's typical audience Develop interpretive materials for placement in the Boston metropolitan area to reach nontraditional audiences Active friends group supports refuge activities An entrance fee will be charged	Same as Alternative B

Table 2-6. Actions and Strategies Matrix, Great Meadows National Wildlife Refuge

Issue	Alternative A Current Management	Alternative B Service's Proposed Action	Alternative C
What non-wildlife dependent public uses would be allowed on the refuge?	Current nonwildlife-dependent uses occurring: picnicking jogging dog walking (on leash)	Refuge is closed to picnicking and dog walking Study impacts of jogging	Same as Alternative B
How would we ensure resource protection and visitor safety?	Wildlife and cultural resource law enforcement is provided by two full-time and one co-lateral duty staff shared with other Complex refuges. Federal cultural resource protection laws and regulations are enforced. Soil disturbance requires cultural resource evaluations and clearance	In addition to Alternative A: Hire additional full-time Park Rangers Complete an overview survey of cultural resources of the refuge. Develop predictive model for probable archeological and historic sites.	Same as Alternative B, except the refuge-wide archeological survey would be reduced in scope, eliminating studies needed to develop predictive models.
What buildings and facilities would be used or constructed for Refuge operations?	Continue to use existing refuge buildings including Refuge Visitor Center/ headquarters- Sudbury Comfort Station- Concord 4 storage barns/buildings (Sudbury- 3, Concord) 3 residences (Sudbury 2, Carlisle)	Same as Alternative A plus: Conduct a Site Requirement Analysis Construct new Visitor Center in the high traffic flow area Construct new Visitor Contact Station at Concord Unit	Same as Alternative B

Table 2-6. Actions and Strategies Matrix, Great Meadows National Wildlife Refuge

Issue	Alternative A Current Management	Alternative B Service's Proposed Action	Alternative C
What would be the future staffing needs at Great Meadows Refuge?	1 Refuge Manager (Vacant) 3 Maintenance Workers 1 Office Assistant 1 Admin Support Ass. (Vacant) Total FTEs = 6	Alternative A plus: 1 Biologist 1 Biological Technician (Seasonal) 1 Education Specialist 3 Park Rangers 1 Outreach Specialist/ Volunteer Coordinator 1 Maintenance Worker Total FTEs = 14	Alternative A plus: 1 Education Specialist 3 Park Rangers 1 Outreach Specialist/ Volunteer Coordinator 1 Maintenance Workers Total FTEs(A+C)= 12
Should the two Units within Great Meadows NWR be spilt into 2 separate NWRs?	Great Meadows Refuge remains one refuge with 2 Units Concord Unit and the Sudbury Unit	The Concord Unit (From 117 Bridge in Lincoln/Concord to the Northern boundary) remains Great Meadows NWR and the Sudbury Unit (From 117 Bridge in Lincoln/Concord to the Southern boundary) becomes the Sudbury River Refuge	Same as Alternative B

Part 3: Oxbow National Wildlife Refuge

Alternative A - The Current Management Alternative

Under the Current Management Alternative, there would be very little or no change in our current management programs at Oxbow Refuge. We would initiate few, if any, new wildlife population, habitat or ecosystem management activities, and provide no new public recreation opportunities. The refuge would continue to pursue current land acquisition within the boundary, and operations and maintenance activities within its current staffing and funding levels.

Habitat and Wildlife Populations

We would continue current population baseline surveys (woodcock, marsh birds, breeding birds and anuran surveys) as long as funding for these activities is available through the Service's Regional Refuge Biological program. Table 2-7 describes biological surveys at Oxbow Refuge.

We would continue cooperating in current, partners-based, monitoring programs for contaminants (USFWS Ecological Services, EPA, MADEP) and water quality/flow levels (USGS, MADEP, and the Nashua River Watershed Association). We would also continue to seek any information compiled by others related to habitat and wildlife populations within the refuge and surrounding ecosystem.

We would continue to protect nesting, wintering and migration habitat for the Service's trust resources, in particular, migratory bird species. Approximately 25-30 acres of presently existing old-field grass/shrub habitat would continue being maintained by mowing. Maintenance of this grassland/old-field habitat by use of fire would be evaluated.

American Woodcock. *USFWS Photo*

Approximately 15-20 acres of existing, predominately mineral, sandy soil turtle nesting habitat would be maintained by mowing, discing or blading. Devens currently supports the largest known population of the State-listed Blanding's turtle in the Northeast. Eight to ten acres of the refuge were formerly suitable turtle nesting habitat, but have since succeeded to old-field vegetative type cover. In an effort to contribute to the success of this species, and complement other efforts in the area, we would restore this acreage for turtle nesting habitat by discing or blading. With the planning assistance of cooperating researchers, we would restore approximately eight to ten acres of turtle nesting habitat that has reverted to shrub and tree cover. These areas would be restored by removing vegetation and surface organic duff layers.

At some time prior to its transfer to the Service, a beaver colony and its dam were removed from a 25-30 acre wetland along the north side of Route 2. The wetland hydrology has been compromised with the removal of the beavers and its wildlife values have been degraded.

We would work toward establishing a partnership with the Massachusetts Highway Department to re-establish a water-control structure on the Route 2 underpass culvert in order to restore this wetland (see Map 2-17 which depicts the general areas within the refuge where these activities would occur). The remaining, current mix of wetland and upland habitats would be protected, but allowed to mature to shrub and forest under natural successional processes.

We would provide minimal on-site support for research projects. We would continue to identify other research needs to the Service's Regional Research Coordinator, and to other potential research partners (e.g., USGS, Biological Resources Division and universities).

Within the portion of the refuge north of Route 2, which was transferred to the Service from the U.S. Army in May, 1999, we would selectively remove and restore to natural habitat existing roads and dirt trails that are not needed for refuge management, visitor use or fire-control purposes.

Table 2-7. *Wildlife Surveys at Oxbow Wildlife Refuge*

Survey	Purpose	Points	Observation	Other Information
Landbird Breeding Survey	• occurrence of species • occurrence within habitats • relative abundance • changes in populations	4-6 points refuge wide	late May to mid-June for 10 days observations made in 5 minute intervals 1 time/season	began in 2000 survey points visited once during survey period, habitat is classified at each point birds are identified by sight and sound
Marsh Callback Survey	• identify species presence • monitor change in abundance • evaluate species response to habitat modifications	8 points in ponds, marshes and emergent vegetation	early May- mid July 3 times/ season	began in 2000 birds are identified by sight and sound callback tapes are used
American Woodcock Survey	• presence and abundance	6 points in fields, clear cuts, meadows, etc.	mid-April to mid-May observations made in 2 minute intervals 1 time/ season	reestablished in 2000
Anuran Call Counts	• presence and abundance	12 points in wet meadows, pools, and along river	mid-March- mid-July 5 minute observation period 4 times/season	began in 2000

Invasive and Overabundant Species

We would continue to use host-specific beetles (*Galerucella calmariensis or G. pusilla*) in a program to control purple loosestrife within an approximately 20 acre potion of a larger (240+/- ac) wetland on the refuge (See Map 2-17). Unless project-specific funding becomes available, the effects of treatment with the beetles would continue to be evaluated only by simple year-to-year photographic recording of the release site(s) on the refuge.

Purple loosestrife. *USFWS Photo*

Existing stands of spotted knapweed, glossy buckthorn, cattail and common reed would be monitored to determine changes in areal extent. Limited treatment of these invasive plant species would occur only if project-specific funding was made available.

In recent years, beaver have caused minor flooding of refuge trails and maintenance roads. To date, control of such situations has been limited to manually clearing culverts, installing grates on culverts and water-control structures, and by installing beaver exclosures and "deceivers" in dams or on culverts. These practices would continue to be employed under the No-Action Alternative.

Priority Public Uses

Hunting

Big and Upland Game Hunting

The refuge is currently closed to big game hunting and would remain so under Alternative A.

Shotgun hunting of upland game birds (ruffed grouse), turkey (spring season only per current State season restrictions), and small game (rabbit, gray squirrel) are currently allowed on the portions of the Oxbow Refuge located south of Route 2 and west of the B&M rail line. All State regulations and restrictions apply, and are enforced. In addition, the use of non-toxic shot (non-lead) is required for all seasons, with a current exception for turkey hunting. Alternative A would continue these seasons (See Map 2-18).

Migratory Bird Hunting

Currently, Oxbow Refuge is open for woodcock season on the portion of the refuge located south of Route 2 and west of the B&M rail line. State regulations and restrictions apply, and are enforced on the refuge. Use of non-toxic shot is required. Waterfowl hunting (ducks and geese) is closed on the refuge. These limitations would continue under Alternative A.

Fishing

Boat or canoe fishing opportunities, in compliance with State regulations and restrictions, would continue to be provided on the Nashua River throughout its course along and within the Oxbow Refuge. Fishing within refuge ponds, pools and wetlands would continue to be prohibited for wildlife nesting and habitat protection purposes. Fishing from the river-banks of the Nashua within the refuge would continue to be closed to to prevent disturbance to migratory birds, destruction of habitat, including the marshes along the shoreline, bank erosion, litter and due to limited accessibility.

Wildlife Observation and Photography

Current wildlife observation and photography opportunities would continue under Alternative A. Visitors would be able to observe and photograph wildlife along approximately 2.5 miles of existing trails within the portion of the refuge located south of Route 2.

Walking, snowshoeing and cross-country skiing to make use of these opportunities would continue on this portion of the refuge under Alternative A. Current informational and interpretative signs along these trails, and the single informational kiosk at the Still River parking area would continue to be maintained. The refuge is included in the Eastern Massachusetts Complex brochure, and in the Oxbow, Great Meadows and Assabet River Refuges' bird list brochure (See Map 2-18).

The existing canoe launch and two parking areas located at the Still River Depot Road entrance to the refuge would be maintained. Limited interpretive signing along portions of the current trails south of Route 2 will be maintained (see Map 2-18).

Our current, very limited, monitoring (infrequent visitor and vehicle counts) would continue to be the refuge staff's sole method of gauging refuge-use levels.

Environmental Education and Interpretation

Present levels of refuge staff, Friends of the Refuge and other volunteer led educational and interpretative programs would continue under Alternative A.

We would continue providing environmental education oriented teacher workshops (primarily at the Complex Headquarters in Sudbury, MA) on an "as-requested" basis. We would continue development and implementation of our Urban Education Program at the Oxbow Refuge in cooperation with the Worcester Public School System and the Friends of the Oxbow Refuge.

We would continue to provide support as available for educational and interpretative programs organized and led by the Friends of the refuge and other groups.

Public and Community Outreach

The Complex would continue to distribute a monthly electronic newsletter, which replaced the previous quarterly "Meadows Messenger".

Monthly news releases would continue (on a Complex-wide basis) to provide information on refuge management activities and upcoming events or programs. Work on development of a refuge web-site would also be completed under this Alternative, and the Meadows Messenger, news releases and other information would also be made available.

Refuge staff would continue to provide presentations related to the refuge and its resources to local schools, clubs, and community organizations as time and staff resources allow. We would also continue to work closely with the Friends of the Oxbow Refuge, to assist them in membership and program development, and to assist in the organization and leadership of volunteer programs and work activities on the refuge.

Refuge staff and volunteers clear a trail. *USFWS Photo*

Non-Wildlife Dependent Public Uses

The refuge public use trails would continue to be open to jogging and walking dogs on leash. Picnicking would be allowed, though no would be available. Bicycles are allowed in parking lots and on the Still River Depot entrance road. Bikes are not permitted on refuge trails.

Resource Protection and Visitor Safety

The current law enforcement staffing of one full-time and one temporary Park Ranger who share responsibilities at a number of the Complex Refuges would be maintained. These officers would continue to enforce the Service's refuge protection regulations, State and federal wildlife protection and hunting laws and regulations, and federal cultural resource protection laws and regulations.

Cultural Resource Protection

Cultural resource (archeological and historical) evaluations or surveys would continue on a refuge project-specific basis. Soil disturbance requires resource evaluation and clearance. Federal cultural resource protection laws and reguations would be enforced.

Refuge Buildings

There are no buildings on the Oxbow Refuge at the present time.

Refuge Staffing

Currently the Oxbow Refuge shares one refuge manager position with the newly formed Assabet River Refuge The refuge also currently shares the support of a refuge biologist, a biological technician, an outdoor recreation planner, a visitor services park ranger, two law enforcement rangers, two maintenance workers, two administrative technicians and seasonal employees with the Complex. The Oxbow Refuge minimum staffing needs have been determined to include:

- one refuge manager
- one assistant refuge manager or refuge operations specialist
- one outdoor recreation planner
- one maintenance worker
- one administrative technician
- one park ranger (law enforcement).

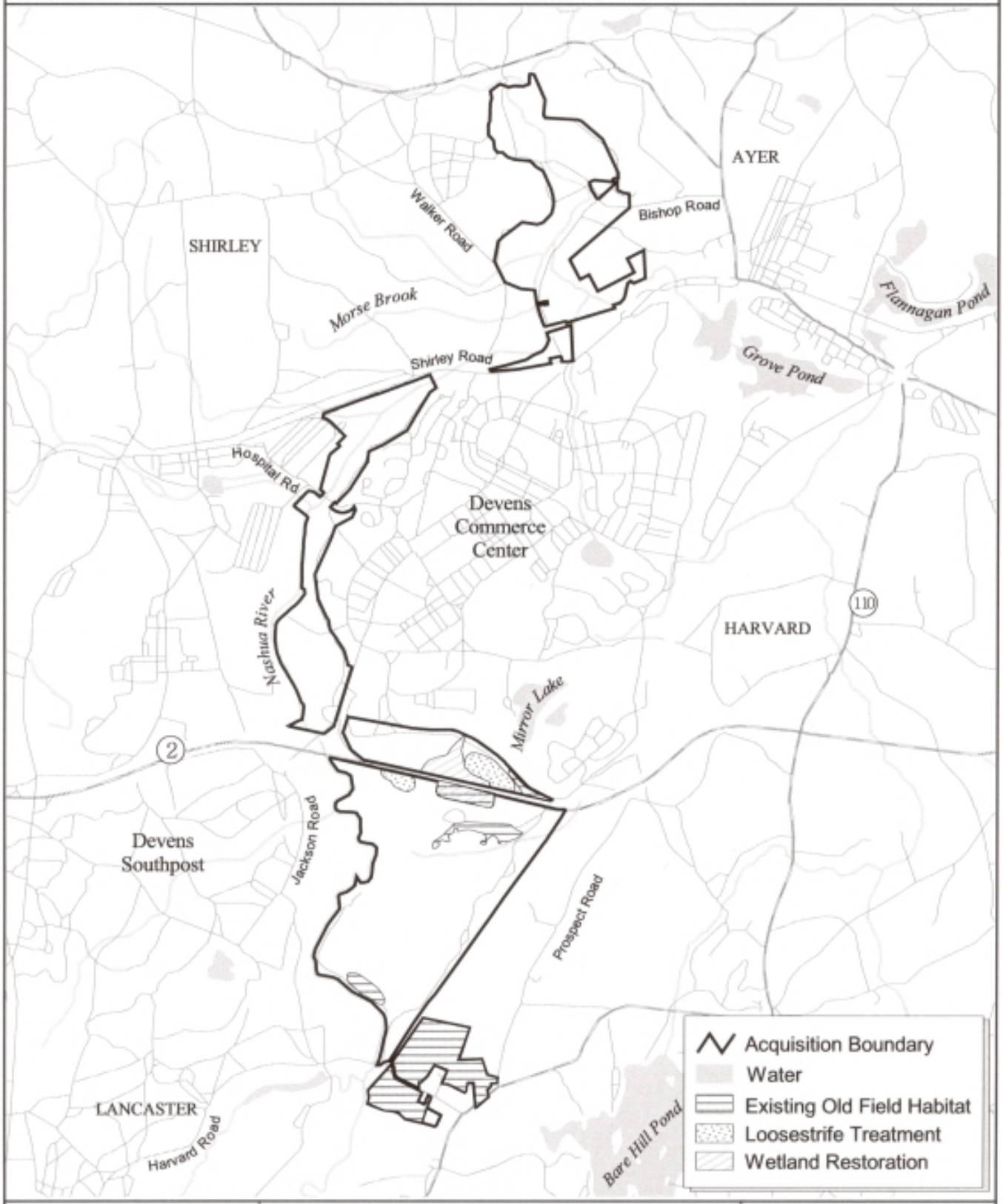
The remainder of the positions listed are currently unfilled. Under Alternative A, the Service would work toward filling these minimum staffing needs for the Oxbow Refuge.

Alternative A: Current Management

Existing Habitat Management

Oxbow National Wildlife Refuge

Eastern Massachusetts NWR Complex Comprehensive Conservation Plan



Data Sources:
USGS 1:100,000 roads & hydrology.
USFWS refuge boundaries & other refuge information.

Map prepared for Eastern Massachusetts National Wildlife Refuge Complex Comprehensive Conservation Plan, August 2001. This map is for planning purposes only.

0 2000 4000 6000 8000 10000 Feet

0 500 1000 1500 2000 2500 3000 Meters

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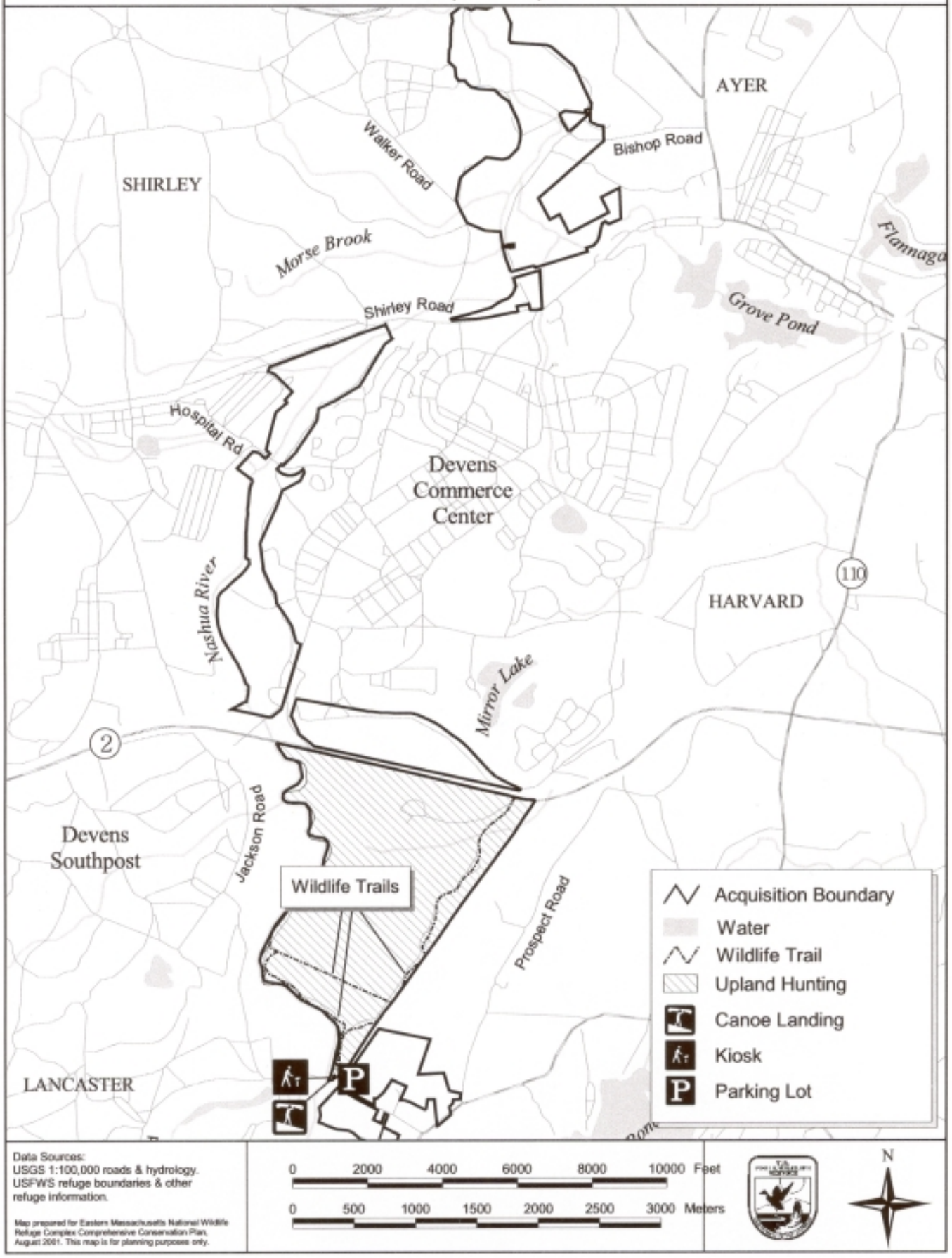
Alternative A: Current Management

Existing Public Use

Oxbow National Wildlife Refuge

Eastern Massachusetts NWR Complex Comprehensive Conservation Plan



Alternative B - The Service's Proposed Action

Under the Service's Proposed Action, refuge staffing and funding levels would be increased, and we would initiate new wildlife population, habitat and invasive and overabundant species management activities; and provide new compatible wildlife-dependent recreational opportunities. We would also work with State, Federal and non-governmental partners to secure funding for the construction of new visitor facilities and a Visitor Contact Station to support the goals and objectives of the National Wildlife Refuge System and the Oxbow Refuge.

Special emphasis would be placed on obtaining baseline data of wildlife populations and habitat conditions required to develop the detailed step-down plans under this CCP. These plans are needed to provide professional and scientifically adequate resource management planning. Wildlife population and habitat monitoring surveys and inventories would be continued to provide the data needed to assess the effectiveness of management programs and practices, and to make mid-course adaptations to these practices to ensure they meet long-range refuge goals and objectives.

Special emphasis would also be placed on providing enhanced, and sustainable, opportunities for the six priority, wildlife-dependent public uses defined in the Refuge Improvement Act of 1997 (environmental education, fishing, hunting, interpretation, photography and wildlife observation). The Visitor Services Plan would include a monitoring program to evaluate intensity and potential impact of all the wildlife-dependent public uses on the refuge. Public use activities in general, would be modified in the future if adverse impacts on wildlife or habitat are identified. Public use evaluations, along with wildlife and habitat monitoring programs, would assist the refuge in both assessing the intensity of public use and adapting our management strategies and practices for those uses.

Brief explanations of the Service's Proposed Action follow. The Proposed Action(s) are also summarized under Alternative B in **Table 2-8**, *Actions and Strategies Matrix for the Oxbow NWR.*

Habitat and Wildlife Populations

In addition to the activities described previously under Alternative A, the increased staff and funding resources associated with our proposed action would enable us to take a number of actions that would lead to the completion of two key step-down plans under this CCP: a Habitat Management Plan and a Habitat and Wildlife Inventory and Monitoring Plan.

First, we would expand our inventory of wildlife species utilizing the Oxbow Refuge (See Chapter III: Part 1 Affected Environment and Appendix F, Species Lists). Our current inventories would be updated or expanded upon to close data gaps including: information

gaps about the refuge north of Route 2 (recently transferred to the Service from the Army); seasonality of use; habitat-type preferences; and, where practicable, estimates of population numbers. Although under Alternative B, surveys and inventories of both the Service's Trust Resources (migratory birds and Federal listed threatened and endangered species) and resident wildlife, including State listed threatened and endangered species are expected to be accomplished concurrently. If necessary, surveys and inventories related to the Service's Trust Resources may receive priority. These additional surveys would include, but may not be limited to such activities as:

Our Proposed Action for habitat and wildlife management includes four parts:

1. Collect information for all species on the refuge,
2. Determine resources of concern based on national and regional Service plans,
3. Using information gathered in Steps 1 and 2, develop a Habitat Management Plan,
4. Develop a Habitat and Wildlife Inventory and Monitoring Plan to insure objectives in the Habitat Management Plan are reached.

- Collecting information on nesting species, migrating raptors and neotropicals would be censused for two seasons by 2007 by the refuge and partners. Raptor surveys would be conducted throughout the fall, using methods and forms established by the Hawk Migration Association of North America.

- Small mammals would be surveyed by 2010 using small live box traps, snap traps, and pitfall traps. Traps would be arranged in a grid and trapping would be done during the spring, summer, or fall. If any threatened or endangered species are found, mark recapture studies may be initiated to determine a population estimate.

- Freshwater fish would be sampled in all the "substantial" ponds by 2010 using passive and active capture gear and electro fishing. Passive gear includes, but is not limited to, gill nets, trammel nets, and fyke nets. Active gear includes, but is not limited to, seines, nets, and hooks. Depending on the diversity and abundance of fish that are found in the ponds, mark recapture studies may be initiated.

- We would conduct a comprehensive survey of invertebrates in the spring and summer by 2007, noting Federal and State listed endangered and threatened species. "Sticky" sticks (paint stirrers dipped in Tanglefoot Insect Trap Coating and placed horizontally on and vertically in the substrate) would be used to sample ground-based invertebrates throughout the refuge. Collecting nets would be used to sample winged invertebrates.

Second, we would determine resources of concern, including focus species or species-groups and their habitat needs. Focus species and habitats are most likely to be selected based on a combination of factors such as: endangerment (federal and State-listed species); priority, national and regional Service plans (such as the North American Waterfowl Management Plan, the Partner's in Flight, etc; developing Service Policies/regulations such as those related to Habitat Management Planning and Maintenance of Ecological Integrity; the purpose for which Oxbow Refuge was established (its value for the conservation of migratory bird species); current/historical species and habitat presence; and recommendations from the Massachusetts State Division of Fisheries and Wildlife or other

partners.
Third, we would develop a long-range Habitat Management Plan (HMP) by 2006. The HMP would contain information for all habitats and species on the refuge, with a focus on resources of regional and national concern (based on regional and Service plans). It would provide quantitative and measuable objectives and strategies for habitat management to enhance resources of concern.

Fourth, our Habitat and Wildlife Inventory and Monitoring Plan would be completed by 2007. This plan would include an on-going monitoring component designed to measure progress toward those objectives outlined in the HMP, and to allow mid-course corrections or alterations as they may be needed. Depending on specific habitat management techniques or practices that may be recommended in the plans including chemical, mechanical or fire, several additional step-down plans may be required (e.g., a pesticide (or herbicide) use plan, specific wetland restoration plans, etc). Protocal developed in this plan would be statistically sound and peer reviewed.

A considerable amount of work is needed to obtain the needed detailed species and habitat data in order to complete steps 2, 3 and 4. Until our management plans are complete, the refuge will continue with the grassland and old field, wetland and upland habitat management described in Alternative A.

In addition to the four steps above, the refuge would continue to seek opportunities to develop cooperative management agreements with neighboring conservation organizations and individuals.

Invasive and Overabundant Species

Beaver at Oxbow NWR. *USFWS Photo*

Under the Service's proposed alternative, a comprehensive invasive plant inventory would be developed and implemented. In addition to determining areal extent of those species currently of concern, additional or incipient problems would be documented, and baseline measurements of key condition indices such as species diversity, density, height, percent cover, etc. would be made. An Integrated Pest Management Plan would be developed, which would provide a full range of potential and alternative mechanical, biological and chemical control strategies. The plan would also include preparation of on-going monitoring survey methods to assess rate of change of invasive species stands, with or without treatment.

Control strategies to be developed will be species and condition specific. Control practices may employ biological vectors such as the use of Galerucella beetles for purple loosestrife control, water level manipulation, mechanical methods (e.g., hand-pulling, mowing, or discing), use of fire, or use of herbicides (see section Fire Management at the beginning of this chapter). The least intrusive, but effective, control practice will be preferred. As previously discussed, use of herbicides will require action-specific step-down plans, and in some situations, proposed control methodologies may also require wetland permitting review and approval.

There are no currently identified problems related to overabundant or invasive animal species on the Oxbow Refuge. Beaver have occasionally caused localized flooding of on-refuge trails and maintenance roads. To date, these problems have been controllable by use of perforated pipe and wire mesh fence "beaver exclosures" installed on culverts, water-control structures or beaver dams. If more serious threats to habitat, refuge facilities, adjacent property or endangerment of health arise, we would work, in coordination with the Massachusetts Division of Fisheries and Wildlife, to either trap and relocate individual animals from problem sites, permit licensed sports trappers or hunters to reduce population numbers, remove individual beavers through trapping or shooting by refuge staff, or to permit a licensed animal damage control firm to reduce population numbers by trapping. If needed, we will issue a special use permit and complete a compatibility determination (see Chapter 2: Introduction, Actions Common to All Action Alternatives) outlining specific requirements and conditions for beaver removal.

Under this alternative, the refuge would monitor mute swans on the refuge. In an effort to keep this aggressive, non-native species from becoming a resident on the refuge, territorial or nesting swans on the refuge would be lethally removed after obtaining appropriate permitting from our migratory bird office. Currently mute swans only occasionally use the refuge and do not pose a problem.

The refuge would also participate in appropriate, experimental invasive species control research programs, if such programs have been reviewed and approved by Service Regional or national biological staff and the Department of Interior's wildlife research division, the Biological Resources Division, now located within the U.S. Geologic Survey.

Priority Public Uses

Refuge Access and Fees

A fee program would be initiated at Oxbow Refuge. For details on fee program, see the New Recreational Fees section at the beginning of this chapter.

A Visitor Services Plan which describes all the planned public uses would be developed using standard regional guidelines by 2007. The plan would involve setting public use goals, determining measurable objectives, identifying strategies, and establishing criteria for all visitor services. The plan will also outline future funding and staffing needs. Serval step down plans would be required prior to opening or expanding public use plans including a fishing plan and hunting plan.

Hunting

Under this alternative, the current Refuge Hunting Plan would be updated to reflect the proposal below. Refuge-specific regulations or restrictions would be described in the revised Hunting Plan, based

on the description of hunting in this plan, and published in the Federal Register, and disseminated through refuge hunting brochures, news releases and on-refuge informational signing. A refuge permit and fee would be required to hunt on the refuge. For additional information see the Hunting and Fishing and New Recreational Fee sections at the beginning of this chapter

Big and Upland Game Hunting

Archery, shotgun and primitive firearm deer hunting opportunities would be provided on portions of the refuge in accordance with Massachusetts State regulations and requirements. Among other restrictions, these regulations prohibit the discharge of any firearm or arrow upon or across any State or hard-surfaced highway or within 150 feet of any such highway, and the possession or discharge of any firearm within 500 feet of any dwelling or building in use, except as authorized by the owner of occupant thereof (See Map 2-20 which depicts the general areas within the refuge where these activities would occur).

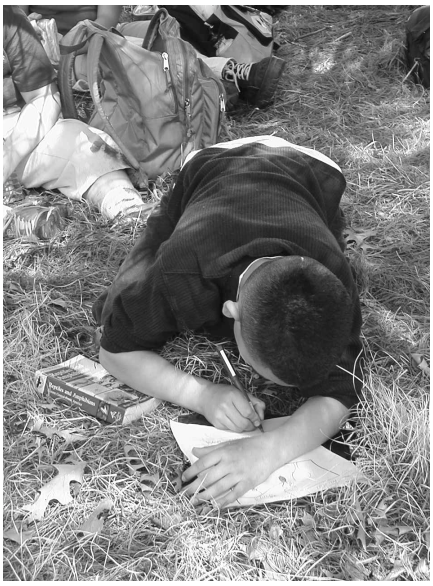
The portions of the refuge located south of Route 2, except the "Watt Farm" addition would be open for all three deer seasons. The Watt Farm area would be open for the archery season only.

The portions of the refuge from the Route 2 underpass to Hospital Road would be open for the archery season only. The portion of the refuge from Hospital Road to Shirley Road would not be open for hunting.

The portion of the refuge located on the westerly side of the Nashua River north of Shirley Road would be open for all three deer season, and the portion of the refuge on the easterly side of the Nashua River in this area would be open only for the archery season.

A limited special season will be provided for physically handicapped hunters. Selected roads on the refuge would be open for vehicle traffic during this season. We believe the physical configuration of trails and roads on the refuge will allow us to provide handicapped accessible deer hunting opportunities from several of these access ways.

Shotgun hunting of upland game birds (ruffed grouse), turkey (Spring season and fall season per current State restrictions), and small game (rabbit, gray squirrel) are currently allowed on the portions of the Oxbow Refuge located south of Route 2. Under Alternative B, upland game bird and small game hunting (but not turkey hunting) would also be permitted on the portions of the refuge north of Route 2 and south of Hospital Road, and the westerly side of the Nashua River north of Shirley Road. (See Map 2-20. which depicts the general areas within the refuge where these activities would occur). All State regulations and restrictions would continue to apply, and be enforced, including the safety related



Students participating in the Urban Education Program at Oxbow Refuge. *Under the Proposed Action, the refuge would expand this program. USFWS Photos*

restrictions discussed above. In addition, the use of non-toxic shot (non-lead) would continue to be required for all seasons, with a current exception for turkey hunting.

There were several options to deer hunting that were analyzed and considered during the CCP process but were eliminated as non-viable management options. These include immunocontraception, steroidal implants, oral delivery of contraceptives, GNRH vaccine, sterilization, live trapping and relocation, and habitat management. Please refer to the section at the beginning of this Chapter 2, Alternatives Addressed but not Considered, for their description and discussion.

Migratory Bird Hunting

Woodcock hunting would be open in the same areas described above for Upland Game Hunting. Under this alternative, we would also open waterfowl hunting south of Route 2 on the Nashua River. Waterfowl hunting on wetlands and ponds within the refuge or adjacent to the Nashua River would remain closed under this Alternative. Woodcock and any future waterfowl hunting would be regulated in accordance with federal and State regulations and restrictions.

Fishing

We propose to increase fishing opportunities on the refuge by providing river-bank fishing at up to four areas along the Nashua River. These areas may need to receive stabilization or be provided with erosion control measures prior to being opened, and they may be closed as needed to prevent or repair bank erosion or prevent disturbance to migratory birds, if either should occur. At least one, and, based on further evaluation of their compatibility with habitat and wildlife considerations, all of these locations will be made handicapped accessible.

Wildlife Observation and Photography

We would open an additional 5 to 6 miles of foot trails and a second canoe launch on the portion of the refuge north of Route 2. Parking areas for these facilities would be constructed off Jackson, Hospital and Walker Roads. A third canoe launch and parking area would be constructed within the former Fort Devens North Post. A wildlife observation platform and a photography blind would be constructed. The current, proposed locations of these facilities are depicted on Map 2-19.

We would evaluate the potential for a foot trail on the Watt farm. Before allowing this use, we would conduct surveys to determine what species are using the farm. We would consider a trail if our surveys show that this use would not disturb birds using the area.

Environmental Education and Interpretation

Our participation in local and regional environmental education and interpretive programs would be increased under Alternative B. Our Urban Education Program is currently in its second year of development in cooperation with the Worcester Public School System and the Friends of the Refuge. This program would be expanded to include at least one additional elementary-middle or high school either from Worcester or another school system within the region. We would also endeavor to work with other school systems to provide instructional materials and presentations related to refuge resources and management programs that are occurring at Oxbow. In addition, we would work with our Friends of the Refuge and other partners to expand our current staff and volunteer-led interpretive programs on Oxbow.

Three informational kiosks would be constructed at entrances to Refuge foot trails, and a self-guided interpretive trail with signage and explanatory pamphlets would be developed for both a refuge trail and a reach of the Nashua River. Refuge-specific informational and species list brochures will be developed. The current, proposed locations of these facilities are depicted on Map 2-19.

Public and Community Outreach

We would increase current Outreach Programs by adding sponsorship of one or more additional annual events (such as National Fishing Day, National Wildlife Refuge Week or Earth Day) designed to promote wildlife-dependent recreation and natural resource education. In cooperation with area teachers, we will assess the needs for, and work toward development of a refuge-specific environmental education curriculum for grades between kindergarten and the senior year of high school. We will provide an annual teacher workshop either at Oxbow or at the Complex Headquarters to cooperatively share experience and ideas related to these curricula.

We would also initiate programs to provide local communities and landowners educational and informational material and strategies related to natural resource protection and restoration. On-going refuge resource management practices and habitat restoration areas would be incorporated in all of these programs to serve as illustrations or demonstrations of resource management concepts and techniques.

We would also work with partners and local communities to place informational kiosks related to the refuge and resource management at three off-refuge locations.

Non-Wildlife Dependent Public Uses

Dog walking and picnicking, which occur now, would be eliminated from the refuge by 2004. These uses have been found to disturb wildlife and other visitors and are not considered one of the six priority uses on national wildlife refuges. Jogging would continue to be allowed, but would not be encouraged. We plan to analyze the potential impacts of jogging within the next three years on Service trust resources and priority public uses and would consider modifying or eliminating the use in the future, based on this additional analysis. The refuge would remain closed to other non-wildlife dependent activities such as bikes on trails, horseback riding, dog sledding, snowmobiling and swimming. See Alternatives or Actions Considered, but Eliminated from Further Evaluation, Proposals for new, non-wildlife-dependent public uses at the beginning of this chapter for additional information.

Resource Protection and Visitor Safety

Protection of visitors and both natural and cultural resources would be significantly improved under Alternative B. We would increase refuge staff by one additional, full-time Park Ranger, and provide the necessary, intensive federal law enforcement training required for co-lateral duty law enforcement responsibilities to two additional staff (e.g., an assistant manager, refuge operations specialist, or an outdoor recreation planner).

Refuge staff would complete a fire suppression contract or agreement with State or local fire suppression agencies for wildfires occurring on the refuge (see section Fire Management at the beginning of this chapter).

Cultural Resource Management

We would initiate and complete archeological and historical resource surveys and inventories on a refuge-wide basis (in comparison the current, more limited project-specific evaluations described under Alternative A). The archeological survey portion of this work would be designed to develop predictive models that could be applied refuge-wide in evaluating the potential of future projects to impact cultural resources.

Refuge Buildings

We would work with State, private and other federal partners to obtain authorization and funding that would enable the construction of a visitor contact station at Oxbow Refuge. This facility would likely be constructed just north of the Route 2 exit 37B adjacent to (the westerly side of) Jackson Road. The visitor contact station would be approximately 4000 square feet in size. It would provide space for interpretative exhibits, a meeting room and administrative offices for refuge staff. The current, proposed locations of these facilities are depicted on Map 2-19.

Refuge Staffing

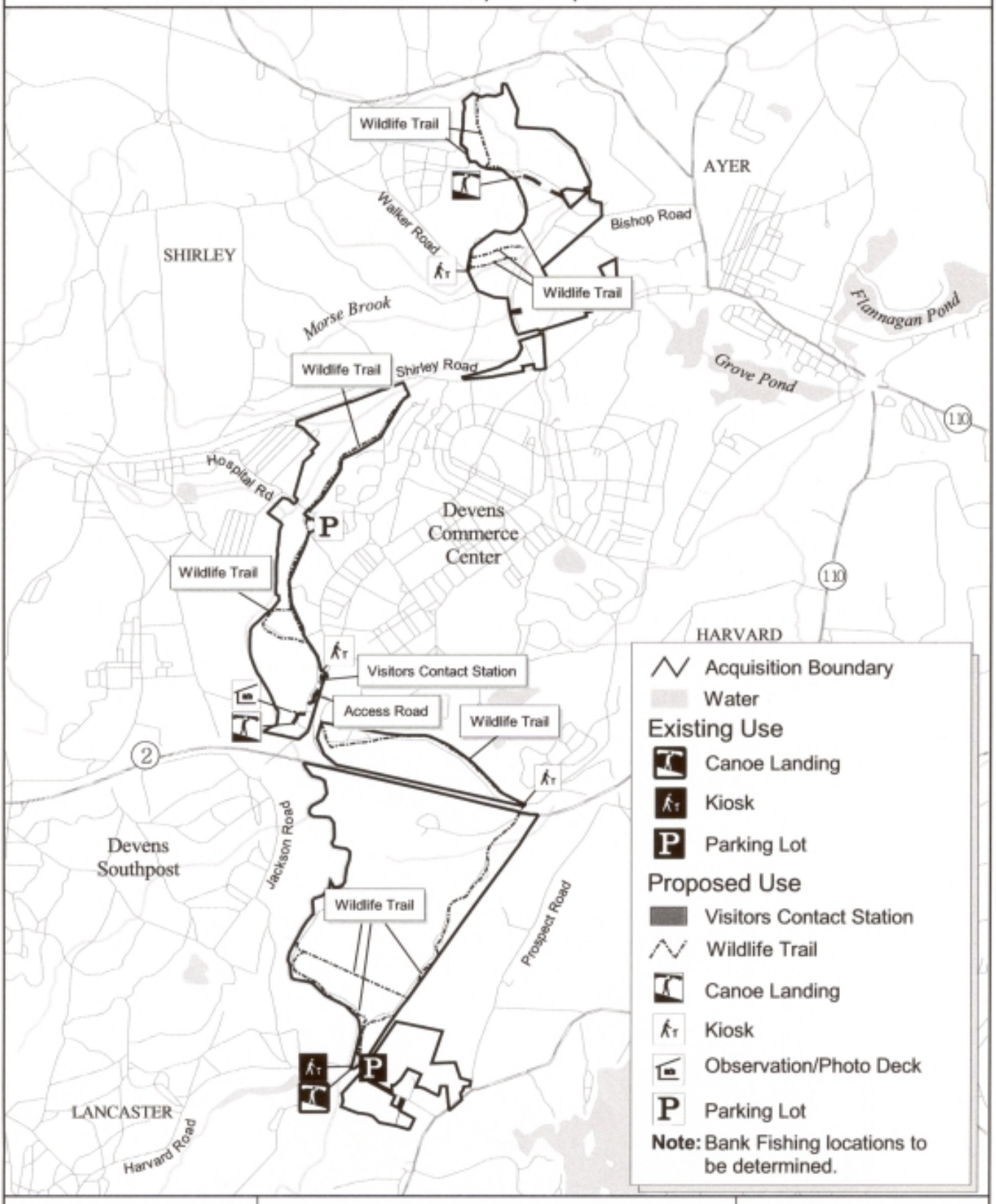
Under Alternative B, the Service would seek to fully staff the minimum requirement identified under Alternative A, the "No-Action" alternative. The Oxbow Refuge minimum staffing needs have been determined to include:

- refuge manager
- assistant refuge manager or refuge operations specialist
- outdoor recreation planner
- maintenance worker
- administrative technician
- park ranger (law enforcement).

In addition, several new staff positions would be required to enable us to implement the full range of programs, facilities and activities identified in this alternative. The additional proposed staff includes:

- park ranger with refuge and visitor protection responsibilities
- one biological technician
- heavy equipment operator.

Alternative B: Proposed Action
Proposed Public Use
Oxbow National Wildlife Refuge
Eastern Massachusetts NWR Complex Comprehensive Conservation Plan



Data Sources:
USGS 1:100,000 roads & hydrology.
USFWS refuge boundaries & other refuge information.

Map prepared for Eastern Massachusetts National Wildlife Refuge Complex Comprehensive Conservation Plan, August 2001. This map is for planning purposes only.

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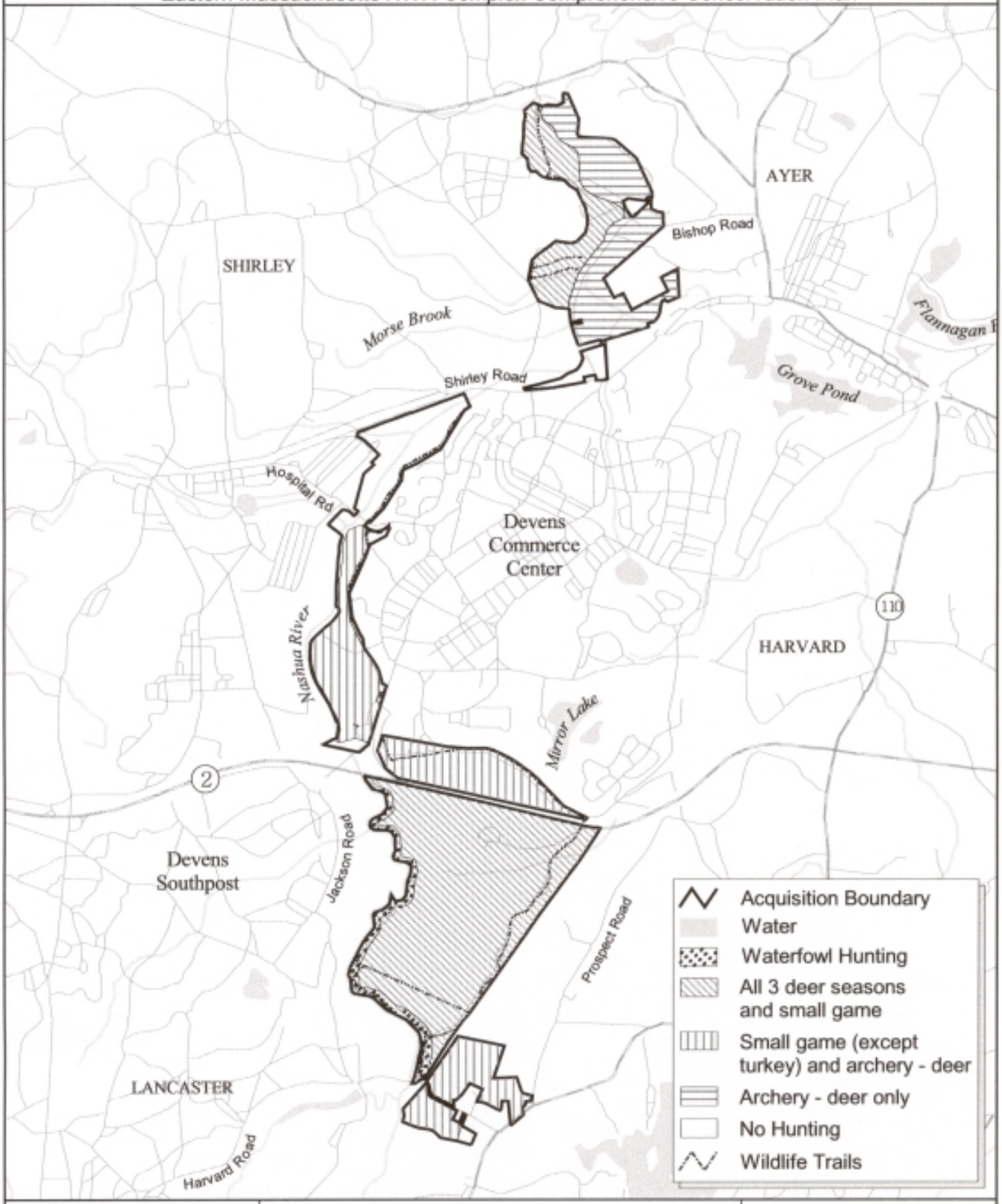
Alternative B: Proposed Action

Proposed Hunting

Oxbow National Wildlife Refuge

Eastern Massachusetts NWR Complex Comprehensive Conservation Plan



Data Sources:
USGS 1:100,000 roads & hydrology.
USFWS refuge boundaries & other refuge information.

Map prepared for Eastern Massachusetts National Wildlife Refuge Complex Comprehensive Conservation Plan, August 2001. This map is for planning purposes only.

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Alternative C

Under this alternative the refuge management strategy would be oriented towards a "hands-off, let nature take its course approach." We would curtail or forego most, active wildlife and habitat management planning and implementation. Natural succession of habitats would be the selected strategy across the refuge. Additional opportunities for wildlife-dependent recreational activities would be reduced or eliminated within the portions of the refuge located south of Shirley Road, and no facilities would be established in the portion of the refuge located north of Shirley Road.

Hunting, fishing and public use plans will be completed. Any necessary, refuge-specific regulations or restrictions will be described in the hunting or fishing plan, published the Federal Register, and disseminated through refuge hunting brochures, news releases and on-refuge informational signing. The public use plan will include monitoring programs to evaluate intensity and potential impact of all wildlife-dependent public uses. Public use activities may be modified, curtailed or eliminated in the future, if adverse impacts on wildlife or habitat are identified.

Habitat and Wildlife Populations

We would limit wildlife and habitat planning to only basic survey work, compiling inventory lists of species presence, and the development of a current habitat cover-type map. These activities would be repeated at 10-year intervals to measure changes and to reassess refuge management objectives. Detailed wildlife and habitat management plans would not be required nor would they be prepared. No management activities would be undertaken that would impede or slow natural successional processes, and no habitat restoration projects would be envisioned.

Oxbow NWR. *USFWS Photo*

Invasive and Overabundant Species

An inventory and mapping of the current extent of invasive plant species would be completed. These activities would be repeated at 10-year intervals to measure changes and to reassess refuge management objectives. No active management would be undertaken except in the event of a threat to property or human health.

Big and Upland Game Hunting

Same as Alternative B, except areas of the refuge north of Shirley Road would be closed for hunting (See Map 2-22).

Migratory Bird Hunting

Same as Alternative B for woodcock hunting except areas of the refuge north of Shirley Road would be closed for hunting (See Map 2-22). No waterfowl hunting is proposed under this alternative.

Fishing

Alternative B would be modified to provide river-bank fishing opportunities at two areas within the portion of the refuge south of Route 2. Areas of the refuge north of Shirley Road would be closed for fishing (See Map 2-21).

Wildlife Observation and Photography

Same as Alternative B, except the portions of the refuge located north of Shirley Road will remain closed to public use. The parking areas and canoe launches in this portion of the refuge would not be constructed (See Map 2-21).

Environmental Education and Interpretation

Alternative C would modify Alternative B by eliminating kiosk construction north of Shirley Road, and limiting the majority of non-refuge staff led educational and interpretive programs to the portion of the refuge south of Shirley Road. Development of self-guided canoe or foot trails would also be limited to these southern portions of the refuge (See Map 2-21).

Public and Community Outreach

Same as Alternative B, however use of on-refuge wildlife or habitat management demonstrations areas described under Alternative B would be reduced or eliminated.

Non-Wildlife Dependent Public Uses

Same as Alternative B.

Resource Protection and Visitor Safety

Same as Alternative B

Cultural Resource Protection
Same as Alternative B, except the refuge-wide archeological survey would be less intensive and predictive modeling to evaluate refuge management actions would not occur

Refuge Buildings

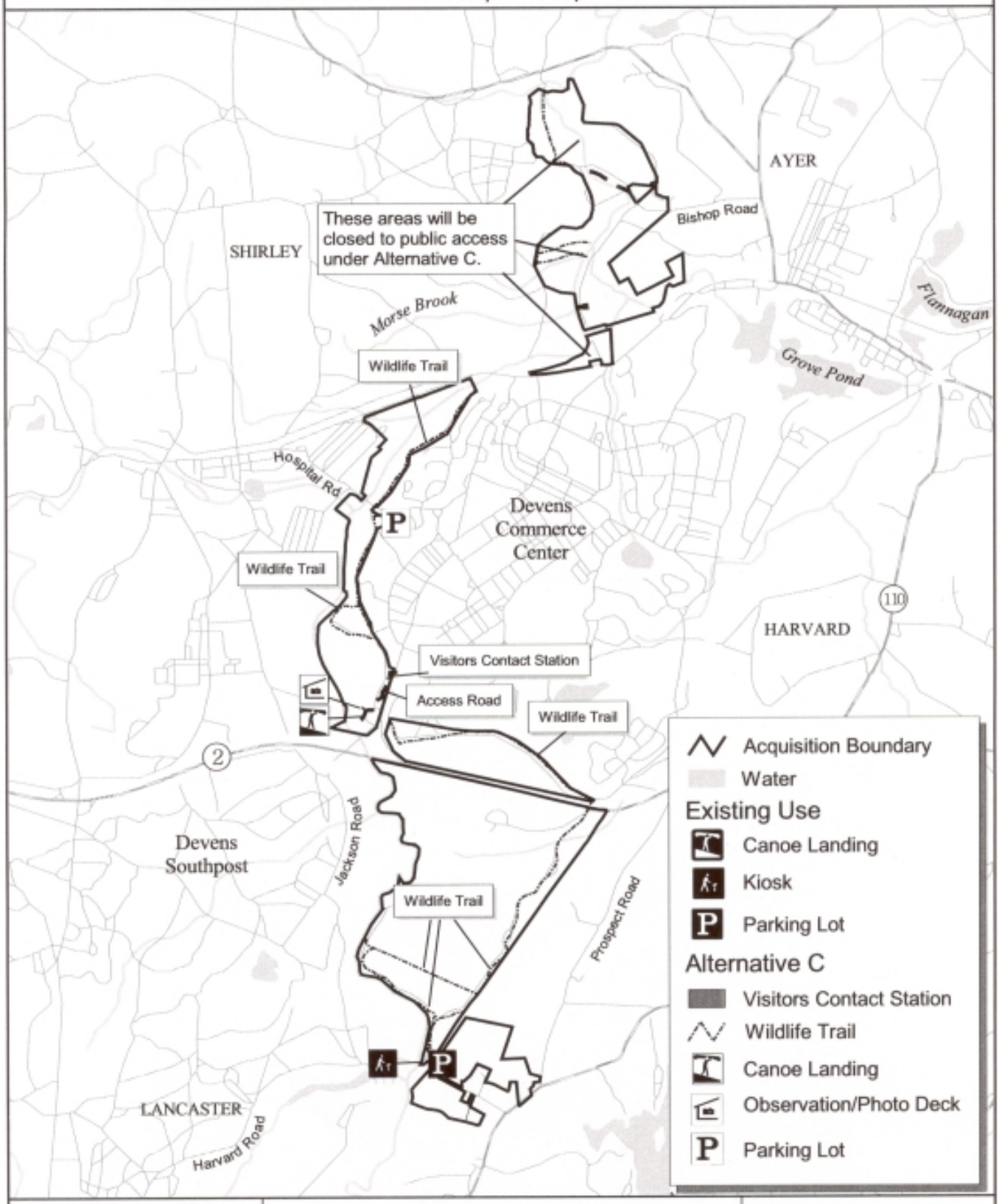
Same as Alternative B.

Refuge Staffing

The reduced levels of wildlife and habitat management activities and public use opportunities included in Alternative C would result in fewer required staff. The proposed staffing level under this alternative includes:

- refuge manager
- assistant refuge manager or refuge operations specialist
- outdoor recreation planner
- maintenance worker
- administrative technician
- 2 park rangers (law enforcement).

Alternative C
Public Use
Oxbow National Wildlife Refuge
Eastern Massachusetts NWR Complex Comprehensive Conservation Plan



Data Sources:
USGS 1:100,000 roads & hydrology.
USFWS refuge boundaries & other refuge information.

Map prepared for Eastern Massachusetts National Wildlife Refuge Complex Comprehensive Conservation Plan, August 2001. This map is for planning purposes only.

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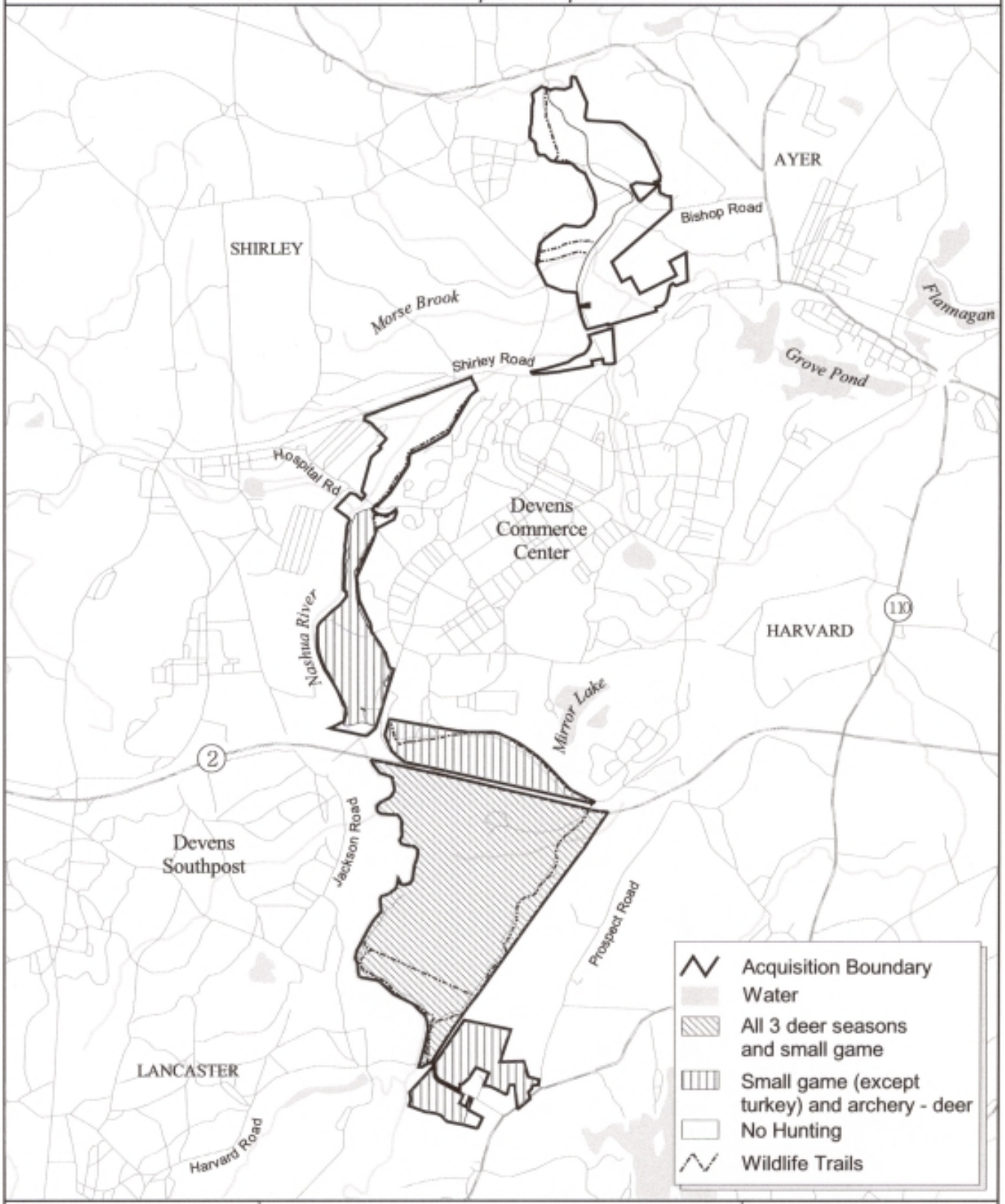
Alternative C
Hunting
Oxbow National Wildlife Refuge
Eastern Massachusetts NWR Complex Comprehensive Conservation Plan



Data Sources:
USGS 1:100,000 roads & hydrology.
USFWS refuge boundaries & other refuge information.

Map prepared for Eastern Massachusetts National Wildlife Refuge Complex Comprehensive Conservation Plan, August 2001. This map is for planning purposes only.

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Table 2-8. Actions and Strategies Matrix, Oxbow National Wildlife Refuge

Issue	Alternative A Current Management	Alternative B Service's Proposed Action	Alternative C
How would we manage habitats and wildlife populations?	Conduct baseline population surveys and inventories for - woodcock - marsh birds - breeding birds - anuran Blandings turtle monitoring occurs by a partner. Expand Blanding's turtle nesting habitat by removing vegetation and surface organic matter on approximately eight acres that were formerly in this condition. Continue management of 15-20 existing acres Continue partner based contaminants monitoring program Existing information on wildlife populations and habitat is being obtained from partners. Maintain existing old field habitat (approximately 25-30 acres) utilizing fire management techniques or mechanical means. Maintain existing wetland habitat. Restore approximately 30 acres of currently degraded wetlands. Selectively remove existing roads and trails not required for refuge maintenance, visitor use or fire control purposes. Allow the remaining, existing mix of wetland, hardwood and pine forest to mature under natural succession processes.	In addition to Alternative A: Develop inventory list of migratory bird and federally listed threatened and endangered species. Inventory and evaluate population statuses of key, resident vertebrate and invertebrate species, including State listed threatened/ endangered species, deer, small mammals, anuran, and others on the refuge. Identify focus species Develop species management objectives Inventory Refuge habitats, surface hydrology, soils & topography Develop an updated cover type map Develop & implement a Habitat Management Plan and a Habitat and Wildlife Inventory and Montioring Plan which may utilize mechanical, chemical and fire management techniques to accomplish potential habitat plan recommendations Seek opportunities to develop cooperative management agreements with neighboring conservation agencies, organizations and individuals.	Active management practices would be severely curtailed or eliminated. Planning and monitoring would be limited. Inventory migratory bird and Federal listed threatened and endangered species, resident vertebrate (e.g., deer, small mammals, anuran, etc.) and invertebrate species, including State listed threatened/endangered species, on the refuge. Develop an updated cover type map. Repeat inventory surveys at 10 year intervals to evaluate successional changes.

Table 2-8. Actions and Strategies Matrix, Oxbow National Wildlife Refuge

Issue	Alternative A Current Management	Alternative B Service's Proposed Action	Alternative C
How would we manage invasive and overabundant species?	A limited program of purple loosestrife control occurs in one wetland area. Host-specific beetles are used to control loosestrife. Monitor known stands of invasive species Continue beaver management program which currently relies primarily on non-lethal methods of control.	In addition to Alternative A: Inventory and document all invasive species locations and pest or overabundant animal species Monitor and evaluate rate of spread of invasive pest or overabundant species Develop and Implement an Integrated Pest Management Plan (IPM) for invasive plant species which utilizes biological, mechanical, chemical and fire management or control techniques. Manage overabundant/invasive animal populations identifed in surveys using hunting, trapping and relocation, and lethal controls as may be necessary. Specifically, remove nuisance beaver where other control methods fail and remove territorial exotic mute swans from the refuge. Conduct/participate in experimental control technique research.	Active management practices would be severely curtailed or eliminated. Planning and monitoring would be limited. Inventory and document all invasive species locations and pest or overabundant animal species Monitor and evaluate rate of spread of invasive pest or overabundant species at 10-year intervals
What big and upland game hunting opportunities would we provide?	The refuge is not currently open for deer hunting.	The current Refuge Hunting Plan will be updated, and: Portions of the refuge opened to archery, shotgun and black powder deer hunting. (See text and maps for specifics). Handicapped accessible deer hunting opportunities will be provided. All Public use programs will be monitored for potential impacts on wildlife and habitat, programs will be modified as needed, if adverse impacts are identified Annual fee permits will be required for hunting on the refuge.	Same as Alternative B., except areas of the refuge north of Shirley Road, portions of the refuge would be closed to hunting.

Table 2-8. Actions and Strategies Matrix, Oxbow National Wildlife Refuge

Issue	Alternative A Current Management	Alternative B Service's Proposed Action	Alternative C
What migratory game bird hunting opportunities would we provide?	Portions of the refuge are open to woodcock hunting	Additional portions of the refuge, north of Route 2 will be open for woodcock hunting. Waterfowl hunting would be open on the refuge South of Route 2 on the Nashua River. Annual fee permits will be required for hunting on the refuge.	Same as Alternative B for woodcock hunting, except areas of the refuge north of Shirley Road would not be open for hunting. No waterfowl hunting is proposed under this alternative.
What fishing opportunities would we provide?	The Nashua River is open to boat fishing. Refuge wetland pools are closed to public access. Bank fishing is not allowed.	In addition to Alternative A, River-bank fishing access points will be provided at up to 4 designated areas. These may be closed from time to time to minimize river bank vegetation damage. One or more access points will be made handicapped accessible.	Alternative B, except: only two river-bank fishing locations will be provided. the portions of the refuge north of Shirley Road would remain closed to fishing.
What wildlife observation and photography opporutnities would be provided?	The refuge currently provides approximately 2.5 miles of trails, one canoe launch, and a parking area. Snowshoeing and cross country skiing are allowed on the trails currently open for public use.	Same as Alt. A, plus: An additional 5 to 6 miles of hiking trails will be provided on the portion of the refuge north of Route 2. An additional canoe launch, with a parking area will be provided off Jackson Road in the vicinity of Jackson Gate. One additional canoe landing and an additional parking area will be developed within the former North Post portion of the refuge (North of Shirley Road). One wildlife viewing platform and a photography blind will be constructed. Public use programs will be monitored for potential impacts on wildlife and habitat, programs will be modified as needed, if adverse impacts are identified. Evaluate the potential for a foot trail on the Watt farm. An entrance fee would be charged	Same as Alternative B, except: the portions of the refuge located north of Shirley Road will remain closed to public use; and, the parking areas and canoe launches in this portion of the refuge would not be constructed.

Table 2-8. Actions and Strategies Matrix, Oxbow National Wildlife Refuge

Issue	Alternative A Current Management	Alternative B Service's Proposed Action	Alternative C
What environmental education and interpretation opporutnities would we provide?	Both on and off-refuge environmental education and interpretive programs are being provided by refuge staff, the Friends group and volunteers. Assistance with teacher workshops is being provided, as requested. An Urban Education program with Worcester school systems has been initiated.	Same as Alternative A plus: Develop a Visitor Services Plan Expand volunteer led interpretive and education programs on the refuge. Expand Urban Education Programs to other regional school systems. Coordinate with area environmental educators to integrate refuge programs into their education programs. Construct three on-site informational kiosk, and implement self-guided interpretive walking and canoeing trails. Review non-Service sponsored uses of the refuge for compatibility. Regulate this uses through use of Special Use Permits, Memoranda or Understanding or Agreement, or Concessions, as appropriate	Alternative B would be modified by eliminating kiosk construction and limiting most non-refuge staff led programs to the portions of the refuge south of Shirley Road. Self-guided foot or canoe trails would be limited to the southern portions of the refuge, below Shirley Road.
How will the Refuge provide outreach to increase the public's awareness of the Refuge?	FWS staff and partners provide off-site, refuge-related presentations to school, clubs, communities, etc. as requested. Continue to develop and build the Refuge Friends group. A quarterly news letter is distributed A refuge Web-site and monthly news releases are used to provide information on refuge management activities and upcoming events.	Same as Alternative A, plus: One or more annual events (such as National Fishing Day, Refuge Week, etc.), which promote wildlife dependent uses and natural resource education will be held on the refuge. Work with partners to construct a visitor center at Jackson Gate entrance. Develop refuge-specific EE curriculum for K-12. Develop annual teacher workshop. Develop program to educate local communities and landowners about existing programs and strategies for resource protection and restoration. Utilize on-going refuge management areas to illustrate beneficial wildlife and habitat practices. Work with partners to place information kiosks with refuge oriented materials at 3 strategic, off-refuge locations.	Same as Alternative B, except on-refuge wildlife and habitat management demonstration areas would essentially be eliminated from the programs.

Table 2-8. Actions and Strategies Matrix, Oxbow National Wildlife Refuge

Issue	Alternative A Current Management	Alternative B Service's Proposed Action	Alternative C
What non-wildlife dependent public uses would be allowed on the Refuge?	Current uses occurring: Picnicking, jogging, dog walking (on leash)	Refuge is closed to dog walking and picnicking Study impacts of jogging	Same as Alternative B
How would we ensure resource protection and visitor safety?	Wildlife and cultural resource law enforcement is provided by one full-time and one co-lateral duty staff shared with other Complex units. Enforce Federal cultural resource protection laws and regulations. Soil disturbance requires cultural resource evaluations and clearance	In addition to Alternative A: Law enforcement staff would be assigned specifically to the Oxbow Refuge. Survey sites proposed for construction of all facilities- roads, trails, buildings, etc. Modify construction as necessary to minimize impacts to cultural resources. Complete an overview survey of cultural resources of the refuge. Develop predictive model for probable archeological and historic sites.	Same as Alternative B, except the refuge-wide archeological survey would be reduced in scope, eliminating studies needed to develop predictive models.
What buildings and facilities would be used or constructed for Refuge operations?	The are no buildings on the refuge at the current time.	Working with partners to obtain funding, a Visitor Contact Station with administrative offices will be constructed at the Jackson Gate entrance to the refuge.	Same as Alternative B.

Table 2-8. Actions and Strategies Matrix, Oxbow National Wildlife Refuge

Issue	Alternative A Current Management	Alternative B Service's Proposed Action	Alternative C
What would be the future staffing needs at Oxbow Refuge?	Current Staffing Level: 1 Refuge Manager 1 Assistant Mgr. (vacant) 1 ORP (vacant) 1 Maintenance Worker (vacant) 1 Admin. Tech (vacant) 1 Park Ranger (LE) (vacant) Total FTEs 6	In addition to Alternative A: 1 Park Ranger 1 Biological Technician 1 Equipment Operator Total FTEs 9	In addition to Alternative A: 1 Park Ranger (LE) Total FTEs 7

Chapter 3

Rabbit foot clover. *Photo by Marijke Holtrop*

Affected Environment

Part 1: Assabet River National Wildlife Refuge
- Physical Resources
- Biological Resources
- Cultural Resources
- Socioeconomic Environment

Part 2: Great Meadows National Wildlife Refuge
- Physical Resources
- Biological Resources
- Cultural Resources
- Socioeconomic Environment

Part 3: Oxbow National Wildlife Refuge
- Physical Resources
- Biological Resources
- Cultural Resources
- Socioeconomic Environment

Part 1: Assabet River National Wildlife Refuge

Physical Resources

Location

Assabet River Refuge, formerly referred to as the U.S. Army's Fort Devens Sudbury Training Annex, is a 2,230-acre parcel of land located approximately 20 miles west of Boston, and 4 miles west of the Complex Headquarters. It is located in portions of the Towns of Hudson, Maynard, Stow and Sudbury and covers approximately 3.5 square miles. The Assabet River Refuge consists of two separate pieces of land. The larger northern section is just north of Hudson Road. The southern section is located to the south of Hudson Road (see Map 1-2).

Table 3-1: *Assabet River National Wildlife Refuge Acreage*

TOWN	MAYNARD	SUDBURY	STOW	HUDSON
Area of Refuge North of Hudson Road	698.63	214.47	994.28	0
Area of Refuge South of Hudson Road	0	257.5	0	40.30
Total Acres	698.63	471.97	994.29	40.30

Assabet River Refuge. *USFWS Photo*

The land, centered in a developed area, has been protected by the Army for the last 58 years. That protection has allowed the maturation of extensive, structurally diverse wetland habitats, whose ecological integrity is enhanced by its surrounding upland forests and grasslands. The refuge provides significant habitat for migrating and resident wildlife. Along with providing habitat to numerous species considered threatened or endangered by the State of Massachusetts, the refuge also includes several rare wetland types and a number of vernal pools, which are considered to be habitats of special concern. More specifically, approximately 70 percent of the refuge land is forested with white pine (*Pinus strobus*) and mixed hardwoods dominating. Approximately 22 percent is considered wetland habitat, including: a remnant Atlantic white cedar swamp, 6 dwarf-shrub bogs, 2 minerotrophic peatland bogs, a collection of vernal pools and historical cranberry bogs, and, grass and shrubland habitats in the remaining areas.

Climate

Assabet River Refuge experiences moderately cold, moist winters and warm, damp summers with an annual mean precipitation of 44 inches per year. Precipitation is fairly well distributed throughout the year. The driest months are July and October, with mean precipitation of 3.3 inches, and the wettest months are March and November with mean precipitation of 4.7 inches. Winter

precipitation is usually in the form of snow and ice storms. Due to its proximity to the Atlantic Ocean, the refuge experiences the influence of tropical storms and hurricanes and their associated gusty winds and torrential rains. July is the warmest month, with an average temperature of 72 degrees Fahrenheit (U.S. Army 1995).

Geology, Topography, Soils, and Hydrology

The refuge is located near the western boundary of the Seaboard Lowlands of the New England-Maritime Province, and is dominated by broad flat plains with elevations of 190-200 feet above mean sea level. Overall, elevations on the refuge range from approximately 170 to 321 feet above mean sea level (U.S. Army 1995). Hills are located across the refuge, but predominate across the northern boundary and the central area of the northern portion of the property. In general terms, the topographic features on the refuge may be described as being approximately: 81 percent lowlands, 16 percent hills and 3 percent open water (U.S. Army 1980).

Geology

The Wisconsin stage glaciation has shaped the landform of the refuge, and the Northeast in general. Eight surface depositional types are found on the refuge, and six of these are from glacial action: kames, kame terraces, kame fields, outwash plains, ground moraines and drumlins. The remaining two sediment deposits are alluvium swamps. Glacial tills are compact , unsorted mixtures of clay, silt, sand, gravel and boulders. The hilly portions of the refuge tend to be till, with the flatter areas being glacial outwash. The tills may reach thicknesses of up to 40 feet in moraine areas, and up to 80 feet in drumlins. Alluvium is generally fine gravel, and the swamps are predominately sand, silt and organic matter. Kames are irregularly shaped mounds of poorly sorted sands and gravels. Kame fields are simply described as areas of closely spaced kames. Kame terraces were formed by glacial meltwater depositing suspended matter between ice sheets. Vose Hill and the hill immediately south of Tuttle Hill are mapped as drumlins, glacially formed accumulations of till indicating by their orientation the direction of ice flow (USGS 1956). A million-year old river valley underlies Lake Boon, White Pond and the southern portion of the refuge. (U.S. Army 1995).

The deeper lying bedrock is igneous and metamorphic rock of the Precambrian and Paleozoic Ages. Depth to bedrock across the refuge is generally in the range of 40 to 100 feet below the ground surface. Primary formations found on the refuge include the Precambrian Marlboro schist; the Devonian age Salem and Dedham Granodiorites; the Carboniferous Nashoba gneiss; and, the Gospel Hill gneiss. Bedrock outcrops occur in several irregularly distributed areas across the refuge (U.S. Army 1995).

Soils

Soils across the refuge are comprised of a diverse range of types reflecting varied glacial and alluvial depositional processes. The U.S. Department of Agriculture, Natural Resources Conservation Service soil maps indicate the more common soils include those of the Carver, Windsor, Merrimac, Paxton, Deerfield, Montauk, and Charlton-Hollis series in the uplands; and, the Swansea and Freetown series in wetlands (USDA 1995).

The Carver soil series consists of nearly level to steep, deep (5+ feet), excessively drained soils on glacial outwash plain, terraces, and deltas. They are very friable or loose loamy coarse sands, with very rapid permeability. They tend to be droughty, with severe concern for seedling survival and slight concern for erosion in well managed forest cover.

Windsor soils are found in nearly level to very steep conditions; are up to 5+ feet deep; excessively drained soils on glacial outwash plains, terraces, deltas and escarpments. They formed in sandy glacial outwash, and have a very friable or loose loamy sand or loamy fin sand surface soil. They have rapid permeability and tend to be droughty, but concern for seedling mortality is listed as being slight.

Merrimac soils occur in level to steep slopes; are up to 5+ feet deep; and, are excessively drained soils found on glacial outwash plains, terraces, and kames. They formed in water-sorted, sandy glacial material, and are friable, fine sandy loams and sandy loams in the surface. The are moderately rapid in permeability, with few limitations for most uses, and moderate risk for seedling mortality.

Paxton soils are deep (5+ feet), well drained soils found on glacial drumlins. They formed in compact glacial till. These soils are friable fine sandy loams, with a very stony surface. They have slow or very slow permeability and moderate risk for seedling mortality.

The Deerfield series are deep, well drained, loamy fine sand soils. They are found on glacial outwash plains, terraces, and deltas. These soils may have a seasonal high water table at 18 to 36 inches and moderate seedling mortality risk.

Montauk soils are well drained and found on drumlins. They formed in compact glacial tills, and are friable, fine sandy loams, with moderately rapid permeability. Montauk soils are stony to extremely stony, with a slight seedling mortality risk.

The Charton-Hollis-Rock Outcrop complex soils are well drained, with (on average) approximately 10% bedrock outcrops.

The Swansea and Freetown series are very poorly drained wetland soils. They formed in depressions and flat areas of glacial outwash plains and terraces, and may be 50 inches to many feet of black,

Wetlands and marsh. *Assabet River Refuge protects valuable wetland and marsh areas for migratory birds. USFWS Photo*

highly decomposed organic material over sandy mineral materials. They have a water table that is at or near the surface most of the year. (USDA 1995).

Hydrology

Most of the northern section and westernmost parts of the southern section of Assabet River Refuge fall within the Assabet River drainage basin. The majority of the northern portion of the refuge drains northward through Taylor Brook and its tributaries, including Honey Brook. Two small, intermittent streams also flow from the northern/northwest portion of the refuge into the Assabet River.

The central and eastern area of the southern portion of the refuge are within the Sudbury River drainage basin. Marlboro Brook drains from the southeastern portion of this section of the Refuge into Hop Brook, a tributary of the Sudbury river, just above Stearns Millpond. The western portions of this section of the refuge drain toward White Pond, which has no surface outlet, but is thought to drain underground to Lake Boon and thence to the Assabet River (U.S. Army 1995).

The water table under much of the refuge is shallow, as indicated by the extensive swamps, bogs, and water-holes found on the property. Groundwater discharge is thought to be supplying much of the flow occurring through the outwash plains underlying the lowlands of the site (U.S. Army 1995). The poorly drained lowlands soils have supported the establishment of extensive and diverse wetland habitats, which include forested and shrub-dominated wetlands, bogs, emergent wetlands, open-water bodies in the form of several lakes and ponds, an abandoned cranberry bog, and scattered seasonally-flooded vernal pools (USFWS 1995).

Air Quality

The Massachusetts Annual Air Quality Report for 1999 (MADEP, 2000), and the U.S. Environmental Protection Agency's Air Quality Planning and Standards Web Page (EPA, 2001), contain the most recent data available for air quality in this area. The nearest data appear to be limited to those from monitoring sites in the City of Worcester and the Town of Stow. The Stow monitoring site has been located on the Assabet River Refuge since 1999, and prior to that time was located nearby on the Great Meadows Refuge in Sudbury.

The pollutants for which State-wide data are available are ozone (O_3), carbon monoxide (CO), nitrogen dioxide (NO_2), Lead (Pb), sulfur dioxide (SO_2) and particulate matter (both 2.5 microns (PM2.5) and 10 microns (PM10)).

The National Ambient Air Quality Standards (NAAQS) determined by USEPA set the concentration limits that determine the attainment status for each criteria pollutant. Massachusetts does not attain the public health standard for two pollutants – ozone (O3)

for the entire state and carbon monoxide (CO) in a few cities (MADEP 2000), including parts of Worcester and Middlesex Counties within which the refuge is located (USEPA 2001).

There are two ozone standards based on two different averaging times, 1-hour and 8-hour. In 1999, there were 85 exceedances of the 8-hour standard occurring on 22 days, and 5 exceedances of the 1-hour standard occurring on 4 days on a State-wide basis. The 12 year trends for ozone readings in the State have been generally decreasing toward better quality since 1988.

Massachusetts has made significant progress in attaining the CO standard by implementing air pollution control programs. The last violation of the CO NAAQS occurred in Boston in 1986. The Boston metropolitan area was redesignated to attainment of the CO federal air quality standard by the USEPA in 1996. Lowell, Springfield, Waltham, and Worcester remain in non-attainment of the CO standard. MADEP is currently preparing a request to the USEPA to redesignate these areas to attainment for CO because monitoring data has been below the standard for many years. The redesignation request, which includes technical support and a maintenance plan, will be subject to public review and comment prior to being submitted to the USEPA.

In recent years there has been concern regarding the aerial deposition of mercury from atmospheric sources outside the northeast region (see for example Sweet and Prestbo 1999). Researchers have speculated that this may be the source of mercury levels found in some species and age-classes of fish in New England above the 1 part per million standard established by the U.S. Food and Drug Administration (see discussion in the Water Quality Section below).

The annual average concentration of Pb in the air decreased substantially since 1985 from more than 300 ug/m^3 to less than 0.05 ug/m^3 (the annual average NAAQS for lead is 1.5 ug/m^3). Massachusetts is well below the standard. This result is attributed to the use of unleaded gasoline in motor vehicles, which are the primary source of airborne lead emissions (MADEP 2000). While air quality concentrations of lead have dramatically decreased, there may still be concern regarding residual lead levels in soils along heavily traveled roadways deposited prior to the change to unleaded gasoline usage.

Water Quality

The waters of the Assabet River have been designated as Class B, Warm Water Fisheries by the Commonwealth of Massachusetts. Class B waters are defined as being suitable for "protection and propagation of fish, other aquatic life, for wildlife, and for primary and secondary contact recreation" (MADEP 1998). All sections of the Assabet River are included in the Massachusetts Department of Environmental Protection 303(d) List of Waters as failing to meet the Class B standards, primarily due to elevated levels of phosphorus and nitrogen, and low dissolved oxygen concentrations (OAR 2000).

The source of nutrient input is thought to be associated with discharges from seven municipal wastewater treatment facilities, storm water runoff from lawns and agricultural lands and releases from nutrients previously settled in the sediments of the river bottom (OAR 2000). Environmental consulting firms working for the Army have conducted four studies of contaminants in surface water, sediment and fish of Puffer Pond since the mid-1980s. Summaries of these studies (taken from U.S. Army 1995) are presented below:

Dame & Moore - 1984

In 1984 Dames & Moore (D&M) collected background samples of surface water and sediment (D&M 1986). One of the samples was collected upstream of Puffer Pond, and one of them was collected downstream. Phenols were detected in upstream surface water, and polycyclic aromatic hydrocarbons (PAHs) were detected in downstream sediment. D&M reported that the observed PAH compounds may have resulted from widespread distribution of coal ash at the installation.

D&M conducted an expanded second round of surface water and sediment sampling, to better define the pattern of contaminant distribution. On the basis of the second-round sampling results, D&M concluded that "no significant contamination sources exist in the Puffer Pond area" (D&M 1986, p. 2-32).

U.S. Army Environmental Hygiene Agency - 1991

The potential presence of contaminants in and around Puffer Pond led the Fort Devens Preventive Medicine Service to request a study of the pond by the U.S. Army Environmental Hygiene Agency, "to determine if there is contamination that would compromise the health of people fishing in Puffer Pond" (AEHA 1991).

AEHA conducted its study of Puffer Pond in April of 1991. They collected surface water and sediment samples at four locations in the pond, and fish at one location. Sixteen fish were collected, only one of which was from the predator trophic level (a large pickerel). The fish were filleted, and the samples were analyzed for metals, pesticides, and polychlorinated biphenyls (PCBs). The surface water and sediment samples were also analyzed.

In the surface water samples, cadmium, lead, silver, and zinc exceeded U.S. Environmental Protection Agency (USEPA) Water Quality Criteria for the protection of aquatic life. In sediment, the concentrations of all metals were "extremely low compared to sediments from other Army installations around the country and background soil concentrations in the eastern United States" (AEHA 1991, p. 5). The mercury concentration (1.2 ug/g) in the pickerel sample exceeded the U.S. Food and Drug Administration (USFDA) action level (1.0 ug/g). All other analytes in all fish samples were within safe levels for human consumption.

AEHA (1991, p. 6) concluded that: (a) "no contamination was detected from past practices"; (b) exceedence of the USFDA action level by mercury in one fish sample may not be representative of the fish population in Puffer Pond; and, (c) that more fish should be sampled before releasing a health advisory. AEHA recommended that the additional fish sampling be conducted as part of investigations then being planned by USATHAMA. As a result of the AEHA findings, Fort Devens issued a catch-and-release advisory for Puffer Pond.

OHM Corporation - 1992

OHM Corporation (OHM) prepared a work plan (August 1992) for a Puffer Pond fish study to be conducted under contract to USATHAMA. The work plan incorporated a discussion of the methods and results of an ecological survey of Puffer Pond fish conducted by OHM in the spring of 1992. Using hook and line, on April 24 OHM caught and released 23 largemouth bass, and on May 1 OHM caught and released three pickerel, three largemouth bass, two black crappie, and two yellow perch. OHM visually inspected the fish, looked for swimming eccentricities, and observed nesting patterns along the shoreline. They found no deformities, behavioral problems, or other indications of stress or disease. OHM concluded that Puffer Pond contained a diverse and balanced fish population with no overt signs of stress.

Puffer Pond. *USFWS Photo*

OHM's work plan expanded the goals of the Puffer Pond fish studies to address ecological risks as well as human health risks. The plan was to make comparisons to background ponds, using fish data from the Service, the Massachusetts Department of Environmental Protection (MADEP), and the published literature. OHM presented criteria for selecting background data from the identified sources.

The field program was conducted in October 1992. OHM collected fish using a shrimp trawl instead of seines, because of flood conditions and because of cold water and air temperatures. The flood conditions prevented OHM from collecting largemouth bass or any other top predator species. Black crappies were collected, and they were used to represent the predator trophic level. Fish background data provided to OHM were rejected as insufficient or inappropriate, on the basis of the selection criteria established in the work plan. OHM concluded from its quantitative human health and ecological risk assessments that the observed conditions do not pose a risk to human receptors (OHM April 1994, p. 5-9) and that the

concentrations of analytes observed in the fish tissue "do not appear to be affecting the ecological health of Puffer Pond" (OHM 1992, p. 6-5).

Ecology and Environment - 1993

E & E conducted a bioaccumulation study at Puffer Pond to evaluate the extent of fish contamination and to fill data gaps in previous investigations. Sampling of surface water, sediment, and fish was conducted in Puffer Pond and in a background pond in November, 1993.

Ministers Pond, located northeast of the junction of Routes 117 and 62 near the center village of Stow, was selected as the background pond to use for comparing Puffer Pond sampling results. It generally met the following criteria:

- No or minimal potential site-related impacts;
- A central Massachusetts location; and
- Morphology, pH, alkalinity, trophic status, and watershed characteristics similar to Puffer Pond.

Surface water and sediment sample pairs were collected at six locations in each pond. Fish samples were collected at four locations in each pond, using gill nets, angling, and electroshocking.

Chain pickerel were sampled as predators, yellow perch as foragers, and bullheads as bottom feeders. During actual sampling, four bullheads were the only bottom feeders collected in Ministers Pond. In the predator and bottom feeding levels, fillet concentrations were used to calculate human health risks, and whole fish concentrations were used to determine ecological risks. In the forager level, only whole fish samples were analyzed.

In water samples from Puffer Pond, arsenic, cadmium, and lead were detected at concentrations above the screening values. Concentrations of those metals were below the screening values in all of the background pond surface water samples. However, the maximum lead concentration in the Puffer Pond samples was only slightly higher than the maximum concentration detected in the background pond.

In sediment samples, arsenic concentrations exceeded the screening value in all Puffer Pond samples, whereas only one of the background samples exceeded the arsenic screening value. Concentrations of cadmium, lead, silver, and the pesticides DDD and DDE exceeded the respective screening values at approximately the same frequencies in samples from both ponds.

Mercury was not detected in surface water or sediment from either pond at concentrations above the laboratory method detection limits (0.2 ug/L and 0.1 ug/g, respectively).

Although mercury was not detected in surface water or sediment, it was detected in 14 of 24 fish from Puffer Pond and in 17 of 19 fish from Ministers Pond. Mercury exceeded the U.S. Food and Drug Administration (USFDA) action level (1.0 mg/kg) in only one fish (a yellow perch from Puffer Pond), at a concentration of 1.12 mg/kg. Concentrations of mercury, arsenic, chromium, and lead in Puffer Pond fish samples "were not statistically different from local background conditions" (E & E 1994).

E & E concluded that potential human health risks associated with eating fish from Puffer Pond are negligible and that potential ecological and human health risks are no greater than those posed by Ministers Pond or other similar ponds in the area. Despite low environmental concentrations, mercury is bioavailable to aquatic organisms. The fish are a primary food source for piscivorous wildlife and "may result in allowing the contaminants to magnify in the food chain as they are generally consumed whole" (E & E 1994).

Other Contaminant Issues

The USEPA designated the Fort Devens Sudbury Training Annex as a National Priorities List (NPL) Superfund site in 1990 based on environmental studies that had been conducted by the Army. Under USEPA and the Massachusetts Department of Environmental Protection oversight, the Army completed investigations and, where necessary, clean-up actions at 73 locations that were identified through record searches, interviews with past and current employees and field sampling results as being potentially contaminated. Facility-wide investigations of groundwater hydrology and quality, background soil contaminant concentrations and surface water and sediment quality were conducted. In addition, a site-wide investigation of potential arsenic contamination in soil, water, sediment, plants and soil invertebrates was completed USEPA 2000).

The 73 specific sites investigated included individual, abandoned empty drums, disturbed ground and vegetation, underground fuel storage tanks, demolition grounds, solvent and waste dumps, test clothing burial areas, refuse dumps, old gravel pits, chemical disposal sites, etc. The U.S. Army's Master Environmental Plan, revised and reissued in December 1995 provided a status report of Army actions on these sites (US Army 1995). The U.S. Environmental Protection Agency issued a Final Close Out Report for the 73 sites at the Fort Devens Sudbury Training Annex in September 2000 (USEPA 2000).

Of the 73 sites investigated on the Fort Devens Training Annex, USEPA and the State Department of Environmental Protection determined:

- 18 were classified No Contamination Found;
- 11 were classified No Contamination Found following an Enhanced Area Reconnaissance;

- 9 were classified as posing No Risk to humans or wildlife following Preliminary Risk Assessments;

- 5 were classified as having No Contamination Found following a Full Risk Assessment;

- 12 were classified as posing No Risk to humans or wildlife following a Full Risk Assessment;

- 16 sites were subjected to Removal Actions, with confirmatory sampling indicating there was no residual risk to humans or wildlife;

- 1 site was considered to be free of risk to humans and wildlife, but an additional set of testing results were to be evaluated for confirmation; and,

- 1 site (A7) was classified as No Further Action following construction of a full, lined and capped landfill at the site (A7). Long-term monitoring by the Army for groundwater quality, landfill cap integrity and site fencing condition is required at Site A7.

The USEPA Final Close Out Report is available at the refuge headquarters in Sudbury. USEPA and the State expect to propose formal de-listing of the property from the National Priority List Superfund Sites following review of the first 5-Year Review report for Site A7, a small, capped landfill in the northwest portion of the refuge, in 2001.

The Fish and Wildlife Service accepted the transfer of the Sudbury Training Annex subject to our complying with certain long-term Institutional Controls. These Institutional Controls were established by the Army and EPA in consultation with the State and the Service. They restrict the Service from conducting any actions that would impair the integrity of the landfill cap, liner, topography, etc. at Site A7, and from allowing the construction of residences within 50 feet of the center line of the former World War II era railroad beds and the former internal Army fence line/firebreak along what the Army called the Patrol Road.

According to the Bioaccumulation Study At Puffer Pond, mercury, zinc and DDT degradation products are present in fish tissue from Puffer Pond; however, the levels were generally below available regional and national background fish tissue levels. This report concluded that the site-related human health and ecological risks associated with the use of Puffer Pond are not likely to be greater than those associated with the use of any other local pond. Puffer Pond is listed in the Massachusetts Department of Public Health Freshwater Fish Consumption Advisory List for mercury hazard. The advisory states that “The general public should not consume any fish from this Water Body.”

Obstacle course removal. *The Friends of the Assabet River Refuge restore habitat on the refuge. Photo by Marijke Holtrop*

Physical Safety Hazards

Assabet River Refuge is currently closed to the public due to a number of unmitigated safety hazards. These include:

- 26 dilapidated buildings (all alternatives address building removal)
- at least 33 open, hand-dug farm wells that pre-date the Army
- some concertina wire
- some smooth communication wire in the woods

Most of the concertina wire, the bunkers, the large utility pole physical fitness obstacle course and others have all been removed by or with help from the Friends of the Assabet River Refuge We do not need to remove the bunkers as they are covered with vegetation and have blended into the habitat.

Biological Resources

Vegetation and Habitat Types

Service biologists completed a survey and evaluation of the habitat of portions of what then was still the Fort Devens Sudbury Training Annex in 1992 (USFWS 1995). Short duration site visits, wetland mapping produced by the Service's National Wetland Inventory team, forest cover mapping completed by the Fort Devens Natural Resource Management Office, aerial photographs and other existing data were used in the evaluation. The portion property south of Hudson Road, and most of the western and northwestern portions of the northern portion of the property were not closely examined in the Service's evaluation.

The report notes that aerial photos, extensive stone walls, successional second-growth forests, the presences of old cranberry bogs and discussions with knowledgeable people all document the fairly extensive farming history of the land prior to the Army's acquisition in the early 1940's. The presence of diverse wetland and upland habitat of high value to wildlife species was noted. Others have suggested that the diversity of habitat found on the refuge is due to the presence of highly varied topography, soils, drainage patterns, and the Army's ownership and management of the property over a 50 year time span.

Although only portions of what is now the refuge were evaluated, the report found 476 acres of wetland habitat (21%) of the 1647 acres evaluated. North of Hudson Road, approximately 291 acres (67%) were forested or mixed forested/shrub cover; 29 acres (7%) were

shrub dominated; 41 acres (9%) were shrub/emergent herbaceous cover; 62 acres (14%) were open water ponds; and 14 acres (3%) were former cranberry bogs. The report indicated the portion of the property south of Hudson Road contained approximately 39 acres of wetlands (~9% of the area). Approximately 87% of these wetlands were forested and the remainder was shrub-dominated wetland habitat.

The forested wetlands are dominated by red maple (*Acer rubrum*) with black ash (*Fraxinus niger*), swamp white oak (*Quercus bicolor*), and some eastern hemlock (*Tsuga canadensis*) and white pine (*Pinus strobus*) present. Understory shrubs included sweet pepperbush (*Clethra alnifolia*), swamp azalea (*Rhododendron viscosum*), European buckthorn (*Rhamnus frangula*), winterberry (*Ilex verticillata*), and maleberry (*Lyonia ligustrina*). At least one remnant Atlantic white cedar (*Chamaecyparis thyoides*) wetland was also noted.

Fall at Assabet River NWR. *USFWS Photo*

Shrub-dominated wetlands were characterized as including speckled alder (*Alnus serrulata*), silky dogwood (*Cornus ammomum*), gray stemmed dogwood (*Cornus racemosa*), elderberry (*Sambucus canadensis*) and black chokeberry (*Aronia melanocarpa*), buttonbush (*Cephalanthus occidentalis*), meadowsweet (*Spiraea latifolia*), steeplebush (*Spiraea tomentosa*), and others. Emergent wetland type vegetation included broadleaf cattail *(Typha latifolia L.)*, sedges *(Abildgaardia)*, blue-joint grass *(Hemarthria)*, boneset (*Tamaulipa*), joe-pye-weed *(Eupatorium)*, purple loosestrife, pickerel weed *(Pontederia cordata L.)*, arrowhead *(Sagittaria L.)*, smartweed *(Polygonum)*, spike rush *(Eleocharis. R. Br.)*, waterlily *(Nymphaea)*, and many submergent plants.

Though historically much of the area was logged for agriculture, a majority of the upland areas within the refuge have succeeded back to forest. Mixed white pine (*Pinus strobus*) and oak hardwoods dominate. Common hard woods included red maple, white oak (*Quercus alba*), red oak (*Quercus rubra*), quaking aspen (*Populus tremuloides*). Other frequently encountered species included birches, beeches, American elm (*Ulmus americana*), black cherry (*Prunus serotina* var. *serotina*), and shagbark hickory (*Carya ovata* var. *ovata*). The understory was commonly mixes of sassafras (*Sassafras albidum*), blueberries and dogwoods. The cleared fields that were once utilized as agricultural land are now in successional transition into forests. These meadows, shrub thickets and immature forests have the potential to provide food and cover to many species of migratory birds and other wildlife. Approximately 70% of the portions of the Army property surveyed were in forest at the time (USFWS 1995).

The former ammunition bunkers that were once employed as storage facilities had become well revegetated. The bunkers measuring approximately 75 feet long and 40 feet wide, are surrounded by dry, sandy, disturbed soils, which had good growth of cherry, white pine, oak, aspen, sweetfern, sedges, mosses and other plant species.

Approximately 3% of the Army lands included in the survey were primarily in native and introduced grasses, including approximately 30 acres at the Army Taylor Drop-Zone.

The Service's evaluation summarized the National Wetland Inventory mapping based on 1975-77 aerial photography, and an earlier forest cover type mapping done for the Fort Devens Natural Resource Management Office by Leupold Forestry Service using 1980 aerial photography. B.H. Keith Associates of Conway, NH prepared a wetland cover type map for all of the Sudbury Training Annex for the Fort Devens NRO in April, 1983 using 1980 aerial photography. However, the wetland classification scheme used by B.H. Keith does not conform with the National Wetland Inventory classifications, and it was not used for the Service's evaluation. See Table 3-2 for the 1647 acres the Service evaluated.

Table 3-2. *Cover Types and Acreage at Assabet*

Cover Type	Acreage	Percent
White Pine	191	12
White Pine - Hardwoods	123	7
White Pine-Oak	561	3
Oak Hardwoods	73	14
Mixed Oak	159	10
Cherry Hardwoods	11	<1
Red Maple-Ash	37	2
Grasses-Forbs	54	3
Developed	1	<1
Wetlands (total)	476	29
Forested, deciduous	179	11
Forested, mixed deciduous/conifer	68	4
Forested/Shrub, mixed	78	5
Shrub, Deciduous	33	2
Shrub/Emergent, Mixed	39	2
Emergent	3	<1
Open Water, Pond	5	<1
Open Water, Lake	57	3
Former Cranberry Bog	14	<1

In 1991, Anepteck Corporation completed an inventory of wildlife species and their habitats on portions of the Army's Sudbury Training Annex, which were in use by the Army's Natick Research, Development and Engineering Center, Natick, MA (Aneptek 1991). The Aneptek evaluation included the areas around the Army Family Housing on Bruen Road and the Taylor Drop Zone on the northern portion of what is now the refuge. The Family Housing area abuts the portion of the refuge located south of Hudson Road. Detailed inventories of the plant and animal communities found in these two areas are provided in the Aneptek report. Where species observations made at the Taylor Drop Zone have not been superceded by more recent or more encompassing evaluations, Aneptek's records are included in the Service's developing species lists for the Assabet River Refuge (Appendix F).

In 1992, Dr. David Hunt completed a very thorough survey of the plant communities found on the portions of the Training Annex located north of Hudson Road for the Fort Devens Natural Resource Management Office (Hunt, 1992). Habitats spanning the full range of elevations, slopes, and combination of the diverse mix of 34 soil types found on the area were surveyed. A total of 667 species (in 681 taxa) were identified with certainty; 72.4% of these were native plant species and 21.6% were characterized as being introduced. For the remaining 6% (41), Dr. Hunt believed 37 should be considered native and 4 introduced. Although not found during this survey, Hunt indicated an additional 99 plant species were likely to occur on what is now the northern portion of the refuge (USFWS 1995).

High plant diversity found on the property was attributed to the broad range of soil types and the mix of introduced species. Several dwarf shrub bogs, open canopied minerotrophic peatlands and areas of exposed sand, an Atlantic white cedar swamp, and a small sandy-bottom kettlehole pond were found to contain exceptionably high plant diversity.

Table 3-3. *Rare Plant Species at Assabet River Refuge*

Midland Sedge	*Carex mesochorea*	SE
Few Fruited Sedge	*Carex oligosperma*	ST
New England Blazing Star	*Liatris borealis*	SC
Philadelphia Panic-Grass	*Panicum philadelphicum var. philadelphicum*	SC
Small Beggar-Ticks	*Bidens discoidea*	WL
Lacegrass	*Eragrostis capillaris*	WL
Northern Starwort	*Stellaria calycantha*	WL

A total of 8 rare plant species were documented on the property, including a State-listed Endangered Species (SE), a State Threatened Species (ST), two species listed by the State as being of Special Concern (SC), and three State Watch List (WL) species and are shown in Table 3-3.

Special Concern species, a lady's tresses (*Spiranthes vernalis*) listed in the Aneptek report as occurring on the property, was not found by Hunt. Hunt found the more common lady tresses (*S. Cernua*) within the same location as the Aneptek record, and believed the earlier identification may have been incorrect.

Included in the species found by Hunt were an additional 34 species (26 native and 6 introduced), which he characterized as being uncommon in eastern Massachusetts.

Vernal Pools

Vernal pools are a priority habitat type within the State of Massachusetts. Several vernal pools have been identified on the Assabet River Refuge (Dineen 2001). Additional surveys to locate vernal pools were initiated in the Spring of 2001. Vernal pools are temporary freshwater depressions which hold spring rains and snowmelt waters, and then typically dry out during late summer. Vernal pools are critical breeding habitat for amphibian and invertebrate species due to the lack of predatory fish. The vernal pools of Assabet River Refuge are confirmed breeding habitat for the blue-spotted salamander (*Ambystoma laterale*), which is a State species of Special Concern, and spotted turtles (*Clemmys guttata*), have also been observed on the refuge (Meyer and Montemerlo, 1995).

Assabet River Refuge. *Photo by Marijke Holtrop*

Invasive or Overabundant Species

Hunt found that the number of exotic plant species was lower than expected, in part due to the undisturbed nature of the former Sudbury Training Annex. However, Hunt identified 19 species on the property that are included in a listing of "nonnative, invasive and potentially invasive plants in New England" prepared by Dr. Leslie J. Mehrhoff of the University of Connecticut (UCONN 2000). No surveys have been completed to determine the extent of occurrence for any of these species on the refuge (see Table 3-4).

Table 3-4. *Invasive Species at Assabet River Refuge*

Acer platanoides	Norway Maple
Cynanchum nigrum (L.) Pers.	Black Swallowwort
Berberis thunbergii DC.	Japanese Barberry
Catalpa speciosa (Warder ex Barney) Warder ex Engelm	Catawba Tree
Myosotis scorpioides L.	True Forget-Me-Not
Lonicera X bella Zabel	Bella Honeysuckle
Lonicera japonica Thunb.	Japanese Honeysuckle
Lonicera morrowii Gray	Morrow Honeysuckle
Celastrus orbiculata Thunb.	Asiatic Bittersweet
Centaurea maculosa Lam.	Spotted Knapweed
Phragmites australis (Cav.) Trin. ex Steud. (= *P. communis*)	Common Reed
Iris pseudacorus L.	Yellow Iris
Robinia pseudo-acacia L. var. *pseudo-acacia*	Black Locust
Polygonum cuspidatum Siebold & Zuccar.	Japanese Knotweed
Rumex acetosella L.	Sheep Sorrel
Lysimachia nummularia L.	Moneywort
Rhamnus frangula L.	European Buckthorn
Rosa multiflora Thunb.	Multiflora Rose
Ailanthus altissima (Mill.)	Swingle Tree-of-Heaven

Wildlife Resources

Migratory Birds

Comprehensive surveys for wintering, breeding, and migrating birds have not yet been completed on the refuge. However, refuge staff initiated breeding woodcock, breeding land-bird, and breeding marsh bird surveys in 2000. The latter two surveys are following protocols of Service region-wide studies. The American woodcock surveys also follow standardized protocols, but it is not currently a part of a region-wide study.

The Service Region 5 Landbird Breeding Survey conducted on Assabet River Refuge is similar to the National Breeding Bird Survey in which singing males are seen or heard at designated points along a route that traverses the refuge during the breeding season (May-July). This survey was initiated in the spring of 2000 and resulted in an initial species list of breeding land birds. The landbird survey is designed to continue for at least 5 years, at which time the data will be analyzed to determine the frequency at which the subsequent surveys need to be conducted to accurately monitor refuge populations.

The Service Region 5 Marshbird Callback Survey was conducted at the Assabet River Refuge for the first time in 2000. This survey follows a national protocol which will assist with the monitoring of marshbirds throughout the nation. The Marshbird Callback Survey specifically targets the secretive birds of wetlands that are generally missed during landbird surveys.

In addition, several other series of migratory bird inventories have been conducted on the refuge. Aneptek surveyed the areas at and around the Army's Capehart Family Housing Area and the Taylor Drop Zone two to three time per week in June and July, 1991. They identified a total of 54 species using the mix of habitat at the Drop Zone. Ron Lockwood, a volunteer master birder has conducted extensive observations on the refuge since 1999. The refuge supports one Federally protected species and four State-listed species (Table 3-5). Additional observations are continuing. For a complete list of migratory birds see Appendix F.

Table 3-5. *Federal and State-listed Species at Assabet River Refuge*

Haliaeetus leucocephalus	*Bald Eagle*	*FT-SE*	*Aneptek, 1991*
Accipiter striatus	*Sharp-shinned Hawk*	*SC*	*Lockwood 1999*
Accipiter cooperii	*Cooper's Hawk*	*SC*	*Lockwood 1999*
Dendroica striata	*Blackpoll Warbler*	*SC*	*Lockwood 1999*
Parula americana	*Northern Parula*	*ST*	*Lockwood 1999 & 2000*

Mammals

Comprehensive surveys for mammal species have not yet been conducted on the refuge. However, two surveys have been completed on portions of the refuge. Aneptek, 1991, inventoried the Taylor Drop Zone and nearby habitat, identifying mammals by sight, vocalization, track and scat through the months of June and July, 1991. A number of pitfall traps and two overnight 15-set Sherman trap transects across a variety of habitats at the Drop Zone were also run. A total of 14 mammalian species were recorded from this portion of what is now the refuge. Thomas, 1992, surveyed small mammal species at seven locations on the Sudbury Training Annex from April 14 to December 10, 1992. Meyer and Montemerlo, 1995, recorded mammals from the portion of the former Sudbury Training Annex south of Hudson Road in June and July, 1995. Additional observations have been recorded by refuge personnel over the years. Twenty five mammalian species have been recorded on the refuge to date (Appendix F).

Species concentrated within the early successional open-land areas include northern short-tailed shrews (*Blarina brevicauda*), meadow voles (*Microtus pennsylvanicus*), and meadow jumping mice (*Zapus hudsonius*). Forested lands are likely to support such species as eastern gray squirrels (*Sciurus carolinensis*), red squirrels (*Tamiasciurus hudsonicus*), white-footed mice (*Peromyscus leucopus*), southern red-backed voles (*Clethrionomys gapperi*), porcupine (*Erethizon dorsatum*) and fisher (*Martes pennanti*). Other species whom occupy a variety of habitat types include white-tailed deer (*Odocoileus virginianus*), coyote (*Canis latrans*), red fox (*Vulpes vulpes*), raccoon (*Procyon lotor*), eastern cottontail (*Sylvilagus floridanus*), woodchuck (*Marmota monax*), eastern chipmunk (*Tamias striatus*), striped skunk (*Mephitis mephitis*), several species of moles and bats. Other species present include flying squirrels (*Glaucomys volens*), bobcat (*Lynx rufus*), beaver (*Castor canadensis*), moose (*Alces alces*) and mink (*Mustela vison*).

Reptiles and Amphibians

Comprehensive surveys of amphibians and reptiles have not yet been completed at the refuge. However, the refuge staff initiated an annual call-count survey for anuran species (frogs and toads) in 2000. The survey is part of a standardized study being conducted on several refuges in the Service's Northeast Region. The survey is planned to continue to detect population changes.

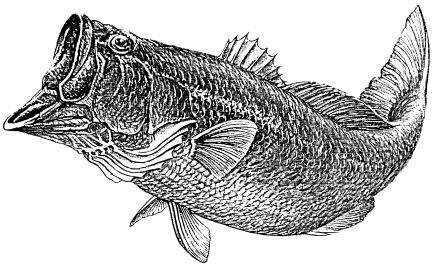
Aneptek, 1991 inventoried amphibians and reptiles within the habitats surrounding the former Taylor Drop Zone on what is now the northern portion of the refuge during June and July of that year. Three reptilian and seven amphibian species were recorded during their surveys. In addition, Meyer and Montemerlo, 1995, surveyed the portion of the refuge south of Hudson Road for amphibian and reptilian species in June and July of that year.

A complete listing of species recorded to date is included in Appendix F. One State-listed amphibian, the Blue Spotted Salamander, and three State-listed reptilian species, one of which is State Threatened, have been reported from the refuge to date. Table 3-6 identifies these State-listed species.

Table 3-6. *State-listed Amphibians and Reptiles at Assabet River Refuge*

Ambystoma laterale	Blue spotted salamander	*SC*
Clemmys guttata	Spotted turtle	*SC*
Terrapene carolina	Eastern box turtle	*SC*
Emys blandingii	Blanding's Turtle	*ST*

Fisheries

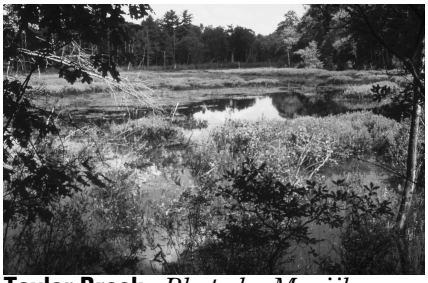


Largemouth bass. *Illustration by Creative ReSources*

The aquatic resources at Assabet River Refuge include the Assabet River, Taylor Brook, Puffer Pond, Willis Pond, Cutting Pond and several other smaller ponds. Approximately one mile of the Assabet River parallels the northwestern boundary of the refuge, although there is a strip of privately owned land between the refuge boundary and the river's edge. Elizabeth Brook is the largest tributary of the Assabet River (Stow 1997), and flows into the Assabet on the opposite bank from the refuge.

The Assabet is characterized by a warmwater fishery in the section below and above the stretch along the refuge. According to the State of Massachusetts Division of Fisheries and Wildlife survey done in July 1997, water temperatures of the Assabet River in the Towns of Maynard, Stow and Acton ranged from 25 ^{o} to 27.2 ^{o} C. Bottom type consisted of gravel, rubble and boulder with some silt and sand in the pools. Gamefish species captured during the State of Massachusetts 1997 survey included largemouth bass (Micropterus *salmonoides*) and chain pickerel (*Esox niger*). Other fish documented included yellow perch (*Perca flavecens*), pumpkinseed, bluegill (*Lepomis macrochirus*), redbreast sunfish, black crappie (*Pomoxis nigromaculatus*), white sucker, golden shiner (*Notemigonus crysoleucas*), fallfish, creek chubsucker, yellow and brown bullhead (*Ictalurus nebulosus*) and American eel. See Appendix F for a complete fish species. Fishing in the Assabet River is regulated by the State of Massachusetts Fish and Wildlife Laws. The Massachusetts Department of Public Health fish consumption advisory for this river is the statewide advisory "for pregnant women not to consume fish caught in freshwater due to elevated levels of mercury in fish flesh" (MDFW 1999).

Puffer Pond is a natural pond, most likely of glacial origin. It is approximately 30 acres (OHM 1994), and lies wholly within the refuge boundary. The northern end of the pond is bounded by a scrub/shrub emergent wetland, with the remainder undeveloped and forested. It is a warmwater pond with a maximum depth of approximately 2.5 to 3 meters (OHM 1994) Taylor Brook is the outlet of Puffer Pond and flows into the Assabet River. Aquatic vegetation consists of yellow water lily (*Nuphor varigatum*), coontail



Taylor Brook. *Photo by Marijke Holtrop*

(*Ceratophyllum spp.*), anacharis (*Elodea spp.*) and cattails (*Typha latifolia*). The pond bottom consists of sandy/silt muck containing coarse organic particulate matter along the shoreline, grading to a more silty muck towards the central, deeper portions of the pond (OHM 1994).

Fish species found in Puffer Pond include chain pickerel , yellow perch, brown bullhead, largemouth bass, golden shiner and black crappie , and bluegill (OHM 1994). A listing of fish species found in the Assabet River and on the refuge is provided in Appendix F. All the fish caught during the 1994 Bioaccumulation Study generally appeared in good health and were relatively abundant due to the high quality habitat found in the pond. Relatively large numbers of forage fish were found in Puffer Pond (OHM 1994).

A portion of the northern shoreline of Willis Pond is on the refuge boundary. Willis Pond is approximately 68 acres (Ackerman 1989. It is shallow, averaging around five feet deep. Fish species found in Willis pond include sunfish (*Enneacanthus obesus*), largemouth bass, rock bass (*Amblophites rupestris)*, yellow perch and chain pickerel (Cutting 2000). There is a report of smallmouth bass being caught from Willis Pond (Ackerman 1989).

Cutting Pond is privately owned; however, its western edge borders the Assabet River Refuge. It is under twenty acres, and averages approximately three feet deep, although there are some springs in the pond (Cutting 2000). Cutting Pond is man-made, and has no public access. Yellow perch, largemouth bass, chain pickerel, and sunfish inhabit the pond according to the owner, Mr. John Cutting.

Invertebrates

Comprehensive surveys for invertebrate species across the entire refuge have not yet been conducted. Aneptek, 1991, surveyed the Taylor Drop Zone and its surrounding habitat in June and July of that year for invertebrate species. One hundred and ten taxa of annelids, mollusks, crustaceans, arthropods, and insects. Identification was made to the family and, in some cases, to the genus level.

Mello and Peters, 1992, completed a survey of the lepidoptera in portions of what is now the northern portion of Assabet River Refuge (efforts were concentrated in the areas bordering Willis Pond and along Puffer Road, and included both deciduous upland habitat and the edges of a small wet meadow draining into Taylor Brook. Eighty five species of moths were recorded. No State-listed species were documented. The fact that night-light traps were not used and cool weather encountered during the survey period may have reduced the number of species observed (Mello and Peters 1992). Additional surveys were recommended, particularly within the Atlantic white cedar swamp area.

Threatened and Endangered Species

With the exception of occasional (most likely wintering) bald eagles, no Federally listed threatened or endangered species are currently known from the Assabet River Refuge. A small number of New England Blazing Stars (a Federal Candidate Species in 1992) were recorded in 1992, but were not found by the New England Wildflower Society during a 1999 re-survey for the Massachusetts Natural Heritage and Endangered Species Program.

Although surveys of the refuge are far from complete, 8 State-listed plant species, 5 State-listed birds, and 4 State-listed amphibian and reptilian species have been recorded to date (See Table 3-3, 3-5 and 3-6).

Special Designations

Assabet River Refuge is included in the Sudbury-Assabet-Concord Inland River priority for protection Focus Area under the North American Waterfowl Management Plan (NAWMP). The refuge area is also included within the Emergency Wetlands Resources Act of 1986 and is included in the U.S. Environmental Protection Agency's Priority Wetlands of New England listing (1987). The refuge is identified as being High Biodiversity Focus Areas in the SuAsCo Watershed Biodiversity Protection and Stewardship Plan (Clark 2000).

Assabet River Refuge has been nominated as a Massachusetts Important Bird Area (IBA) for its rare and unique habitat communities, including: Atlantic white cedar swamp, a kettlehole pond, several dwarf shrub bogs, open canopy minerotrophic peatlands, and other sand communities. IBAs provide essential habitat for at least one or more species of breeding, wintering or migrating birds. The primary goals of the program are listed below.

- "To identify, nominate and designate key sites that contribute to the preservation of significant bird populations or communities.
- To provide information that will help land managers evaluate areas for habitat management or land acquisition.
- To activate public and private participation in bird conservation efforts.
- To provide education and community outreach opportunities."

(http://www.massaudubon.org/Birds_&_Beyond/IBA/iba_intro.html) These lands, along with other nominated areas, will be declared officially designated or rejected sometime this year.

Cultural Resources

Prehistoric Period

The refuge is located within the southern Merrimack River Basin. The earliest settlement/land use pattern in this basin during the Paleoindian period were most likely a widely spaced network of site locations within a very large territory. By 7,500 to 6,000 years ago

(Middle Archaic) populations were beginning to restrict settlement activities that appear to correspond with the boundaries of the larger drainages within the Merrimack basin (Gallagher et. al. 1986). Perhaps due to an increase in population, or changes in natural resource distribution, a maximum concentration of settlement patterns within defined territories occurred between about 4,500 and 3,000 years ago (Late Archaic). A general period of environmental stress that affected the entire region occurred after 3,000 years ago (Terminal Archaic and Early Woodland), had a profound affect on land use activities during that time. A noticeable restructuring of earlier settlement patterns during the period of 3,000 to 2,000 B.P. (Before present), is due to this event. Interior, upland environments appear to be less populated, perhaps because people may have been utilizing coastal resources more intensely (Gallagher et. al. 1986).

Towards the end of the prehistoric period, it appears that interior river drainages and some upland settings were a vital part of settlement patterns by 1,600 to 1,000 years ago (Woodland period). A return to well defined river basin territories and the final episode of the prehistoric period seems to have taken place, although settlement patterns within interior section of the Merrimack basin remain unclear (Gallagher et. al. 1986). The move back into the interior sections may be the result of introduction of agriculture and the suitability of the inland soil to sustain the new subsistence mode.

Remnants from the Past. *USFWS Photo*

Within the Assabet River Refuge, there are a variety of environmental zones that represent areas of both high an low natural resource potential. Puffer Pond and the complex of streams and wetlands associated with it is the most clear general zone of high natural resource potential (Hudson 1889; Ritchie 1980; Hoffman 1983). This pond along with Willis Pond, is one of the few natural lakes or ponds in the western portion of the town of Sudbury (Gallagher et. al. 1986). It is directly connected to the Assabet River by Taylor Brook. Large areas of marsh and wooded wetlands extending the entire length of Taylor Brook form the out at the north end of Puffer Pond to the confluence with the Assabet River, would have been excellent habitat for a variety of waterfowl, fur-bearing mammals, and other species exploited by Native Americans.

The central portion of the refuge contains several large areas of wooded wetlands covering several hundred acres. These wetlands would have provided seasonally concentrated natural resources suitable to winter camps for humans. One prehistoric site has been located in the central wetland portion of the refuge, and with further testing, several more would likely be found.

The elevated, rocky hills within the refuge would have provided another type of environment for humans to utilize. These area would have sustained deciduous forest which would have provided habitat for deer, bear, raccoon and bobcat, as well as acorns, chestnuts and hickory nuts. Five prehistoric sites have been identified through limited archaeological testing (Gallagher et. al. 1986). Most likely more sites located in this environment representing all the major time periods within Native American history would be identified.

Assabet Refuge offers a wide variety of environmental zones ideal for Native American settlement throughout history. This area was a cultural focus of the Merrimack River basin. The limited archaeological studies completed, have revealed prehistoric archaeological sites in all of the various refuge environments (Gallagher et. al. 1986). The refuge should be considered highly sensitive for such cultural resources. The refuge has the potential to contribute information that is significant in understanding Native American settlement patterns and environmental uses for this region of Massachusetts.

Historic Period

Europeans began to settle the refuge area around 1650. In the beginning, there were conflicts with the existing Native American groups. These groups had been decimated by diseases and were beginning to become concentrated in Christian Indian settlements. All English settlements were affected by King Philip's War in 1675, but after the War, with Native American nations losing political strength, the English were able to develop and settle the refuge area (Gallagher et. al. 1986).

The people that settled in the refuge area, primarily were involved with farming activities. The community was mostly self sufficient and provided goods, such as grain, to Boston, which served as a core town for this region. By 1750, the settlement pattern of the refuge area was influenced by increasing development. The towns that lie within the refuge, supplied Boston with timber and agricultural products. After the Revolutionary War, trade networks expanded on an international scale, local centers began to acquire more economic strength (Gallagher et. al. 1986).

During the 19th century, mills developed which provided economic opportunities for immigrants. One of the largest mills in the area was American Woolen Company. This company became the largest wool manufacturer in the region until the end of World War I. Agriculture was also still thriving in this region (Gallagher et. al. 1986).

Within the boundaries of the refuge, many farms and residences were built since the early 19th century. Some, such as the Rice/Vose Tavern and Puffer House, were 17th and 18th century in origin. The number of structures remained stable throughout the 19th century, with a settlement pattern oriented toward the few roadways that traversed the refuge. These roadways linked the homes to local and regional cores, and served as the sole transportation network in the peripheral economic zone of the region. Land use within the refuge was almost exclusively agricultural and pastoral, with some tracts of woodland. By the early 20th century, many of the older farms were acquired and new houses were constructed by Finnish immigrants until 1942, when the military acquired the property (Gallagher et. al. 1986).

With the help of Paul Boothroyd of the Maynard Historical Commission, the Service has been able to acquire information about some of the structures once located on the refuge. One of the most historically significant structures is the Rice/Vose Tavern which was constructed in the early 17th century. During the Revolutionary War, Captain Joshua Berry of Portsmouth, New Hampshire and his wagon train of ammunition and supplies, stayed at the Tavern on the way to New York State. The Tavern also served as the community meeting hall. It was in full operation until 1815. The Army dismantled the Tavern at an unknown date, but the foundation remains (Boothroyd, personal communication).

Several of the houses that were located on the refuge in the earlier part of the 20th century that were demolished by the Army, were associated with farming activities. The Hill farm consisted of two homes that were demolished by the Army. More research is needed to establish when the homes were built, however, the homestead encompassed about 109 acres. The Lent farm, located along Honey Brook was associated with a saw mill and a summer camp. This property contained about 92 acres. The Sarvela Farm, also known as the Haynes place, earlier belonged to a Puffer and was known as an old farm. This farm, located both in Stow and Maynard, contained about 43 acres (Boothroyd personal communication).

The two major roads going through the refuge, Puffer and New Lancaster Road, date back to early colonial times and predate the Great Road. Also, there are two cranberry bogs, one belonging to the Luarila and the other the Huikari farms. The bogs are associated with 19th century agriculture and landscape use (Boothroyd personal communication).

The Paananen Farm, originally owned by the Hendrickson Family, contains the foundation remains of the barn, silo and two wells. The Olila Farm was close to Puffer Rd. Early Colonial history suggests that there may be small pox graves south of the Rice tavern on this property. The Matson Farm was on the corner of Davis Lane. The Matson's are said to have worked at Maynard Mills. The Nelson Farm was a dairy farm with a mill house, greenhouse, and was a very old farm; In the 1850's it was a girls private boarding school run by Miss Hannah Blanchard Wood, youngest daughter of Dr. Jonathan Wood. At that time, the farm was owned by her sister married to Henry Brooks (Boothroyd, personal communication).

Assabet River Refuge provides a good opportunity to analyze early American farmsteads. Because the military allowed the land to regenerate after they acquired the property, soils have remained intact in areas that were not disturbed by military training. There are both prehistoric and historic resources that have the potential to add to our understanding of human history in this area. Further research is necessary to understand a comprehensive history of the refuge. The refuge has the potential to yeild significant information about land use history and cultural landscapes for this part of Massachusetts because of the proximity to Boston and lack of modern development.

Before the military acquired the refuge area, lots were also beginning to be developed as vacation homes next to Puffer Pond. Many of these lots were not yet developed at the time of the purchase. While occupied by the military, the land was used in several ways which included the construction of weapons storage areas, an elaborate railroad construction to transport ammunition between the weapons bunkers and Boston, weapons training areas, chemical testing areas, and other military activities. At times, portions of the Sudbury Annex (the refuge property) were leased out to private companies to develop items that would be useful to the military. The military also allowed the land to regenerate itself from pasture and farm land (Gallagher et. al. 1986). Most of the old farmstead houses were demolished by the military and the most of the fields were allowed to revert through natural succession to forest.

The Army's historic uses of the land area formerly known as the Sudbury Training Annex have been researched by the U.S. Army Environmental Center, and its contractors (U.S. Army 1995). The information was collected through various record searches, interviews, and map reviews. A summary of that information is presented in this section; a fuller description of the Army's land-use history is provided in the U.S. Army's 1995 Draft Master Environmental Plan, Fort Devens Sudbury Training Annex, Middlesex County, Massachusetts. (Prepared by ABB Environmental Service, Inc., Portland, ME for the U.S. Army Environmental Center, Aberdeen, Md. December, 1995.)

Prior to the formal formation of the Annex as a military facility in 1942, the land was privately owned and primarily used as farmland. According to a Goldberg Zoino and Associates (GZA) report some of the land "was owned by industrial companies (such as the Diamond Match Company or Maynard Woolen Mills)." The Annex itself consisted of land falling within the boundaries of the towns of Sudbury, Maynard, Marlboro, Hudson and Stow (GZA 1991).

The Annex became Government property in 1942, when a formal petition was filed by the United States to acquire the land by eminent domain (District Court of United States for District of Massachusetts, Misc. Civil No. 6507, March 25, 1942). The location was selected for strategic reasons -- it was well out of range of naval guns - and for its close proximity to four active railroad lines. On August 16, 1942, the area was designated Boston Back Up Storage Facility under the Commanding General of Boston Port of Embarkation. Transfer of the then 3,100-acre property occurred on November 10, 1942 (U.S. Army 1995).

The Annex was originally used to store surplus ammunition for the war effort. It was named the Maynard Ammunition Backup Storage Point (MABSP). Initially, the Annex served as part of the Boston Port of Embarkation system, and was specifically tied to Castle Island Port, the loading point for ammunition being transported overseas. When ships were not available for loading, or a surplus of ammunition had been received, ordnance would be stored at the

MABSP. Provision for the safe storage of ordnance was ensured by the construction of 50 earth-covered concrete bunkers located around the central section of the Annex. Railroad spurs were developed to provide access between bunkers and the existing main railroad lines (U.S. Army 1995).

In 1946, the facility became part of Watertown Arsenal and was referred to as Watertown Arsenal (Maynard). The facility was apparently used as a storage depot until 1950, when it was transferred to the First Army and became a subinstallation of Fort Devens from 1950 to 1952 for storage and training. In 1952, the facility was again transferred from Fort Devens management to the Chief of Ordnance, renamed the Maynard Ordnance Test Station (MOTS) and maintained that name through at least 1957. The principal use of the Annex from 1952 to 1957 was for Ordnance Research and Development activities (U.S. Army 1995).

In 1958, control of the Annex was transferred to the Quartermaster Research and Engineering Center at Natick; and while troop training activities continued, the Annex was now also available for field testing of experiments developed by the laboratories at Natick. Other agencies and or operators also were granted permission to use the Annex for a variety of activities, primarily related to materials testing and personnel training. The Capehart Family Housing Area was established by Natick Laboratories in 1962 for its employees. The designation for the Quartermaster Research and Engineering Center was changed to Natick Laboratories in 1962 and to United States Army Natick Research and Development Command (NARADCOM) in 1976, but the same group maintained overall control of the Annex until 1982 (U.S. Army 1995).

Custody of the entire Annex was transferred back to Fort Devens in 1982. (Fort Devens is located some 15 miles to the northwest of the Annex). Until the end of 1994, the mission of Fort Devens was to command and train its assigned duty units and to support the U.S. Army Security Agency Training Center and School, U.S. Army Reserves, Massachusetts National Guard, Reserve Officer Training Programs, and Air Defense sites in New England. The Annex was used primarily for personnel training activities for active duty Army units, for the Army Reserve, as well as for the Army and Air National Guard troops.

The Base Closure and Realignment Act of 1990 (Public Law 101-510), and the subsequent decisions by the BRAC-1991 Commission and Congress required the closure and realignment of Fort Devens. The Army realignment action created the Devens Reserve Forces Training Area for use by Army Reserve and National Guard forces. The Sudbury Training Annex remained under the management of the Devens Reserve Forces Training Area while environmental investigations and remediation were being completed. On September 28, 2000, management of approximately 2230 acres of the property transferred to the U.S. Fish and Wildlife Service for the formation of the Assabet River National Wildlife Refuge. At the time of the transfer of management to the Fish and Wildlife Service,

the Sudbury Training Annex, exclusive of the Capehart Family Housing Area under the control of the Natick Research and Development Center, was approximately 2305 acres in size. The Army at the Devens Reserve Forces Training Center retained administrative responsibility for approximately 75.67 acres, of which 71.5+/- acres are planned to be transferred to the Federal Emergency Management Agency and 4.15+/- acres to the U.S. Air Force.

Socio-Economic Resources

The group of towns in which the refuge is located is known as the Metro West section of Greater Metropolitan Boston.

Population and Demographic Conditions

Population trends vary considerably among the neighboring cities and towns of Maynard, Sudbury, Hudson and Stow (U.S. Census Bureau 2001). Overall population levels in the four towns increased from 47,244 to 51,289 (an 8.6% percent increase) between 1990 and 2000. The majority of this increase occurred in Sudbury. The population of Sudbury increased from 14,358 to 16,841 (a 17.3% increase). Maynard's population increased from 10,325 to 10,433 (1%), Stow's increased from 5,328 to 5,902 (10.8%), and Hudson's increased from 17,233 to 18,113 (5.1%) (U.S. Census 2001).

The Boston-Worcester-Lawrence Metropolitan Area population increased by 363, 697 people or 6.7% to a total of 5,819,100 in 2000. The Greater Worcester Metropolitan Area grew by 33,005 people (nearly a 7% increase) to a population of 511,389 in the year 2000 (U.S. Census 2001). A more detailed set of the most recent available U.S. Census (1990) demographic descriptors for Hudson, Maynard and Sudbury is provided at the U.S. Census Bureau's web site for the Census 2000 Data: http://factfinder.census.gov (comparable data for Stow was not available).

Adjacent Communities and Land Uses

Stow, Maynard, Hudson and Sudbury have zoned the refuge what is the equivalent of open-space/conservation. With the exception of the Massachusetts Fire Fighter Training Academy and a nursery, land use surrounding the refuge is nearly entirely low-density residential.

Schools

Maynard

Maynard operates three public schools: an elementary school, a middle/junior high school and a high school, with a total enrollment of 1504 students in the 2000-2001 school year (MDOE 2001).

Sudbury

Sudbury operates five schools: four elementary and a middle/junior high school, with an enrollment of 2,786 students. The Lincoln-Sudbury High School currently has an enrollment of 1173 students (MDOE 2001).

Hudson

There are six public schools operated by Hudson: four elementary, a middle/junior high school, and a high school, with a total enrollment of 2752 students (MDOE 2001).

Stow

Stow participates in the Nashoba School System, which operates seven schools: four elementary, two middle/junior high schools, and a high school. Total enrollment is 2932 students (MDOE 2001).

Part 2: Great Meadows National Wildlife Refuge

Physical Resources

Location/Role

Great Meadows National Wildlife Refuge is located in east-central Massachusetts, approximately 20 miles west of Boston, in the historic towns of Concord, Sudbury, Bedford, Billerica, Lincoln, Carlisle, Wayland and Framingham. The refuge comprises two divisions: lands south of State Route 117 compose the Sudbury Division; lands north of State Route 117 compose the Concord Division. The Refuge contains 3,620 acres, and stretches 12 miles from State Route 4 in Billerica to the Framingham/Wayland town line.

The refuge was established in 1944 as "an inviolate sanctuary, or for any other management purpose, for migratory birds" (Migratory Bird Conservation Act, 16 U.S.C. §715d); and as "suitable for (1) incidental fish and wildlife-oriented recreational development, (2) the protection of natural resources, (3) the conservation of endangered species or threatened species…" (Refuge Recreation Act, 16 U.S.C. §460k-1).

The biological resources of the refuge are valuable to both resident and migrant wildlife. The refuge lies in the Atlantic Flyway and, as a stopover site for migrating birds, provides vital habitat and food. Species seen there during migration include green-winged teal (*Anas crecca*), least sandpiper (*Calidris minutilla*), marsh wren (*Cistothorus palustris*), swamp sparrow (*Melospiza georgiana*), and the willow flycatcher (*Empidonax traillii*). Several upland locations provide habitat for the American woodcock (*Scolopax minor*) and the Eastern bluebird (*Sialia sialis*).

The refuge also serves as an outdoor classroom for thousands of local schoolchildren, and offers numerous programs for visitors. It hosts an annual Bluebird Day, featuring a slide show about bluebirds, wildlife observation walks, opportunities for visitors to build and take home a bluebird nesting box, annual American woodcock walks, orienteering programs, and annual owl prowls.

Climate

The average annual temperature is 51°F. The average monthly temperature in January is 29°F; in July, 74°F. During the growing season, which spans about 225 days, the average temperature is 43°F or higher. Average annual precipitation is 41.76 inches, fairly evenly distributed throughout the year, with slightly more in November and December and less in July (http:\\www.nws.gov/er/box/climate/pcpnbos.html).

Geology, Topography, Soils, and Hydrology

Geology

Evidence of glaciation in this area is readily observable. The Wisconsin glacier (12,000 B.P.) deposited sediment and other materials that shaped the local landscape and, in many ways, have directed this area's development. Eighty percent of the refuge terrain is floodplain along the Concord and Sudbury Rivers (McAdow 1990).

Topography

The topography of the refuge is generally flat with some gently sloping hills, shallow streams, and depressional ponds and wetlands. While elevations on the refuge range up to 60 feet above mean sea level, the overall elevation change is barely perceptible across this area. For example, the Sudbury River drops an average of only one inch per mile (1 foot in 12 miles) in passing through the refuge (McAdow 1990).

Soils

Refuge soils along the rivers are primarily loams: Rippowam fine sandy loam and Saco mucky silt loam. Other soils found along the rivers include Limerick silt loam with a 0%–3% slope, and Hinckley loamy sand with slopes of 0%–3% and 3%–8%. The soil of Ponds 1 and 2 on the refuge (the Concord impoundments) is Freetown muck. Saco mucky silt loam composes the soils of the Rice's Barn parcel in Sudbury.

Several refuge parcels have upland soils: the O'Rourke parcel in Carlisle; the Cook, Strand, and Wolbach properties in Sudbury; and the Lombard parcel in Wayland.

- The soils on the O'Rourke parcel include Hinckley loamy sand with slopes of 3%–8% and 15%–25%, Windsor loamy sand with slopes of 0%–3% and 3%–8%, Deerfield loamy sand with a 3%–8% slope, Wareham loamy sand with a slope of 0%–5%, and Freetown muck.

- At the Cook parcel in Sudbury, the primary soil is Wareham loamy sand with a slope of 0%–5%.

- The Strand property is comprised primarily of Freetown muck, ponded, Hinckley loamy sand with a slope of 15%–25%, Tisbury silt loam with a slope of 3%–8%, and Scio very fine sandy loam with a slope of 0%–3%.

- The Wolbach property soils are Rock outcrop-Hollis complex and Hollis Rock outcrop-Charlton complex with a 3%–5% slope.

- The Lombard property in Wayland consists of Merrimac-Urban land complex with slopes of 0%–8% (USDA 1995 a).

Hydrology

The SuAsCo river basin (Sudbury, Assabet, and Concord Rivers) encompasses 371 square miles of land and 88.1 river miles, from Billerica in the north to Westborough and Hopkinton in the south. These three rivers and their associated tributaries drain their basin into the Merrimack River in Lowell.

The Sudbury River is 41 miles long, and drains 169 square miles. It begins in Cedar Swamp Pond in Westborough, flows eastward to Framingham, then flows north through the towns of Sudbury, Wayland, Lincoln, and into Concord. The Sudbury River has three distinct sections. Its first section, upstream of Framingham, is a narrow, rapidly flowing stream. The second section consists of two large impoundments. One of those impoundments is part of the Metropolitan District Commission water supply. The Colonna Dam in Saxonville (Framingham) creates the other impoundment. The third section of the river is, perhaps, the most unique. As it flows through the refuge, this 12-mile section of the Sudbury River changes elevation by only 1 foot, and has been compared to an elongated lake.

The Assabet River is 31 miles long, and drains 175 square miles. It starts in Westborough, and flows northeast through the urban centers of Northborough, Hudson, Maynard, and Concord. Between these suburbanized centers lie rural and undeveloped watersheds. The repeating discharge of a sewage treatment plant characterizes the Assabet River. Its impoundments are highly eutrophic in summer, containing large amounts of aquatic growth, particularly algal blooms.

Concord impoundments. *Thousands of visitors come to see the birds that use these waters. USFWS Photo*

The Concord River is 15.8 miles long, and drains 27 square miles. It forms at the confluence of the Assabet and Sudbury Rivers in Concord, flows north through the towns of Carlisle, Bedford, Billerica, and then enters the Merrimack River in the city of Lowell. The Concord River retains the slow-moving characteristics of the third section (above) of the Sudbury River.

Surface waters on the refuge are either riverine or ponded. The three rivers primarily affect refuge habitats. The Concord River drains the Concord Division. The Sudbury River and a few unnamed tributaries drain the Sudbury Division.

Ponded waters include the Concord impoundments (Ponds 1 and 2), and the Strand and Headquarters Ponds in Sudbury. We have managed the Concord impoundments primarily as stable water bodies since the mid-1970's. Those stable water conditions in both impoundments have contributed to several problems that now require attention: an infestation of water chestnut in both impoundments, and reduction in the diversity of wetland plants and birds.

Air and Water Quality

Air Quality

Air Quality Reports from 1999 and 1998 contain the most recent data available from the Massachusetts Department of Environmental Protection, Air Assessment Branch. We have included here data for three sites. The Sudbury site, which operated from 1980 until 1998, lies on refuge land; the Stow and Waltham sites are near refuge lands.

The reports contain data for several different pollutants: ozone (O_3); sulfur dioxide (SO_2); and particulate matter [10 microns (PM_{10})]. Data for ozone are available from all three sites; sulfur dioxide data are available from Waltham only; particulate matter data are from Sudbury only. Massachusetts levels for both SO_2 and PM_{10} are below the EPA standards for these pollutants.

There are two ozone standards based on two different averaging times, 1-hour and 8-hour. In 1999, there were 85 exceedances of the 8-hour standard occurring on 22 days, and 5 exceedances of the 1-hour standard occurring on 4 days on a State-wide basis. A total of sixteen 8-hour exceedances were recorded in 1998 at those three sites: Sudbury experienced four, Stow experienced five, and Waltham experienced seven. The 12 year trends for ozone readings in the State have been generally decreasing toward better quality since 1988.

Massachusetts has made significant progress in attaining the CO standard by implementing air pollution control programs. The last violation of the CO NAAQS occurred in Boston in 1986. The Boston metropolitan area was redesignated to attainment of the CO federal air quality standard by the USEPA in 1996. Lowell, Springfield, Waltham, and Worcester remain in non-attainment of the CO standard. MADEP is currently preparing a request to the USEPA to redesignate these areas to attainment for CO because monitoring data has been below the standard for many years. The redesignation request, which includes technical support and a maintenance plan, will be subject to public review and comment prior to being submitted to the USEPA.

The Concord River and Impoundments.
USFWS Photo

In recent years there has been concern regarding the aerial deposition of mercury from atmospheric sources outside the northeast region (see for example Sweet and Prestbo 1999). Researchers have speculated that this may be the source of mercury levels found in some species and age-classes of fish in New England above the 1 part per million standard established by the U.S. Food and Drug Administration.

The annual average concentration of Pb in the air decreased substantially since 1985 from more than 300 ug/m^3 to less than 0.05 ug/m^3 (the annual average NAAQS for lead is 1.5 ug/m^3). Massachusetts is well below the standard. This result is attributed

to the use of unleaded gasoline in motor vehicles, which are the primary source of airborne lead emissions (MADEP 2000). While air quality concentrations of lead have dramatically decreased, there may still be concern regarding residual lead levels in soils along heavily traveled roadways deposited prior to the change to unleaded gasoline usage.

Water Quality

The SuAsCo river basin is one of the fastest-growing areas of the State; consequently, water quality has suffered. The primary water quality classification for both the Sudbury and Assabet Rivers is Class B, Warm Water Fishery. The primary water quality classification for the portion of the Concord River in the refuge is Class B, Warm Water Fishery, Treated Water Supply (MEOEA 1996).

Point sources of pollution heavily impact water quality in the Sudbury River: one wastewater treatment plant; the contamination from both the Nyanza Superfund site and the Raytheon Brook site; and, the Marlborough Easterly Wastewater Treatment Plant, which discharges into the Sudbury River via Hop Brook (MEOEA 1996). The town of Hopkinton proposes to build a wastewater treatment plant as well (Nancy Bryant, SuAsCo Watershed Community Council, pers. comm). We have provided specific information about the contamination from the Nyanza Superfund site and the Raytheon Brook site in "Contaminants," below. Non-point sources also pollute the Sudbury River. Those include pesticides, fertilizers, and storm water and parking lot runoff.

The Assabet River is the one most heavily impacted by point source pollution. Six wastewater treatment plants in Westborough, Marlborough (Marlborough Westerly), Hudson, Maynard, Acton, and Concord are now operating, and another one is proposed in Acton. As with the Sudbury River, many non-point sources of pollution also degrade water quality in the Assabet River.

The Concord River has three wastewater treatment plants operating on its banks: one in Concord and two in Billerica. Although the two plants in Billerica lie downstream of the Refuge, their impact on the river cannot be overlooked. The treatment plant in Concord lies just upstream of the Concord impoundments on the refuge. As with the Sudbury and Assabet Rivers, non-point source pollution also impacts the Concord River (MEOEA 1996).

The public is very interested in protecting the resources in this watershed, as indicated by the establishment of the SuAsCo Watershed Community Council. That nonprofit group is composed of representatives from business and industry, municipal governments, environmental organizations, and State, Federal, and regional agencies.

Noise

Noise is a constant disturbance at the Concord impoundments; planes from Hanscom Field in Bedford fly directly over the refuge. Hanscom Field is the busiest general aviation airport in New England, with more than 200,000 operations per year. Corporate jet traffic amounts to 12 percent of the air traffic leaving Hanscom Field, and that percentage is growing by 22 percent per year. Corporate jets create as much noise as regular jet-airliners (Save Our Heritage 1999).

Contaminants

Elevated levels of heavy metals (mercury, lead, and arsenic) are present at many locations in the Sudbury River. The effects of those metals on wildlife is unclear. Other heavy metals are present as well, including cadmium and chromium. Their effects also are unknown. There are some indications that levels of mercury, while below levels that would affect fish or piscivorous fish, possibly may be high enough to affect piscivorous birds. The Nyanza Superfund site in Ashland and the Raytheon Brook wetlands in Sudbury are two major sources of pollution near the refuge. Both sites have introduced mercury into the Sudbury River (Eaton and Carr 1991).

Concentrations of polychlorinated biphenyls (PCBs) and polynuclear aromatic hydrocarbons (PAHs) in sediments in the vicinity of the Raytheon site are high. The PCB and PAH concentrations for the Sudbury River overall do not appear to represent a significant hazard to piscivorous birds, but could adversely affect highly susceptible mammals, such as mink (*Mustela vison*). No other organochlorine pesticides surveyed appear to represent significant hazards to the Sudbury River (MEOEA 1996 and Eaton and Carr 1991).

In September 1994, the Massachusetts Department of Public Health issued a State-wide Interim Freshwater Fish Advisory because of elevated mercury levels in certain species of freshwater fish. The interim advisory recommends, “Pregnant women should be advised of the possible risk from eating fish in Massachusetts freshwater bodies in order to prevent exposure of developing fetuses to mercury.” This advisory does not include stocked trout or farm-raised fish sold commercially (MEOEA 1996).

Biological Resources

Vegetation and Habitat Types

Wetlands

Along the Sudbury and Concord Rivers, scrub–shrub wetlands predominate. Extensive buttonbush-dominated (*Cephalanthus occidentalis*) wetlands reflect long-term vegetational changes along both rivers. In many areas, invasive species, such as water chestnut or purple loosestrife, have displaced plant species of high waterfowl

American bittern. *Photo by Bruce Flaig*

value, such as bur-reed (*Sparganium sp.*) and bulrush (*Scirpus palustris*). Despite having low food source value for waterfowl, these wetlands still provide excellent brood cover.

Less prevalent along the rivers are valuable "sedge meadows," which are dominated by non-woody vegetation, including extensive areas of bulrush and cord grass (*Spartina pectinata*), with beds of water pepper (*Polygonum hydropiper*), wild rice (*Zizania aquatica*), arrow arum (*Peltandra virginica*), pickerelweed (*Pontederia cordata*), and smartweed (*Polygonum amphibium*). These meadows are especially attractive to waterfowl. All wetland areas are typically flooded in spring; their water levels gradually decline throughout the summer.

Forested wetlands make up about 8 percent of the refuge. The dominant trees and shrubs in their overstory are red maple (*Acer rubrum*), swamp white oak (*Quercus bicolor*), hemlock (*Tsuga canadensis*), sweet pepperbush (*Clethra alnifolia*), white swamp azalea (*Rhododendron viscosum*), and rosebay rhododendron (*Rhododendron maximum*). Herbaceous plants found in these areas include skunk cabbage (*Symplocarpus foetidus*) and Jack-in-the-pulpit (*Arisaema spp.*).

Dense stands of cattail (*Typha latifolia*) and purple loosestrife dominate the edges of the Concord impoundments. Vegetation within the impoundments varies depending on the water level management. In years when the impoundment is kept flooded as poind habitat, common littoral emergents include arrow arum, arrowhead (*Sagittaria sp.*), bur-reed, wild rice, pickerel weed, sweet flag (*Acorus calamus*), and smartweed. In years when the impoundment is drained in the spring, common vegetation includes Walter's millet *(Echinochloa walteri), Cyprus Spp.* and *Bidens spp.*

Uplands

Uplands compose about 20 percent of the refuge. They form critical edges between refuge wetlands and the suburban development adjacent to them. Most of this land was once farmed. Many areas have grown into solid stands of white pine. Other areas now support species typical of a mixed eastern deciduous forest. Dominant species in the forested upland include red maple, red and white oak (*Quercus rubra*; *Q. alba*), white pine (*Pinus strobus*), blueberry (*Vaccinium spp.*), sweet pepperbush, rosebay rhododendron, and sweet fern (*Comptonia peregrina*). Common species found in the open fields include common milkweed (*Asclepias syriaca*) and goldenrod (*Solidago spp.*).

The refuge now contains approximately 160 acres of fields. Dense stands of hardwood are gradually replacing other fields in the uplands. All the fields are bordered by brush edges that, in most places, change into mature deciduous woodlands. Songbirds and small mammals use these edges extensively. The fields provide dense nesting cover for some grassland bird species, such as

meadowlark (*Sturnella magna*) and song sparrows (*Melospiza melodia*). Male American woodcocks also use the fields as "singing grounds" for their courtship displays in the spring.

One six-acre field is currently cooperatively farmed. The field is generally wet and is not high producing farmland.

Invasive Plants

Several species have invaded the refuge: water chestnut (*Trapa natans*), purple loosestrife (*Lythrum salicaria*), Asian bittersweet (*Celastrus orbiculatus*), common reed (*Phragmites australis*), Japanese knotweed (*Polygonum cuspidatum*), and common buckthorn (*Rhamnus cathartica*). Water chestnut and purple loosestrife are found in the Concord impoundments and along both the Sudbury and Concord Rivers.

Water chestnuts choke out native spcies . *The refuge uses a water chestnut harvester, along with other management tools, to remove the plant. UFWS Photo*

Special Designations

Wild and Scenic River Designation

In April 1999, Congress included 29 miles of the Sudbury, Assabet, and Concord Rivers within the National Wild and Scenic Rivers System (NWSR), in recognition of their outstanding ecology, scenery, recreation value, and their place in American history and literature. Those 29 miles, which are further subclassified as 14.9 miles scenic and 14.1 miles recreational. The 14.1 miles classified as scenic are located on the Sudbury River, and include the 12 miles on the refuge. See Maps 1-2 and 1-3 to see where the Designated Concord and Sudbury rivers flow through the refuge.

•The NWSR designation of the Sudbury River begins at the Danforth Street bridge in Framingham, 14.9 miles downstream to the Route 2 bridge in Concord, thence 1.7 miles to its confluence with the Assabet River at Egg Rock.

•The NWSR designation of the Assabet River begins 1,000 feet downstream from the Damon Mill Dam in Concord, 4.4 miles to its confluence with the Sudbury River at Egg Rock.

•The NWSR designation of the Concord River begins at the confluence of the Sudbury and Assabet Rivers, 8 miles downstream to the Route 3 bridge in Billerica.

The goal of any National Wild and Scenic River designation is to preserve the character of a river, not to curtail its use or halt further development. Uses that are compatible with the management goals for a designated river are allowed. Usually, development that does not damage the resources of a designated river or curtail its free flow is allowed (www.nps.gov/rivers/wsract.html).

Portions of Great Meadows Refuge have been nominated as a Massachusetts Important Bird Area (IBA). IBAs provide essential habitat for at least one or more species of breeding, wintering or migrating birds. The primary goals of the program are listed below.

- "To identify, nominate and designate key sites that contribute to the preservation of significant bird populations or communities.
- To provide information that will help land managers evaluate areas for habitat management or land acquisition.
- To activate public and private participation in bird conservation efforts.
- To provide education and community outreach opportunities."

(http://www.massaudubon.org/Birds_&_Beyond/IBA/iba_intro.html) These lands, along with other nominated areas, will be declared officially designated or rejected sometime this year.

Wildlife Resources

Migratory Birds

Many species of birds stopover at the refuge during spring and fall migration. Peregrine falcons (*Falco peregrinus*) and bald eagles are occasionally seen over the refuge during fall migrations. The northern harrier (*Circus cyaneus*), often seen hunting at the Concord impoundments, is listed as threatened by the Massachusetts Natural Heritage and Endangered Species Program. Various species also depend on the refuge for wintering habitat, or breed on the refuge. For a complete list of avian species that are known to use the refuge, see Appendix F.

Green-winged teal. *Photo by Bruce Flaig*

Thousands of waterfowl, over 20 different species, use the refuge throughout the year. Common species include green-winged teal *(Anas crecca)*, American black duck (*Anas rubripes*), wood duck, and mallard (*Anas platyrhynchos*). Species less commonly observed include northern shoveler (*Anas clypeata*), blue-winged teal (*Anas discors*), hooded merganser (*Lophodytes cucullatus*), and gadwall (*Anas strepera*).

Many marsh and water birds use the refuge, particularly the Concord impoundments. The most common are great blue heron (*Ardea herodias*), great egret *(Ardea alba),* Virginia rail (*Rallus limicola*), and green heron (*Butorides virescens*). The pied-billed grebe (*Podilymbus podiceps*), a State-listed endangered species, is a common sight on the Concord River or in the impoundments in the summer and early fall. Less common species found at the impoundments include sora rail (*Porzana carolina*), and American bittern (*Botaurus lentiginosus*). The least bittern (*Ixobrychus exilis*), also a State-listed endangered species, historically has nested on the refuge.

Shorebirds are generally seen at the Concord impoundments during migration. More shorebirds are usually present during the fall migration. Species frequently seen include killdeer (*Charadrius vociferus*), least sandpiper, greater and lesser yellowlegs (*Tringa melanoleuca*, *T. flavipes*), pectoral sandpiper (*Calidris melanotos*), lesser golden plover (*Pluvialis dominica*), and semi-palmated plover (*Charadrius semipalmatus*). Less common species include stilt sandpiper (*Calidris himantopus*), white-rumped sandpiper (*Calidris fuscicollis*), and black-bellied plover (*Pluvialis squatarola*).

Many songbird species nest, feed, and rest on the refuge. They include marsh wren (*Cistothorus palustris*), gray catbird (*Dumetella carolinensis*), yellow warbler (*Dendroica petechia*), red-winged blackbird (*Agelaius phoeniceus*), common grackle (*Quiscalus quiscula*), swamp sparrow (*Melospiza georgiana*), common yellowthroat (*Geothlypis trichas*), yellow-rumped warbler (*Dendroica coronata*), and northern mockingbird (*Mimus polyglottos*). A number of bird species nesting on or migrating through the refuge are Neotropical migrants (these species winter in Central and South America). As a group, Neotropical migrants have shown recent population declines due to habitat deterioration and loss in wintering areas and along migration corridors.

Mammals

We have not conducted any formal surveys; however, many mammal species are found on the refuge: Virginia opossum (*Didelphis virginiana*), several shrew species, chipmunks (*Tamias striatus*), eastern gray squirrel (*Sciurus carolinensis*), flying squirrel species (*Glaucomys spp.*), white-tailed deer (*Odocoileus virginianus*), muskrat (*Ondatra zibethica*), mink (*Mustela vison*), coyote (*Canis latrans*), red fox (*Vulpes fulva*), and American beaver (*Castor canadensis*). For a complete list of mammals likely to be present, see Appendix F.

Vernal Pool at Great Meadows Refuge. *Photo by Leon Latino*

Reptiles and Amphibians

Frog species on the refuge include green frog (*Rana clamitans cl.*), bullfrog (*Rana catesbiana*), northern spring peeper (*Pseudacris crucifer*), pickerel frog (*Rana palustris*), gray tree frog (*Hyla*

versicolor), northern leopard frog (*Rana pipiens*), and wood frog (*Rana sylvatica*). The American toad (*Bufo americanus*) also appears there.

Reptile species found on the refuge include snapping turtle (*Chelydra serpentina*), Blanding's turtle (*Emys blandingii*), Eastern box turtle (*Terrapene carolina carolina*), common garter snake (*Thamnophis sirtalis*), Eastern ribbon snake (*Thamnophis sauritus*), and Northern water snake (*Nerodia sipedon*). For a list of amphibians and reptiles, see Appendix F.

Fisheries

Similar fish species appear in the Concord and Sudbury Rivers. Common species include northern pike (*Esox lucius*), yellow perch (*Perca flavescens*), brown bullhead (*Ictalurus nebulosus*), rainbow trout (*Salmo gairdneri*), and pumpkinseed (*Lepomis macrochirus*). A cooperative recovery program now underway for the alewife (*Pomolobus pseudoharengus*) will continue for the next several years. Service personnel and volunteers at the Concord Division of the refuge have released alewife into the Concord River. For a complete list of species, see Appendix F.

Invertebrates

Invertebrates are not well documented. A number of varied invertebrates, both terrestrial and aquatic, are of biological importance. Lepidopterans are frequently observed (see Appendix F).

Threatened and Endangered Species

No Federal-listed endangered or threatened species reside on the Refuge. Bald eagles (*Haliaeetus leucocephalus*) are occasionally seen over the Concord impoundments.

Cultural Resources

Prehistoric Period

Recorded prehistoric archeological sites and artifact "find spots" show that prehistoric occupation in the Sudbury-Assabet-Concord drainage system spans 11,000 years. The first Native American occupation in this area occurred during the Paleoindian period (11000–8000 B.P.). While no definite paleoindian sites have been reported within the boundaries of the refuge, a diagnostic paleoindian fluted point of unknown type was reported as an isolated find spot in the Sudbury drainage (Dincauze and Mulholland 1977:440).

The Early Archaic period (9000–7000 B.P.) follows the Paleoindian. Small, widespread populations that practiced diversified hunting and

gathering characterize the Early Archaic culture. The diverse flora and fauna associated with the wetlands in the Refuge would have supported this type of subsistence strategy. Several Early Archaic sites containing bifurcate-base projectile points lie within the Refuge boundary. They include areas around Heard Pond (SUD-028P, MA State #19-MD-207, 208, 209) south of the Headquarters Tract in Wayland, and the Davis Farm site, located along Pantry Brook north of the Headquarters Tract. Ritchie's reports discuss in detail the Early Archaic materials found not far from those areas (Ritche 1980, 1985; Ritchie and Davin 1984).

During the Middle Archaic period, (8000–4500 B.P.), hunters and gatherers focused their subsistence strategies on drainage systems. Fishing gear appears during that time, and people heavily use local sources of stone. The refuge environment was ideal for the people of the Middle Archaic.

Several Middle Archaic sites near the refuge are known. Ritchie argues that the Sudbury and Concord Rivers drainage in eastern Massachusetts was a major focus of Middle Archaic activity(Begley and Ritchie 1998; Ritchie 1985). The settlement patterns of the Middle Archaic people suggest an intricate population distribution that ranges in site size and internal complexity. Several small sites in upland settings contrast sharply with known larger riverine zone sites, like the Heard Pond Middle Archaic complexes, which suggests functional diversity of site settlement patterns. Also, the tool kits associated with the various sites are functionally diverse. These include chipped and ground stone tools (usually associated with the production of plant foods), gouges, choppers, and net sinkers. That diversity may indicate that the Middle Archaic people would travel within river drainage territories and upland areas to exploit seasonal resources (Ritchie 1985; Dincauze 1976:136).

The lithic materials during the Middle Archaic period were primarily from local sources. Local Westboro formation quartzite or mylonite and rhyolite or felsite from sources in the Blue Hills and Charles-Neponset River drainage area dominate Neville Phase sites. Other Middle Archaic materials that dominate the stone assemblages of the sites in the refuge area include both local and non-local sources. The non-local sources include quartzite, crystal tuff, and amphibolite schist or argillite from source areas in the Charles River drainage and, occasionally, chert from New York State. Middle Archaic people quarried the local quartzite, mylonite, crystal tuff, and amphibole schist from bedrock outcrops in upland sections of the Sudbury-Assabet drainage (Ritchie 1985).

Following the Middle Archaic is the Late Archaic period (4500–3000 B.P.), at the onset of the Terminal Archaic period. Intensive hunting and gathering over a large region characterizes the Late Archaic. People also began to exploit freshwater and saltwater shellfish. The Late Archaic population may have been the largest for the Archaic period (Ritche 1985).

Late Archaic cultural complexes show the greatest frequency and widest distribution in different environmental zones. Surface collections from the larger, multicomponent sites along the Sudbury River drainage, contain projectile points diagnostic of the three major cultural traditions which are Laurentian/Brewerton-Vosburg, Small Stem Point, and Susquehanna (Ritchie 1985). Several Late Archaic projectile points have been recovered at the Headquarters Tract. These include Brewerton eared notched projectile points, small-stemmed and triangular projectile points. Artifacts recovered from the Late Archaic sites include hunting tools (projectile points, bifacial knives), woodworking tools (full-grooved axes, adzes, gouges, whetstones) and processing tools (pestles, scrapers, hammerstones, soapstone cooking vessels).

To summarize, people during the Late Archaic intensely exploited the habitats within the refuge. Diverse tool assemblages and relatively large population densities characterize this period. As in the Early and Middle Archaic, there was much activity on the refuge during the Late Archaic. The intense use of resources in the immediate area does not appear to decrease during the Transitional Archaic period and the Woodland periods.

The Transitional Archaic (3600–2500 B.P.) is characterized as economically similar to the Late and Middle Archaic, but more groups may have been migrating into New England, or more local groups may have been developing technologies strikingly different from those previously used (Ritchie 1985). Trade in materials such as soapstone becomes important, and burial rituals become more complex, perhaps due to an increase in population size.
Very often, Transitional Archaic sites are placed in the same category as Early Woodland, because there is much overlap among projectile point styles, and no other attributes clearly distinguish the two cultural periods. The dates given for the Early Woodland are 2600 to 1,500 B.P. During the Early Woodland, clay pottery begins to appear. This may correlate with early horticultural efforts by New England populations.

In the refuge area, diagnostic Orient Fishtail and Meadowood projectile points were in collections from most of the large riverine multi-component sites like Heard Pond, Davis Farm, and the Rice Tract. Meadowood points made of non-local chert from the Headquarters Tract show that the use of the Weir Hill area continued through the Archaic into the Woodland period (Ritchie 1985). Most of the site locations used during the Terminal Archaic/ Early Woodland period continued to be staging points for Middle Woodland resource exploitation. Significant reuse of other sites that people used during the Middle and Late Archaic also occurred (Ritchie 1985).

Coastal resources were important for people of the Middle Woodland period (1650 B.P.–1000 B.P.). Horticulture of local northern plants, such as *Chenopodium*, became increasingly important; however, gathering and hunting were still the main subsistence means.

The Late Woodland is an extension of the Middle Woodland. The Late Woodland begins at 1000 B.P. and ends with the arrival of Europeans in New England. During the Late Woodland, horticulture of local domesticates intensified and neighbors to the south and west introduced maize horticulture. People lived in larger groups, and sometimes in fortified villages. During this period, complex political alliances emerged, perhaps reflecting an increase in sedentary lifestyle and population growth. This was most evident in coastal areas. Some inland groups may have continued a more mobile hunting and gathering subsistence strategy.

Middle and Late Woodland settlement patterns near the refuge are similar, with a possible reduction in resource exploitation territories during the Late Woodland period. Many site locations at Weir Hill, Heard Pond, and around the Rice Tract were fishing stations during these periods (Ritchie 1985:40).

The complex political structures that emerged during the late Woodland collapsed due to European expansion and disease. During this time, projectile points made from metals traded to the Native Americans by the Europeans emerge. Other European materials were also adapted to suit Native American needs and ideologies. No contact period sites have been identified on the refuge or in the immediate vicinity. However, people may have used the fishing weir that gave Weir Hill its name.

The refuge has significant potential to contribute to our understanding of prehistoric settlement patterns in eastern Massachusetts. The ecology of the area certainly played a significant role in the development of the cultures in this area, as did human impact on the environment. The refuge area was a "highway" for people during the Middle Archaic through the Woodland periods, and continued to be important for people during the historic period.

The Historic Period

Rock wall. *Photo by Marijke Holtrop*

People used the Headquarters Tract for agricultural and pastoral purposes over the last 350 years. Extant remains of this type of lifestyle are still visible, including remains of agricultural land use patterns, farm dump areas, abandoned fields, former roadways, stone walls, fence lines, and drainage or boundary ditch systems. The refuge area was settled in the early part of the 17th century, soon after Plimouth Colony.

By 1640, Sudbury was settled, and had a unique political and economic structure. The town practiced an open field system. These commons surrounded the town center, with about 2,750 acres on the east side of the river, and 5,000 acres to the west, extending to Pantry Brook. These commons were used mostly for cattle, except for 50 acres of upland near Hop Brook that were used for a mill in 1659. The primary crops grown by the early settlers were corn, rye, barley, wheat, peas, oats, hemp, and flax. Hay was also grown along river meadows.

Several historic period Christian Indian towns were located outside the perimeter of English frontier towns like Sudbury and Concord. The Indian town of Ockookamkomesit eventually became the English plantation of Marlborough between 1650 and 1660. Most of these Indian towns were diminished by European-introduced diseases and, later on, by warfare.

During the 18th century, the primary changes in the town were a population increase, the establishment of a militia, and the Revolutionary War. Also, several roads and bridges were constructed, which allowed for more commerce between the surrounding towns and Boston. In 1780, the East and West Precincts of Sudbury were divided into two towns. The Sudbury River formed the town line between East Sudbury and Sudbury. By 1794, a report on the town of Sudbury described three grist mills, two saw mills, and a fulling mill as local industries; all were located along the Wash Brook and Hop Brook drainage (Ritchie 1985).

Public Use. *Each year thousands visit Great Meadows Refuge for wildlife observation and photography opportunities. USFWS Photo*

During the 19th century, the village of South Sudbury developed into a commercial district known as mill village, with a church, town library, post office, general store, and malt house. Several small industries, including a grist mill, blacksmith, machine shop, wheelwright's shop, tannery, and a shoe factory were located near a mill pond on Hop Brook. The Framingham and Lowell Railroad was extended through South Sudbury in 1870. Ten years later, the Massachusetts Central Railroad formed a junction with the Framingham and Lowell at South Sudbury, and a railroad station was built for regular use (Ritchie 1985).

Sudbury Center continued as a focus of community activity in the 19th century with a town hall, three churches, school houses, stores, railroad depot, and close to fifty houses. The district on North Sudbury remained open farmland throughout the nineteenth century with a small station on the Old Colony Railroad (Ritchie 1985).

Mining of bog iron from the swamps in the north part of Sudbury was also an important small-scale rural industry during the 19th century. The bog iron ore was carted to the Sudbury River where it was loaded onto barges and transported to forges in Chelmsford (Ritchie 1985).

Around the refuge area, the primary activity for all historic periods until the late 20th century has been farming. Several farm archeological sites located on the refuge date back to the early settlement of the area. More recently, a summer camp called the Elbanobscot Environmental Education Center built in the 1950's stood on what is now refuge land. The summer camp altered the Weir Hill area by constructing a swimming pond on the edge of the Sudbury River floodplain, near the present-day headquarters building and a leaching field on top of Weir Hill (Ritchie 1985).

The refuge offers an excellent opportunity to study early American history. Several important cultural resources located on the refuge potentially can contribute significant information about human activity there over the last 10,000 years. The archeological studies now completed have yielded important information. Other archeological resources still undiscovered also may exist on the refuge.

Socio-economic Environment

Threats

All open space near Metropolitan Boston's population of 6.2 million is under great pressure for recreational use. The refuge is a half-hour drive from downtown Boston. The population of Massachusetts increased 5 percent from 1980 to 1990, and has increased 1.7 percent since then. The SuAsCo watershed is home to 365,000 people; a number that will grow.

Great Meadows Refuge receives more than 500,000 visitors each year; wildlife observation and environmental education predominate. The Concord impoundments, which are a popular destination for birders and school groups, draw the largest number of visitors by far, probably more than 450,000.

The boom in the local technology industry has spurred rapid construction of housing units and support infrastructure (e.g., roads, malls, plazas, utility towers, and corridors). The increase in human density and associated uses have caused considerable strains on the ecosystem from the following factors:

- Habitat loss through direct conversion of natural habitat types to developed types;

- Habitat fragmentation through conversion of contiguous tracts of natural habitat types to a mosaic of discontinuous, smaller habitat type relicts; or erecting barriers that cause direct lethal impacts to fish, wildlife, and plants (.e.g., roads and communications towers);

- Habitat degradation through partial deterioration of habitat due to pollution (siltation, nutrients, pesticides, metals), exotic and pest species (Phragmites, house cats), incompatible uses (all-terrain vehicles, personal watercraft);

•Water consumption that reduces subsurface and surface water due to home and business consumption and industrial applications.

We have excerpted from publications of the Massachusetts Department of Revenue the information below, about the towns in which the refuge is located (MDOR 2000).

Bedford

Bedford is located 15 miles northwest of Boston, between Billerica to the north and Concord and Carlisle to the west. Its total land area is 13.87 square miles. Its population of 13,067 in 1990 increased by 1 percent to a population of 13,947 in 1998. Middlesex Community College, the Edith Nourse Rogers Memorial Veterans Hospital, Hanscom Air Force Base, and other businesses in Bedford employ about 23,000 persons.

Founded in 1729, Bedford has retained both its natural and architectural beauty. Visitors find an attractive historic district and town common in the center, the famous Bedford Flag on display in the library, the 1790 Job Lane house, and several national historic landmarks. Annual town celebrations include "Pole Capping" in April, when the Bedford Minuteman Company reenacts a Revolutionary-era tradition, and "Bedford Day" in September, celebrated with a parade, street fair, and dancing. Bedford has a unique community spirit. Bedford residents make a conscious effort to be inclusive of its diverse ethnic, religious, and special interest groups, and believe it is a fine place to work, visit, or call home.

Concord River. *Photo by D. Mackey*

Bedford residents enjoy many town services. Education is a top priority, with schools well known for scoring competitively by all standards. The library serves everyone, and has active children's programs. All age groups enjoy recreation programs, including after-school day-care, a summer day camp, and a senior center offering daily health and leisure services. An in-town minibus runs weekdays. Outdoor facilities include a swimming pond, a lake for boating, a bike path to Cambridge, and walking trails through conservation lands. Bedford's residents vote on all services at open town meetings.

Billerica

Billerica is located 20 miles northwest of Boston, and has a population of 40,000 residents (1998). That population has grown only 1.1 percent over the 1990 Census figures. Its total land area is 26.39 square miles; and although much of Billerica has been developed, significant parcels of vacant land still lend a certain rural character to many areas of town.

Remnants of the historic Middlesex Canal, which once connected the Merrimack River to Boston, traverse the town north to south. Two rivers pass through town: the Concord River is a major regional water feature; the Shawsheen River meanders through the southern part of town.

Incorporated in 1655, Billerica remained predominately agricultural until the mid-nineteenth century, when a major mill complex was sited on the Concord River in North Billerica. Although a number of smaller industries grew up over the next 100 years, it was not until the 1950's that the present-day industrial base was established. Today, Billerica is a major regional employer, and home to several high technology firms, some of which are offshoots of companies along Route 128 to the south. Billerica is also the site of the Middlesex House of Correction, a significant town employer.

Carlisle

The Town of Carlisle offers peaceful residential living within 20 miles of Boston. The 1998 population of 4,760 has increased only 1.1 percent since 1990. Although the town is primarily residential, a few businesses are located there. Carlisle maintains a rich tradition in preserving open space and scenic ways; almost 20 percent of the town's 15 square miles is dedicated conservation land. The only working cranberry bog in Middlesex County is located in Carlisle. The town also offers residents and visitors the beauty of Great Brook Farm State Park, numerous hiking trails, and vistas of open fields. Carlisle maintains its small-town atmosphere with the enthusiastic support of its citizenry. The town operates by the historic open town meeting form of government, and its residents volunteer their time to serve on the town's boards and committees. Carlisle also offers an excellent elementary school system, and is joined with the Town of Concord to offer a quality high school education.

Concord

The junction of the Concord, Sudbury, and Assabet Rivers historically was the site of seasonal Native American camps, because of plentiful runs of shad, salmon, and herring. The English settled Concord as an early frontier outpost of the Massachusetts Bay Colony. Named in 1635, the historic town of Concord lies west of present-day suburban Boston. It was the first non-tidal-water town in interior Massachusetts. Concord retains many well-preserved colonial houses: nine of them stood near Concord green during the battle that opened the Revolutionary War.

Concord also has a significant literary history, having been the home of the leaders of the intellectual movements of 19th century America. Louisa May Alcott, Bronson Alcott, Ralph Waldo Emerson, and Nathaniel Hawthorne lived in Concord at one time, and Henry David Thoreau wrote his internationally known philosophical treatise at Walden Pond in Concord.

Concord evolved from a frontier town into a prosperous regional center with a mixed society, including small yeoman farmers, affluent gentry, and immigrants from Italy and Norway. High-style, handsome houses, along with some country estates, are relics of that affluent society. One of the well-preserved sights in the community is the Victorian Gothic State Prison, built in 1878, that still houses prisoners today.

Concord is located 18 miles west of Boston, and comprises 26 square miles. Several major roadways (Routes 2, 128, and I-95), are easily accessible from Concord. Since 1990, the town's population has grown one percent, from 17,076 to 17,867. The town is a mix of residential neighborhoods, retail centers, and high-tech industry. Skyrocketing land prices in the real estate boom of the 1980's resulted from Concord's proximity to Boston and the Route 128 technical and industrial corridor, coupled with a vigorous regional economy. Concord residents feel that its tourism and rapid suburban development are placing considerable pressure on the town.

Framingham

The Town of Framingham, located 19 miles from Boston and midway between Boston and Worcester, is the hub of the Metro-West region. The town's total land area is 26.44 square miles, and its population in 1998 was 64,646. That estimate is down 1 percent from 1990.

Framingham offers a unique blend of urban and rural qualities. The vibrant retail area along Route 9 lies close to quiet residential areas and the town common. The historic strengths of the town have been its location and its people. From its founding in 1700, Framingham has supported a variety of industries. The mills and factories that flourished in Framingham encouraged the growth of the Saxonville area of the town and the downtown.

The major employers now are primarily non-manufacturing, including medical, retail, educational, office, and biotechnical. The residents of Framingham value public participation, and the town is the largest in Massachusetts with a town meeting form of government. Framingham offers all sorts of recreational activities for its residents, from its many organized team sports leagues to the nationally renowned Garden in the Woods. Residents unite for numerous municipal celebrations throughout the year, with a major focus on Flag Day in June.

Lincoln

The Town of Lincoln is a small suburb with a strong sense of place 13 miles northwest of Boston. It began as a rural farming community made up of pieces of land "nipped" from adjacent towns; hence, its nickname was once Niptown. The town also became a popular site for country estates, some of which have become schools, museums, town buildings, or parks. Lincoln's total land area is 15.01 square miles. Its population is 7,921, up 1 percent since 1990.

Retaining open space and protecting its rural character against encroaching urban development are extremely important to the community. To that end, Lincoln was one of the first towns to create

a Conservation Commission that has, with the Lincoln Land Conservation Trust, acquired key parcels of land throughout the town. Significant areas of the town are now preserved against development, providing protection for wildlife and local water supplies, and creating conservation trails for public use. Residents note that Lincoln is a quiet and pretty place to be, whether to visit a museum or walk in the woods all year round.

Sudbury

We have excerpted here information provided by John Powers, former Sudbury town selectman. Sudbury has roots deep in American history. Like other local towns, Sudbury was home to the Nipmucks of the Algonquin nation before European settlement. In 1638, white settlers first came to Sudbury, and the Sudbury Plantation was settled.

The first town meeting house was actually built in Wayland, before Wayland (and other towns such as Marlborough, Framingham, and parts of Stow) split from the mother town. As Sudbury grew to its present size of 24.37 square miles, townsmen developed not merely a new community but a new concept: government with the consent of the governed. Sudbury's role in the development of the town meeting form of government, and its insistence upon the direct right of a citizen to choose his governors and to make himself heard upon any issue in open forum, did much to lay the foundation of American democracy.

As the first highways, such as Boston Post Road, were constructed, Sudbury developed the small local businesses of a self-sufficient community. There were shoe shops and blacksmiths, tanners and wheelwrights, nail factories, and saw mills. Quiet agricultural growth continued into the 1940's, but as Boston grew, so too did Sudbury, only 15 miles from the burgeoning Boston.

Today, Sudbury is a bustling mix of residential and retail areas and light industry. The residential areas lie beyond the retail and light industry centered along Boston Post Road. The 1998 population of Sudbury was 15,550. Many commute to Boston or to the Route 128 high-tech corridor. Sudbury has a fine elementary school system, and shares its high school resources with the Town of Lincoln.

Wayland

The Town of Wayland, 17 miles west of Boston, was settled in 1673 as part of the Sudbury plantation. Eventually, the town reached its present size of 16 square miles. Its early economy was based primarily on agriculture, although some industries, such as grist- and saw-milling, grew from its available water power. Now an affluent suburban community within easy commuting distance of Boston, the town retains few indications of its early industrial history.

Incorporated in 1780, the town was named much later after Francis Wayland, a preacher and president of Brown University who, in 1848, established the first free library in Massachusetts there. Wayland serves as one of the home communities for commuters to the high-tech industrial belt around Routes 128 and 495 and the business and education center of Boston. Between 1990 and 1998, its population grew by 1 percent, from 11,874 to 12,343.

Residents praise the town for its rural elegance, country charm, and its location near Boston's cultural and recreational opportunities. Its school system is also a source of pride in the community. Wayland's quiet, handsome neighborhoods of spacious homes have been enhanced by its townspeople having funded the purchase of land to maintain open space. The town maintains a municipal beach on the shore of scenic Lake Cochituate. The preservation of open space by the refuge also has aided the town in retaining its rural character.

Part 3: Oxbow National Wildlife Refuge

Physical Resources

Location/Role

Oxbow Refuge is located in north-central Massachusetts, approximately 35 miles northwest of Boston, MA. The refuge lies within the towns of Ayer and Shirley in Middlesex County and the towns of Harvard and Lancaster in Worcester County. The refuge consists of approximately 1667 acres of upland, southern New England floodplain forest and wetland communities along nearly 8 miles of the Nashua River corridor.

The refuge is a long, narrow parcel having a north/south orientation. Roadways running east/west divide the parcel into three sections. The northern end of the refuge abuts the former Fort Devens, Moore Army Airfield just south of Massachusetts Route 2A. Shirley Road/ West Main Street in Ayer separates the northern and middle portions of the refuge. Massachusetts Route 2 bisects the middle and southern parcels. The refuge's southern most boundary is at Still River Depot Road in Harvard, MA.

Oxbow Refuge was formed by three land transfers from the former U.S. Army, Fort Devens Military Installation, and a recent purchase of private land in Harvard, MA. Two of the transfers from the Army (May, 1974 and February, 1988) formed the original 711.03 acre portion of the refuge located south of Massachusetts Route 2. The third Army transfer occurred in May of 1999, and added the 836.3 acre portion of the refuge that is located north of Route 2. Finally, approximately 120 acres was added to the refuge in April, 2001, with the acquisition of the former Watt Farm property along Still River Depot Road in Harvard. Table 3-7 shows the division of refuge lands among these three areas, and among the Towns of Ayer, Shirley, Lancaster and Harvard.

Table 3-7. *Oxbow National Wildlife Refuge Acreage*

Town	AYER	SHIRLEY	HARVARD	LANCASTER
Former Ft. Devens North Post (North of Shirley Road)	252.83	134.4	0	0
Former Ft. Devens Main Post (Route 2 to Shirley Road)	0	89.35	356.47	2.58
South of Route 2	0	0	831.03 (approx.)	0
TOTAL ACRES (~1666.7)	252.83	223.75	~1187.5	2.58

The primary purpose for which the refuge was created is its *"...particular value in carrying out the national migratory bird management program"* (16 U.S.C. 667b, An Act Authorizing the Transfer of Certain Real Property for Wildlife, or other purposes, as amended). The refuge's interspersion of wetland, forested upland and old field habitats is ideally suited for this purpose. The refuge supports a diverse mix of migratory birds including waterfowl, wading birds, raptors, shorebirds, passerines, as well as resident mammals, reptiles, amphibians, fish and invertebrates. The extensive and regionally significant wetlands occurring on and adjacent to the Oxbow Refuge, including their associated tributary drainages and headwaters, have been listed as a priority for protection under both the North American Waterfowl Management Plan and the Emergency Wetlands Resources Act of 1986.

The portion of the Oxbow Refuge south of Route 2 lies within the 12,900 acre Area of Critical Environmental Concern (ACEC) designated by the Massachusetts Secretary of Environmental Affairs due to its unique environmental characteristics and values (MADEP 1998).

The Nashua River at Oxbow Refuge.
USFWS Photo

The refuge's geographic position, accessibility to the local and regional communities, and its diverse biological resources also makes it highly attractive for natural resource educational or interpretive programs, and compatible wildlife dependent recreational uses. An estimated 55,000 people visited the Oxbow Refuge in 2000. All of this use occurred with the older portion of the refuge, south of Route 2.

Climate

Climatic conditions at the Oxbow Refuge are strongly influenced by maritime, Atlantic Ocean processes and weather patterns. The annual range in temperature is broad, with moderately hot summers and cold winters. Precipitation is favorably distributed throughout the year. Seasonally, precipitation is greatest fall through the spring, and least during the summer. The average number of days with snow on the ground is 50 to 60 days.

The average, annual temperature is 48.0 degrees Fahrenheit. January, the coldest month, has an average daily temperature of 24.3 degrees F. In July, the warmest month, the daily temperature averages 71.2 degrees F. The average, annual precipitation is 44.66 inches, with the greatest monthly average occurring in November (4.27 inches), and the lowest monthly average occurring in February (3.21 inches).

Wind speed averages approximately 10 mile per hour on an annual basis. Velocities in excess of 40 miles per hour are not uncommon during summer thunderstorms or winter blizzards. Both tornados and hurricanes impact the area on infrequent intervals (U.S. Department of Justice 1995).

Geology, Topography, Soils, and Hydrology

Oxbow Refuge and the surrounding area has a glaciated topography which has produced landform characteristics of ice sheet impacts such as drumlins, kames, kame terraces, outwash plains, kettle-holes, glacial lake beds and eskers. Underlying the glacial deposits are metamorphic sedimentary and granitic bedrock. The unconsolidated glacial deposits cover most of the bedrock, leaving little bed rock outcropping on the refuge. Topography ranges from the Nashua River, its wetlands and floodplains at approximately 200 feet above mean sea level to hilly uplands at approximately 330 feet elevation. Along the transition zone between the Nashua River floodplain and the adjacent upland, there is generally a fairly steep incline which divides these two habitats. The majority of the refuge consists of the river riparian zone, its adjoining wetlands and low floodplain lands (Roberts 1995).

The surface geology of the refuge consists of glacial, alluvium, and swamp deposits overlaying bedrock. Glacial and post-glacial erosion and deposition during the Wisconsin Period ice age shaped surficial geology approximately 17,500 years ago. In upland areas, glacial activity resulted in a moderately thick layer of glacial till consisting of a heterogeneous mix of clay, silt, sand, gravel and boulders, with occasional bedrock outcrops. Other glacial deposits include layers of well-sorted fine to coarse sand, fine gravel and boulders along with layers of fine sand and silt (Roberts 1995).

Alluvium and swamp deposits overlie glacial deposits on much of the area. Alluvium is light gray to white fine sand and silt with minor gravel. It is 15 feet thick in some areas and primarily found underlying the Nashua River Valley floodplain. Swamp deposits are composed of muck, peat, silt and sand overlying or mixed in with the alluvium (Roberts 1995).

Bedrock is a complex of metamorphic and granitic rocks of the Paleozoic age. Composition ranges from meta-siltstone through phyllite, slate and schist. An intrusive igneous body, the Ayer granodiorite and meta-quartzite also exist. Most contacts between formations are faults, striking northwest. The are was historically depressed under glacial loading and is rebounding (Roberts 1995).

Soils

The soils of Oxbow Refuge are comprised of three generalized types. Nashua River floodplain soils are predominately the poorly drained Winooski-Limerick-Saco map unit. To the east of the Nashua River floodplain, where the majority of the refuge lies, the soils are the excessively drained outwash plain Hinckley-Merrimac-Windsor map unit. West of the Nashua River floodplain, adjacent to the refuge, are the well to moderately drained upland soils of the Paxton-Woodbridge-Canton map unit.

The soils of the Winooski-Limerick-Saco map unit are very deep, nearly level soils that are moderately well drained, poorly drained, and very poorly drained on the floodplain of the River. This map unit consists of broad areas and small depressions. The soils formed in alluvium deposited by the flood waters of the Nashua River. The high water table is at the surface for the Saco soils, 6" for the Limerick soils, and between 1 ½ to 3 feet for the Winooski soils.

The soils of the Hinckley-Merrimac-Windsor map unit, which are primarily the upland soils of the refuge, are very deep, nearly level to steep soils that are excessively drained and somewhat excessively drained on the outwash plain. This map unit consists of broad plains and rolling to steep areas scattered throughout the survey area. The soils formed in water-sorted deposits of glacial outwash. Hinckley soils have a loamy surface underlain by stratified sand and gravel. Merrimac soils typically consist of 2 feet of loamy material over sand and gravel. And Windsor soils are typically sandy throughout.

The soils of the Paxton-Woodbridge-Canton map unit includes deep, nearly level to steep soils that are moderately well to well drained. These soils are predominately upland soils of hills and ridges. Paxton soils are gently sloping to steep with slow to very slow permeability. Woodbridge soils are nearly level to steep, and are predominately found on hill or drumlin tops. Canton soils are also gently to steeply sloping and well drained. However, they are most often associated with the toe of slopes, and have moderately rapid to rapid permeability (USDA 1985).

Hydrology

The hydrology of Oxbow Refuge is essentially that of the Nashua River. All refuge lands are located along 7.5 miles of the Nashua River drainage. The Nashua River flows south to north, drains approximately 538 square miles, and is a major tributary of the Merrimack River System. The main stem of the Nashua River flowing through the refuge is formed by two branches: the North Nashua River, which originates west of Fitchburg, MA, and the South Branch, which flows out of the Wachusett Reservoir. These two branches join at Lancaster, MA to the south of the refuge. Much of this section of the Nashua River is characterized by low gradient, slow moving water with numerous backwaters and wetlands. Primary tributaries of the Nashua River within its course through the refuge include: New Cranberry Pond Brook, Slate Rock Pond outlet, Phoenix Pond outlet (Catacoonamug Brook), Trout Brook, Willow Brook (a tributary of Nonacoicus Brook), Nonacoicus Brook, Morse Brook, Walker Brook, and Mulpus Brook.

The nearest, long-term U.S. Geological Survey gauging station on the Nashua is located downstream of the refuge at Pepperell, MA. Flow records have been made at this station for 33 years (23,376 daily flow records). The average daily flow over this period of record is 583.5 cubic feet per second. Select long-term data (USGS 2001) are presented in Table 3-8.

Table 3-8. *U.S. Geological Survey Discharge Data*

Station name	Nashua River At East Pepperell, Ma
Station number	01096500
Latitude (ddmmss)	424003
Longitude (dddmmss)	0713432
State code	25
County	Middlesex
Hydrologic unit code	0107004
Basin name	Nashua
Drainage area (square miles)	435
Contributing drainage area (square miles)	316
Gage datum (feet above NGVD)	169.04

Discharge is listed in the table in cubic feet per second
This information was obtained from the NWIS-W software package

Data Range In File 10/01/1935-09/30/1999

N	23376 days	
Mean	583.5	
Mode	1040	cfs
Maxium	19400	

Numerous small freshwater ponds, vernal pools and wetlands are associated with this stretch of the Nashua River. Many small ponds along the river's course were formed by glaciers; others, oxbow wetlands, were formed as portions of the river have become silted, and the river's course changed, leaving these cut-off oxbows. Between the northern-most section of the refuge and the middle section, there is a dam, the privately owned Ice House Dam just below Shirley Road on the River. This dam has some impounding influence on the River, at least as far upstream as Route 2, and perhaps further upstream toward the southern part of the refuge.

Groundwater Resources

The groundwater hydrology of Oxbow Refuge and the surrounding area is largely defined by topography and the distribution and saturated thickness of high conductivity glacial outwash deposits within the Nashua river valley and low conductivity glacial till deposits in the upland areas. This distribution of unconsolidated sediments results in steep hydraulic gradients in the upland areas with a general flattening of the water table within the regions of glacial outwash. Maintaining the base flow of the rivers and streams, groundwater flows from hills toward valleys, and discharges into streams, rivers, wetlands, and ponds. An extensive sand and gravel glacial outwash aquifer underlies most of refuge on the former North Post, the eastern portion of Main post, and the northeastern corner

of South Post, in addition to contiguous areas in adjacent towns (U.S. Army 1995).

The most productive parts of the aquifer (the high yield aquifer) are associated with the Nashua River and its tributaries. The glacial outwash deposits present in these high transmissivity areas are major sources of potable water for Devens and the towns of Shirley and Ayer. In most areas where the glacial outwash aquifer is not present, fractured bedrock resources supply water to single-family domestic wells (U.S. Army 1995).

The Devens water supply is provided by the McPherson Well on North Post, the Grove Pond Wellfield in the northeastern corner of Main Post, and the Patton and Sheboken Wells located, respectively, northeast and southwest of the Mirror Lakes in the southern portion of Main Post.

Groundwater in the vicinity of Devens is designated Class I groundwater by MADEP and is considered to be a potable source of water. In general, the water within the main aquifer of Devens is moderately hard, requires minimal treatment and, based on tests at individual supply wells, has met all MADEP water quality standards, with the exception of those for sodium (U.S. Army 1995).

The town of Ayer operates two wells on the southern shore of Grove Pond, to the east of the Devens Grove Pond Wellfield. In the past, these wells have functioned as a backup to Ayer's main water supply wells, which are located adjacent to Spectacle Pond in Ayer, east of Devens. The total rated capacity of the two wells is approximately 2 MGD (U.S. Army 1995).

The Shirley Water Supply District maintains two wells in the vicinity of the Refuge. The Patterson Road Well, located in Shirley along Morse Brook due west of the McPherson Well, supplies approximately 225,000 gallons per day (gpd). Further west, the Catacoonamug Well supplies approximately 62,000 gpd. A supply well, operated by MCI-Shirley, is located in Shirley on the west side of the Nashua River, due west of Jackson Gate. This well is capable of supplying 720,000 gpd to the correctional facility. The extent of this Zone II is limited to the west side of the Nashua river (U.S. Army 1995).

Public water supply for the town of Harvard is provided by a pair of bedrock wells of limited capacity (one active well with an estimated maximum pumping rate of 43,000 gpd and a backup well with an estimated maximum pumping rate of 28,000 gpd). A third bedrock well, which pumps at less than 1,200 gpd, serves the Town's Department of Public Works building and one private residence (U.S. Army 1995).

Floodplains

The estimated 100-year floodplain in the vicinity of the Oxbow Refuge have been delineated by the Federal Emergency Management Agency (FEMA). The 100-year floodplain is most extensive along the Nashua River, reaching its greatest width in the refuge south of Route 2. The floodplain is also fairly wide along the stretch of the Nashua River near portions of the refuge within the former North Post (U.S. Army 1995).

Air Quality

The Massachusetts Annual Air Quality Report for 1999 (MADEP, 2000), and the U.S. Environmental Protection Agency's Air Quality Planning and Standards Web Page (EPA 2001), contain the most recent data available for air quality in this area. No monitoring sites are in close proximity to the Oxbow Refuge. The nearest data appear to be limited to those from monitoring sites in the City of Worcester and the Town of Stow. The Stow monitoring site has been located on the Assabet River Refuge since 1999, and prior to that time was located nearby on the Great Meadows Refuge in Sudbury.

The pollutants for which State-wide data are available are ozone (O_3), carbon monoxide (CO), nitrogen dioxide (NO_2), Lead (Pb), sulfur dioxide (SO_2) and particulate matter (both 2.5 microns (PM2.5) and 10 microns (PM10)).

The National Ambient Air Quality Standards (NAAQS) determined by USEPA set the concentration limits that determine the attainment status for each criteria pollutant. Massachusetts does not attain the public health standard for two pollutants – ozone (O3) for the entire State and carbon monoxide (CO) in a few cities (MADEP 2000), including parts of Worcester and Middlesex Counties within which the Refuge is located (EPA 2001).

There are two ozone standards based on two different averaging times, 1-hour and 8-hour. In 1999, there were 85 exceedances of the 8-hour standard occurring on 22 days, and 5 exceedances of the 1-hour standard occurring on 4 days on a State-wide basis. The 12 year trends for ozone readings in the State have been generally decreasing toward better quality since 1988.

Massachusetts has made significant progress in attaining the CO standard by implementing air pollution control programs. The last violation of the CO NAAQS occurred in Boston in 1986. The Boston metropolitan area was redesignated to attainment of the CO federal air quality standard by the USEPA in 1996. Lowell, Springfield, Waltham, and Worcester remain in non-attainment of the CO standard. MADEP is currently preparing a request to the USEPA to redesignate these areas to attainment for CO because monitoring data has been below the standard for many years. The redesignation request, which includes technical support and a maintenance plan, will be subject to public review and comment prior to being submitted to the USEPA.

In recent years there has been concern regarding the aerial deposition of mercury from atmospheric sources outside the northeast region (see for example Sweet and Prestbo 1999). Researchers have speculated that this may be the source of mercury levels found in some species and age-classes of fish in New England above the 1 part per million standard established by the U.S. Food and Drug Administration (see discussion in the Water Quality Section below).

The annual average concentration of Pb in the air decreased substantially since the 1985 from more than 300 ug/m^3 to less than 0.05 ug/m^3 (the annual average NAAQS for lead is 1.5 ug/m^3). Massachusetts is well below the standard This result is attributed to the use of unleaded gasoline in motor vehicles, which are the primary source of airborne lead emissions (MADEP 2000). While air quality concentrations of lead have dramatically decreased, there may still be concern regarding residual lead levels in soils along heavily traveled roadways (e.g., Route 2) deposited prior to the change to unleaded gasoline usage.

Water Quality and Quantity

The waters of the Nashua River have been designated as Class B, Warm Water Fisheries by the Commonwealth of Massachusetts. Class B waters are defined as being suitable for "protection and propagation of fish, other aquatic life, for wildlife, and for primary and secondary contact recreation" (MADEP 1998a). Although vastly improved in water quality character, the Nashua River has had a long history of water quality degradation. Through the 1960's and early 1970's, paper manufacturing facilities in Fitchburg and Pepperill, inadequately treated municipal wastewater in Fitchburg, Leominster, Clinton, and Ayer, and combined sewer overflows in Fitchburg and Leominster contributed to severe pollution of the river. While the water quality of the river has improved dramatically with closing of some of these facilities and the institution of advanced waste water treatment at others, impacts on aquatic biota and elevated bacteria levels remain problematic (MADEP 1998b).

The mainstem of the Nashua in its reach through the refuge is included in the State's list of impaired waters due to organic enrichment and low dissolved oxygen levels. Grove and Plow Shop Ponds, which are the origin of Nonacoicus Brook just above the refuge boundary, are listed as impaired due heavy metal contamination. Mirror Lake, a kettle-hole pond located within the former Ft. Devens Main Post is also listed as impaired due to heavy metals. (MADEP 1999). Mirror Lake is recharged by ground water, and does not have an apparent surface water inlet or outlet. We do not currently believe water quality within Mirror Lake would have an impact on the refuge.

There is a Massachusetts Department of Public Health fish consumption advisory for Mirror Lake due to elevated levels of mercury in fish tissue. (MADPH 1999). There is also an earlier, State-wide Interim Fish Consumption Advisory for mercury that

encompasses all fresh waters of the State. It is directed to pregnant women only. The general public was not considered to be at risk in this State-wide Advisory (MADPH 1994).

A recent study by the Fish and Wildlife Service examined heavy metal exposure in benthic invertebrates from Grove Pond, Plow Shop Pond and Nonacoicus Brook. The study found that freshwater mussels (the eastern elliptio, *Elliptio complanta*) collected from Nonacoicus Brook near its confluence with the Nashua River contained elevated levels of chromium (5.07 ug/g). Mussel tissue concentrations of arsenic, cadmium, mercury, methyl mercury and lead were found to not be elevated in comparisons with studies conducted elsewhere. However mussels tested from Nonacoicus Brook near the Nashua River exhibited higher levels of arsenic, cadmium, chromium, mercury and lead compared to samples at the inlet and outlet of Plow Shop Pond (USFWS 2000a).

In 1994, a 2.5 mile section of the Nashua River in the Fort Devens area was surveyed by the U.S. Fish and Wildlife Service to check levels of contaminants in fish tissues. PCBs, DDT and mercury were found in fish tissues; as well as chlordane compounds and dieldrin. Chromium, arsenic, cadmium, lead and selenium were also detected at elevated levels in fish tissue. This report recommends separate evaluation of the contaminant concentrations in fish from the Fort Devens section of the Nashua River by human health risk assessors. "Based on fish carcass and whole body analytical results, receptor groups that consume fish organ tissue or use the entire fish in meals may be at greater risk from some contaminants" (USFWS 1997).

Portions of the Department of Environmental Protection's Nashua River Basin 1998 Draft Water Quality Assessment Report focusing on the mainstem of the Nashua from the confluence of the North and South Branches to Squannacock River (including Still River, Nonacoicus Brook and Mulpus Brook) are attached as Appendix C to provide a synoptic view of water quality in these streams.

Woodcock on nest. *USFWS Photo*

Biological Resources

Vegetation and Habitat Types

Oxbow Refuge is located within the southern edge of the Northern Hardwoods Forest region. The refuge is primarily a riparian community consisting of forested wetlands, shrub swamps and oxbow ponds. The Nashua River flows through a broad, low gradient floodplain with extensive wetlands. The floodplain extends up to 1,650 feet in width. Hardwood forests occur long the slopes of the floodplain valley.

A complete habitat cover type map does not currently exist for the refuge, and vegetation surveys have not been conducted on all refuge property. However, the vegetation of portions of the refuge has been examined by a number of surveys. The University of Massachusetts has conducted a plant community and vegetation

analysis on portions of the Nashua River floodplain and surveys for rare plant species have been conducted (Searcy et al. 1993; Searcy 1994; U.S. Army undated; and Biodiversity 2000).

While the majority of work done to date has focused on wetland plant communities, the Fort Devens Natural Resource Office prepared a forest cover and condition inventory that included what is now the portions of the refuge north of Route 2 (Figures 3-1, 3-2, and 3-3). A broad description of these uplands are primarily comprised of: mixed oak-hardwoods, white pine-hardwoods, cherry-aspen hardwoods, red maple, shrub-land, and old field habitat (U.S. Army undated). The forest-stand condition indices reported in the Army inventory maps are likely to be outdated at this time.

The University of Massachusetts surveyed both wetland and upland plant communities along the Nashua River on the refuge north of Route 2 (Searcy et al. 1993). The study describes and evaluates upland forest and wetland plant communities within these areas of the refuge. The upland communities included: two Rich Mesic Forest, an Oak-Hardwood Forest and a White Pine-Hardwood Forest. The wetland plant communities examined were classified as: a Red Maple Swamp, a Southern New England Floodplain, acidic seepage, and two types of Oxbow Pond communities. A brief summary of the results of this study is provided in Table 3-9. A more detailed summary table providing a listing of the 174 plant taxa found in these communities, and their densities and percent cover are provided in Searcy et al., 1993.

Table 3-9. *Selected Plant Communities of the Oxbow Refuge North of Route 2*

Area Surveyed	Communities Identified	Plots Identified	Tree Species	Shrub Species	Herbaceous Species
Nonacoicus Brook Area	S. New England Flood-plain Red Maple Hardwood Swamp White Pine Hardwood	3 1 1	5	6	30
Jackson Road to Hospital Road Area	White Pine Hardwood Mesic Forest Oak Hardwood Red Maple Hardwood Swamp S. New England Flood-plain Acidic Seepage Swamp Oxbow	23 18 11 4 2 1 1	26	23	114

In 1994, the portion of South Post which is adjacent to the Nashua River was more intensely surveyed. This area is directly west of Oxbow Refuge. Although it is not the refuge, many of the characteristics and features of the west side of the river also apply to the east side of the river. This includes the identification of this area as a southern New England floodplain forest, which is a high priority habitat for protection within the State of Massachusetts. The floodplain area of this stretch of the Nashua river is flatter,

wetter, and generally supports a larger more continuous area of forested wetlands (Searcy et al. 1994).

Marsh wren. *Photo by Bruce Flaig*

Oxbow Ponds

In 1995, the vegetation of the oxbow ponds and sloughs along the western floodplain of the Nashua River south of Rt 2, were inventoried and classified as a result of a contract between the Fort Devens Military Reservation and the University of Massachusetts (Hickler 1995). The majority of the oxbows lie west of the Nashua River on the Reserve, however there are oxbows on the eastern floodplain which are on the southern ½ of the refuge. The characteristics and floristic inventories of the western oxbows can be extrapolated to the oxbows that lie east of the river, with caution.

Oxbow ponds are formed when a river cuts through the neck of a meander, leaving behind a section of river channel which forms a pond with a characteristic oxbow shape. One of the unique characteristics of these oxbow communities, is the almost complete turnover of species composition between vegetation zones within one or two meters of each other. The oxbow communities have a higher variety of plant species than the adjacent upland, but more than of half of those species are limited to only one or two oxbow ponds. Therefore, each pond individually contributes unique plant species to the overall biological diversity of the oxbow pond system. The oxbow communities were classified as four major vegetation types: Common Buttonbush *(Cephalanthis occidentalis)* swamp, wet meadow, deep marsh, and open-water aquatic.

Common Buttonbush Swamp

Ten of the 15 ponds studied, were Buttonbush swamps with a well developed border of common buttonbush and a few associated forb species and tree seedlings.

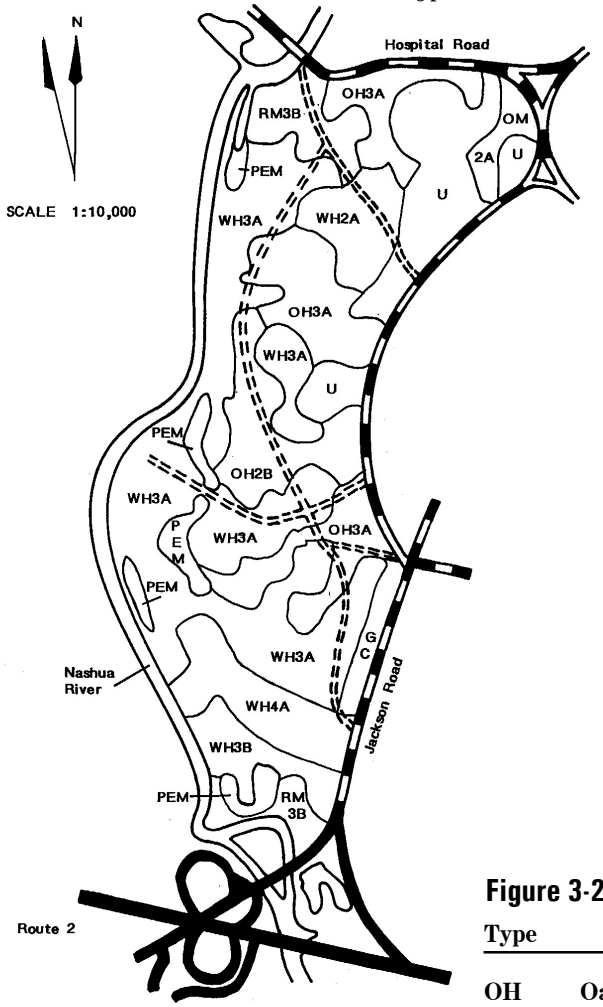
Wet Meadow

Seven of the 15 ponds supported wet meadow communities. The wet meadow communities have many grass and forb plant species that vary widely between ponds and within meadows on a single pond. The most frequently occurring species in the wet meadow are: cut-grass (*Leerzia oryzoides*), swampcandle *(Lysimachea terrestris*), common arrowhead (*Sagittaria latifolia*), false nettle (*Boehmeria cylindrica*), and needle rush (*Eleocharis acicularis*).

Deep Marsh

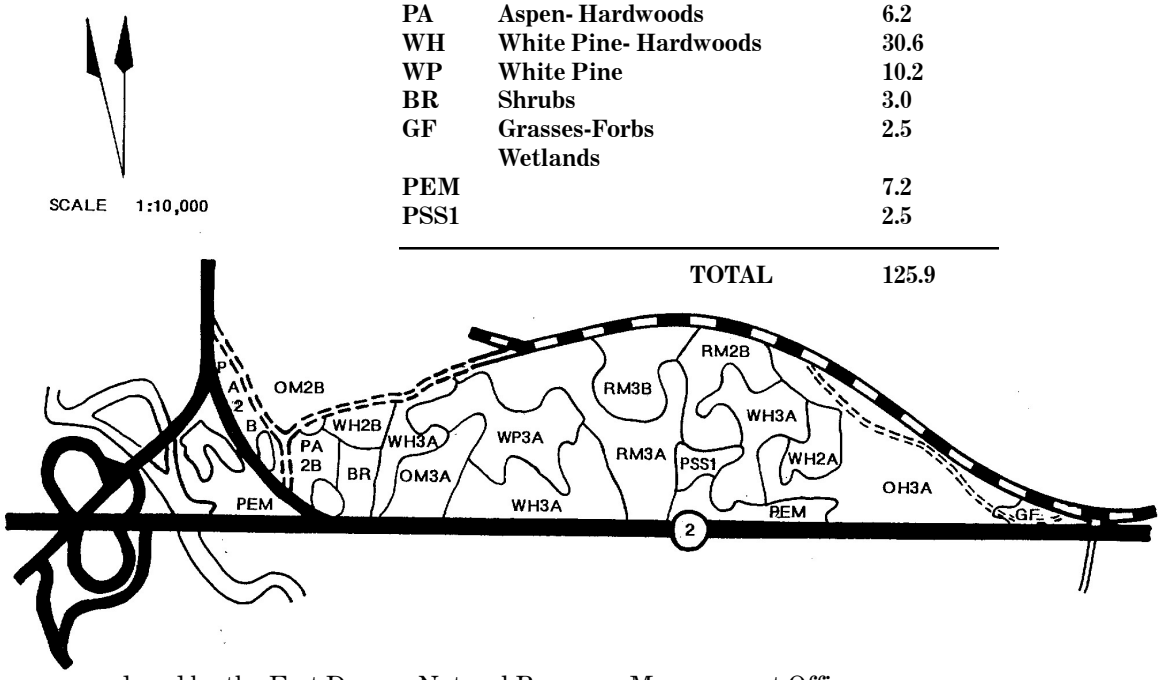
Deep marsh communities occur either as a band between meadow communities and open water, or covering large areas on shallow ponds. Deep marsh is characterized by emergent species along with floating leaved and submersed species. Pickerelweed (*Pontederia cordata*) is the most characteristic species, forming dense floating mats over large expanses on many of the ponds.

Figure 3-1. *Forest and Land Cover Types (Area 1A Fort Devens)*



Type		Acres
OH	Oak-Hardwoods	64.5
OM	Mixed Oak	7.0
WH	White Pine- Hardwoods	138.7
RM	Red Maple	17.4
GC	Gold Course	5.7
U	Developed Land	35.4
	Wetlands	
PEM		11.0
	TOTAL	279.7

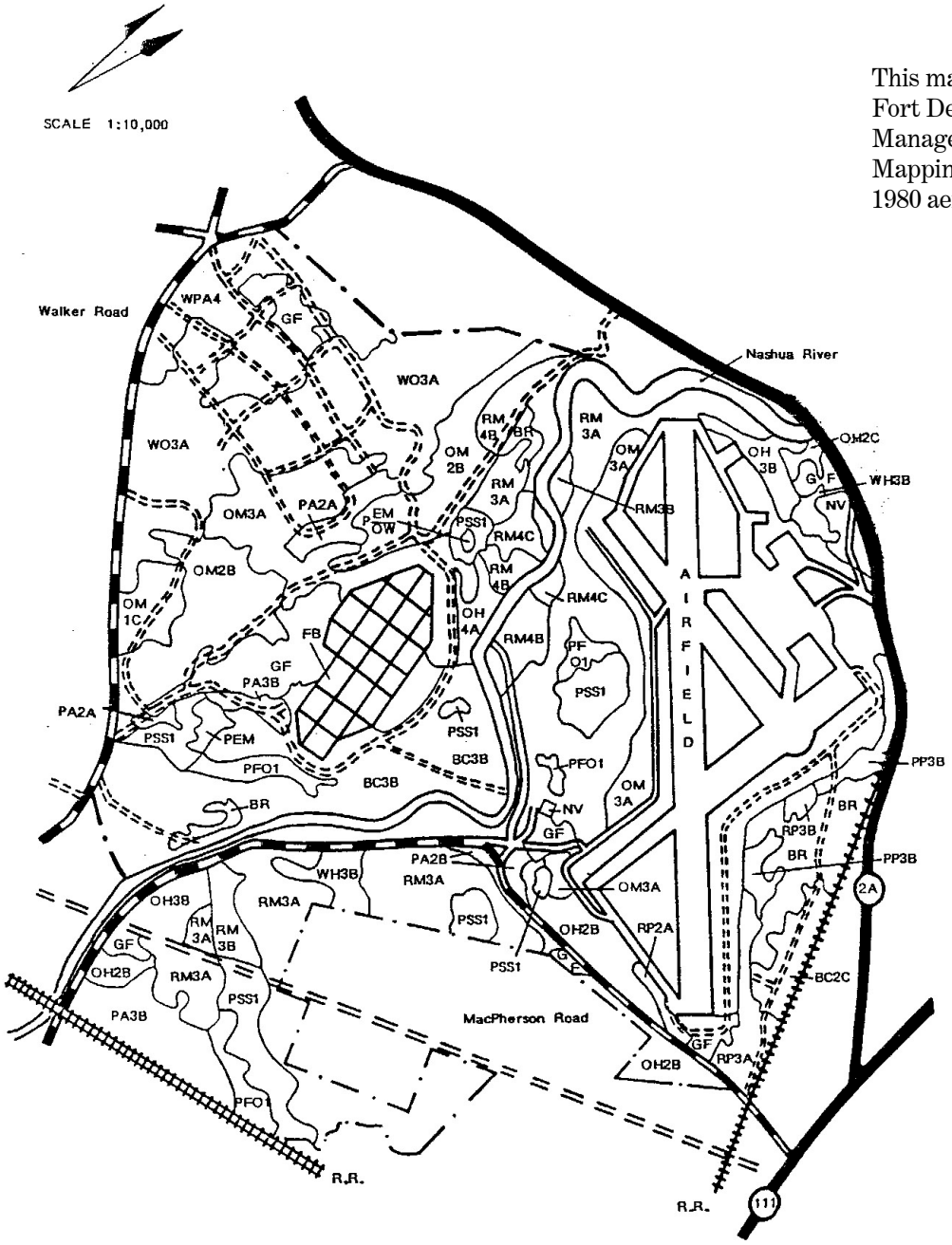
Figure 3-2. *Forest and Land Cover Types (Area 1 Fort Devens)*



Type		Acres
OH	Oak-Hardwoods	23.6
OM	Mixed Oak	6.5
RM	Red Maple	33.6
PA	Aspen- Hardwoods	6.2
WH	White Pine- Hardwoods	30.6
WP	White Pine	10.2
BR	Shrubs	3.0
GF	Grasses-Forbs	2.5
	Wetlands	
PEM		7.2
PSS1		2.5
	TOTAL	125.9

These maps were produced by the Fort Devens Natural Resource Management Office
Mapping based upon October 1980 aerial photography

Figure 3-3. *Forest and Land Cover Types (Area 2, 3 and Airfield Fort Devens)*



Type		Acres	Type		Acres
OH	Oak-Hardwoods	42.6	GF	Grasses & Forbs	20.4
OM	Mixed Oak	106.8		Airfield	176.0
WO	White Pine- Oak	77.2	FB	Filter Beds	31.6
WH	White Pine- Hardwoods	7.2	NV	No Vegetation	5.5
RM	Red Maple	146.4			
WP	White Pine	32.6	Wetlands		
RP	Red Pine	10.2	PSS1		25.1
PP	Pitch Pine	7.2	PFO1		13.6
PA	Aspend	24.4	PEM		2.5
BC	Cherry- Aspen- Hardwoods	73.0	River		23.4
BR	Shrubs	20.4			
				TOTAL	862.3

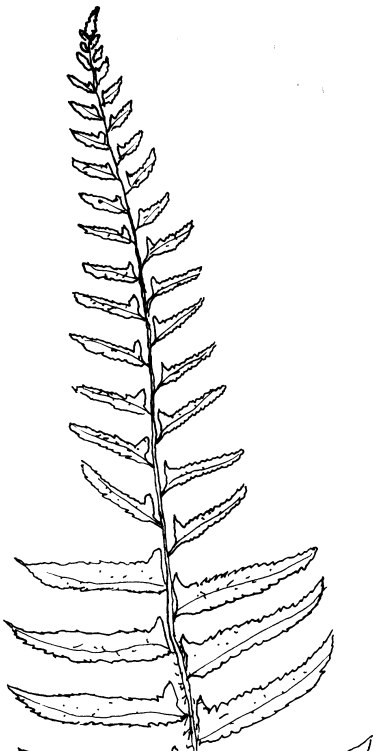
Open Water Aquatic

There are three aquatic cover types which are delineated by water depth. Shallow water areas are characterized by a dense cover of coontail (*Ceratophyllum demersum*), followed by a zone lacking emergent species with a amount of watermeal (*Wolffia spp.*), and a second variety of coontail (*Ceratophyllum echinatum*). The deepest aquatic cover type is distinguished by a high frequency of pondweed (*Potemogetion pusillus*) and yellow water lily (*Nuphar variegatum*) (Hickler 1995).

A general description of the types of oxbow pond communities (with a cross-reference to the most similar National Vegetation Classification System (NVCS) designation) is provided in Table 3-10.

Table 3-10. *Oxbow Pond Vegetative Communities*

Type of Oxbow Community	NVCS Cross-reference
Buttonbush Swamp	Palustrine *Cephalanthus occidentalis* shrub thickets
Wet Meadows	Palustrine medium tall graminoid vegetation
Deep Marsh	Mixed marsh emergents community type: RI Lacustrine emergent community: ME



Christmas fern. *USFWS Illustration*

Vernal Pools

Vernal pools are a priority habitat type within the State of Massachusetts. Many vernal pools have been identified on Oxbow Refuge, associated with the river floodplain and the adjacent forested wetlands. Vernal pools are temporary freshwater depressions which hold spring rains and snow-melt waters, and then typically dry out during late summer. Vernal pools are critical breeding habitat for amphibian and invertebrate species due to the lack of predatory fish. The vernal pools of Oxbow Refuge are confirmed breeding habitat for the State watch-listed spotted salamander and blue-spotted salamander which is a State species of special concern.

Biodiversity

The Friends of the Oxbow National Wildlife Refuge conducted a series of twenty six field trips on the refuge from March through October, 2000 (Friends of Oxbow 2000). All field trips were within the portion of the refuge located south of Route 2. These events were led by naturalists with expertise in the identification and ecology of a variety of biota. Eleven of these events examined a variety of plant groups including: lichens (27 species recorded), grasses and sedges (9 species reported), trees (39 species reported), shrubs/vines (47 species recorded), ferns/fern allies (32 species found), fungi/mushrooms (32 species reported), herbaceous plants/

wildflowers (100 species) and mosses (67 species reported), and liverworts (8 species recorded). A complete listing of species recorded during these Biodiversity Program events and by other observations on the Refuge are provided at Appendix F. To date, 352 species of plants have been identified on the Refuge, included 8 species that are on the Massachusetts State list of Endangered (SE), Special Concern (SC) or Watch-list(WL) of rare plants:

Table 3-11. *Massachusetts State-listed Species at Oxbow Refuge*

Scientific Name	Common Name	Listing
Lygodium palmatum	Climbing Fern	SC
Liatris borealis	New England Blazing Star	SC
Eleocharis ovata	Ovate Spike Sedge	SE
Sparganium minimum	Small Bur-Reed	SE
Populus balsamifera	Balsam Poplar	WL
Asarum canadense	Wild ginger	WL
Bidens discoidea	Small Beggar-Ticks	WL
Geranium bicknellii var. *bicknelli*	Bicknell's Cranesbill	WL

Wildlife Resources

Migratory Birds

Comprehensive inventories for wintering, breeding and migratory birds have not been conducted for all avian species groups at Oxbow Refuge. However, an impressive record of bird species using the Refuge has been developed by staff and expert volunteer birders. A complete listing of bird species identified on the Oxbow Refuge to date is provided at Appendix F. In addition, the refuge staff initiated breeding woodcock, land-bird and marsh-bird surveys on the Oxbow Refuge in 2000. The latter two surveys follow regional Service sampling protocol and contribute to regional and national databases. The annual breeding season American woodcock surveys also utilize standardized protocols, but are not currently a part of a regional or national series of observations.

The wetlands and open water bodies of the refuge provide important migration, feeding and nesting habitat for waterfowl species including the black duck *(Anas rubripes),* wood duck *(Aix sponsa),* mallard *(Anas platyrhynchos),* green-winged teal *(Anas crecca),* and Canada goose *(Branta canadensis).*

Wood ducks and pintail. *Photo by Bruce Flaig*

The wetlands along the Nashua River and its tributaries have been identified as a priority for protection under the North American Waterfowl Management Plan and the area is within one of the seven Focus Areas for the State of Massachusetts under this plan. Priority Waterfowl Species identified include black ducks, wood ducks, and mallards, which nest on the Oxbow Refuge in upland habitat surrounding wetlands that provide brood raising habitat (USFWS 1992).

The Oxbow Refuge also has recorded the presence of a number of other bird species of particular concern due to low or declining population levels in Region 5 of the Fish and Wildlife Service. These

include 5 Nongame Species of Management Concern (NGSMC), three species identified under the North American Waterfowl Conservation Act (NAWCA) and 6 Species of Regional Concern (SRC) identified in Table 3-12.

Table 3-12. *Bird Species of Concern at Oxbow NWR*

Scientific Name	Common Name	Listing
Anas platyrhynchos	Mallard	NAWCA
Aix sponsa	Wood duck	NAWCA
Anus rubripes	American black duck	NAWCA
Asio flammeus	Short-eared owl	Region 5, Nongame Species of Management Concern
Colaptes auratus	Northern flicker	NGSMC
Hylocichla mustelina	Wood thrush	NGSMC
Vermivora pinus	Blue-winged warbler	NGSMC
Sturnella magna	Eastern Meadowlark	NGSMC
Ardea herodias	Great Blue Heron	Region 5, Species of Regional Concern
Butorides striatus	Green heron	SRC
Falco sparverius	American kestrel	SRC
Scolopax minor	American woodcock	SRC
Caprimulgus vociferus	Whip-poor-will	SRC
Melospiza georgiana	Swamp sparrow	SRC

The Service Northeast Region Marshbird Callback Survey was conducted at Oxbow Refuge for the first time in 2000. This survey follows a national protocol which will assist with the monitoring of marshbirds throughout the nation. The Marshbird Callback Survey specifically targets the secretive birds of wetlands that are generally missed during landbird surveys. The initial survey focused on the southern third of the refuge but will be expanded to include the newly acquired northern properties. Great Blue Heron, Green Heron and Black-crowned Night Heron have been observed on the Refuge (Appendix F).

The Service Northeast Region Landbird Breeding Survey conducted on Oxbow Refuge is similar to the National Breeding Bird Survey in which singing males are recorded at designated points along a route that traverses the refuge during the breeding season (May-July). This survey was initiated in the spring of 2000 and resulted in an initial species list of breeding land birds. The Land bird survey is designed to continue for at least five years, at which time the data will be analyzed to determine the frequency at which the subsequent surveys need to be conducted to accurately monitor refuge populations.

Mammals

No formal surveys or inventories have been conducted on the refuge for mammals. However, 30 species of mammals have been identified by sight, sign or tracks on the refuge, including four bats that have tentative records (Friends of Oxbow 2000). A listing of these species is provided at (Appendix F).

In 1992, a small mammal survey was conducted on portions of the adjacent Fort Devens Military Reservation. Most of the areas that were sampled were in or adjacent to wetlands habitat in an effort to obtain specimens of the southern bog lemming (*Synaptomys cooperi*) and water shrew (*Sorex palustris*). Previously, a water shrew was captured in 1986, but in 1992, neither of these two mammals were captured (Thomas 1992). Mammals known to occur on the adjacent Fort Devens property may also occur on Oxbow Refuge given the similarity in habitats (Appendix F).

Reptiles and Amphibians

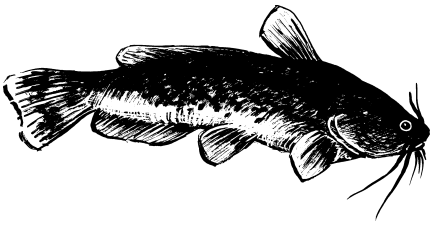
Comprehensive inventories of amphibians and reptiles have not been conducted. However, observations by refuge staff, a long-term series of investigations regarding Blanding's Turtles and the Friends of the Oxbow's Biodiversity-2000 Program have resulted in the compilation of a list of 17 reptile and 15 amphibian species occurring on the refuge. The species known to occur on the refuge include 4 reptiles and 1 amphibian species that are listed as Threatened or of Special Concern by the Massachusetts Division of Fisheries and Wildlife, Natural Heritage and Endangered Species Program. State-listed species of Special Concern are: Spotted turtle (*Clemmys guttata*), Wood turtle (*Glyptemys insculpta*), Eastern box turtle (*Terrapene carolina*), and Blue-spotted salamander (*Ambystoma laterale*). The Blanding's turtle (*Emys blandingii*) is listed as State Threatened.

Spring peeper. *USFWS Photo*

The Service Northeast Region Anuran Call Count survey which is designed to identify breeding frog and toad species of the refuge, and monitor to their populations. The survey began the spring of 2000 and focused on the southern third of the refuge, but, subject to the availability of funds, will be expanded to include the northern portions of the Refuge in 2001. The Anuran survey is designed to continue in order to accurately detect refuge population trends. A complete list of reptiles and amphibians at Oxbow Refuge is located in Appendix F.

Fish

Fish species documented in the main stem of the Nashua River include: largemouth bass (*Micropterus salmonoides*), smallmouth bass (*Micropterus dolomieui*), brown and yellow bullhead (*Ictalurus nebulosus and Ictalurus natalis*), yellow perch (*Perca flavescens*), chain pickerel (*Esox niger*), redfin pickerel (*Esox americanus americanus*), bluegill (*Lepomis macrochirus*), pumpkinseed (*Lepomis gibbosus*), black crappie (*Pomoxis nigromaculatus*), white perch (*Morone americana*), white sucker (*Catostomus commersoni*), blacknose dace (*Rhinichtys atratulus*), spottail shiner (*Notropis hudsonius*), golden shiner (*Notemigonus crysoleucas*), tesselated darter (*Etheostoma olmstedi*), fallfish (*Semotilus corporalis*), common shiner (*Notropis cornutus*), slimy sculpin (*Cottus cognatus*) and goldfish (*Carassius auratus*) (MDFW 1974 and MADEP 1993). Native brook trout are found in Walker



Bullhead. *USFWS Illustration*

Brook (Town of Shirley 1996). The Squannacook River, which flows into the main stem of the Nashua River just north of the refuge, supports wild brook and brown trout populations, and also gets stocked with brook, brown, rainbow and tiger trout (MDFW 1974). It is likely that some of these trout find their way into the main stem of the Nashua River. The fish species found in the Nashua River in its course through the refuge are listed in Appendix F.

In 1994, a 2.5 mile section of the Nashua River in the Fort Devens area was surveyed by the U.S. Fish and Wildlife Service to check levels of contaminants in fish tissues (USFWS 1997). PCB,s, DDT and mercury were found in fish tissues; as well as chlordane compounds and dieldrin. Chromium, arsenic, cadmium, lead and selenium were also detected at elevated levels in fish tissue. This report recommends separate evaluation of the contaminant concentrations in fish from the Fort Devens section of the Nashua River by human health risk assessors. "Based on fish carcass and whole body analytical results, receptor groups that consume fish organ tissue or use the entire fish in meals may be at greater risk from some contaminants."

As part of the large scale plan for fish restoration in the Merrimack River, the Nashua River Watershed is a current and future release location for river herring. Anadromous fish restoration is a cooperative effort among State agencies including the Massachusetts Division of Marine Resources, Massachusetts Division of Fisheries and Wildlife, and federal agencies including the Service, National Marine Fisheries Service and U.S. Forest Service. The Nashua River is considered a self-sustaining river in that it has existing fish passage facilities at dams which need to be modified or improved as part of the plan. This watershed will also be monitored and evaluated to ensure effective and efficient upstream and downstream passage of fish. Fish that would benefit from this effort include the river herring *(Alosa pseudoharengus)*, American shad (*Alosa sapidissima*) and American eel (*Anquilla rostrata*).

Invertebrates

With the exception of a 1994 inventory of moths, no formal surveys have been conducted on the refuge for invertebrate groups. However, the Friends of the Oxbow Refuge's Biodiversity-2000 Program, and other observations, have resulted in the compilation of a list of species that utilize the habitat resources of the refuge. This inventory list includes: 9 freshwater mollusks species, one of which, the Triangle floater *(Alasmidonta undulata*), is a listed as a Species of Concern by the State due its low population numbers; 32 species of Butterflies; 22 species of Dragonflies and Damselflies; and 57 other species of insects.

In 1992 and 1994, entomologists from the Lloyd Center for Environmental Studies inventoried moth species on the refuge (Mello and Peters 1993; Mello and Peters 1994). A total of 246 species of moths were recorded on the refuge. Observations of

moths on the refuge were also made during the Friends of the Oxbow Refuge Biodiversity 2000 Program. A total of 134 species were recorded, including 84 species not observed during the earlier inventories (Appendix F).

Invasive or Overabundant Species

Common reed (*Phragmites*) has invaded a portion of wetlands of Oxbow Refuge. Planning to determine its rate of spread and the most effective means of control has been initiated.

Purple loosestrife (*Lythrum salicaria*) is the another extremely invasive plant species which threatens portions of the wetland habitats of Oxbow Refuge. No formal surveys to determine the rate of spread have been conducted. The refuge has released *Galerucella sp.* beetles and *Hylobius transversovittatus* weevils as biological control agents. The *Galerucella* beetles are leaf-eating beetles which feed on the leaves and the new shoot growth of purple loosestrife, weakening the plant until it eventually is removed or reduced. *Hylobius tansversovittatus* is a root-boring weevil that deposits its eggs in the lower stem of purple loosestrife plants. The hatched larvae feed on the root tissue, destroying the plant's nutrient source for leaf development, which in turn leads to the destruction of the mature plant.

Autumn olive. *USFWS Photo*

Additional plant species that are considered to be invasive, and that require monitoring on the refuge include: Spotted knapweed (*Centaurea maculosa*), Glossy Buckthorn (*Rhamnus cathartica*), Oriental Bittersweet (*Celastrus orbiculatus*), and Autumn Olive (*Elaeagnus angustifolia*).

Threatened and Endangered Species

Rare Vertebrate Species

The Service has not conducted comprehensive surveys for threatened and endangered species on the refuge. The Massachusetts Natural Heritage Program has identified the State endangered pied-billed grebe (*Podilymbus podiceps*) as occurring on the refuge, as well as, the State threatened Blanding's turtle (*Emydoidea blandingii*). The blue-spotted salamander (*Ambystoma laterale*), which is dependent on the vernal pools of Oxbow Refuge, is a State species of special concern.

The pied-billed grebes in the Northeast breed in ponds, sloughs and marshes, along marshy edges of rivers, lakes and reservoirs. They prefer wetlands that are less than 5 hectares with abundant aquatic-bed vegetation and open water interspersed with robust emergent vegetation. Breeding locations are scattered through much of the Northeast and are more localized and less abundant than in other regions of the U.S. In Massachusetts the pied-billed grebe is a local breeder throughout the State, but because of its rarity, the State has listed it as endangered in Massachusetts.

The pied-billed grebe is identified by the Service as a migratory non-game bird of management concern in the Northeast which is representative of a biological community that is threatened in the Northeast. The greatest threat to the northeast pied-billed grebe population is the alteration and loss of wetland habitat through draining, dredging, filling, pollution, acid rain, agricultural practices, and siltation. (USFWS 2000b).

The spotty, low-density distribution of the Blanding's turtle is centered in the Great Lakes region with disjunct populations in southeastern New York, eastern New England and Nova Scotia. In New England, this turtle is found in eastern Massachusetts, southern New Hampshire and southern Maine. There are only seven known nesting sites in Massachusetts.

Blanding's turtles were found at Oxbow Refuge in 1986, when a female and tracks were located by Brian Butler. Since that time, the population has been continually monitored. Individual turtles are uniquely identified with marginal shell notches, which allows for the calculation of local population size. Butler has estimated that approximately 25% of nesting females are new each year. This indicates a thriving population and is impressive for most species but is especially significant for the Blanding's turtle, given that females do not breed until they are about 12 years old.

Habitat loss and predation on eggs are two factors limiting Blanding's turtles. Historical photos and records indicate that approximately 50% of the amount of habitat that historically was available for nesting turtles has been lost, due to the encroachment of shrubs and trees through natural succession.

Blanding's turtle. *Photo by Bruce Flaig*

A high level of egg loss, as a result of fox and raccoon eating the eggs, has been a problem in many areas. During this vulnerable time, nesting areas are activity monitored and protected to reduce predation and human disturbance until the eggs hatch (Brian Butler, personal communication. Oxbow Associates, Lunenberg, MA)

In Massachusetts, the blue-spotted salamander is a species of special concern and occurs predominantly within Middlesex and Essex counties and in the adjacent eastern towns of Worcester county. This 'mole' salamander requires moist, moderately shaded environments, favoring northern hardwood/hemlock forests. The blue-spotted salamander requires vernal pools and small ponds for breeding and egg laying, as well as the survival of their larvae until they metamorphose into air-breathing adult salamanders.

The major threat to this species, and other salamanders as well, is the loss of wetland habitat to draining and development. Some population declines may also be attributed to sample over collection, foot and road traffic and pesticides or other toxic chemicals MDFW undated).

Rare Plant Species

Although a complete plant inventory has not been conducted for the Refuge, four rare plant species are known to occur on the refuge. Another three rare plants occur immediately adjacent to the refuge in habitat similar to that of the refuge. Because of the similarity of habitat on both sides of the river, there is potential that these State-listed rare plants also occur on refuge property.

The State of Massachusetts has listed ovate spike-sedge as endangered. Three populations of ovate spike-sedge occur along this stretch of the Nashua River floodplain. The largest population of ovate spike-sedge is on the refuge. There are four other areas that have been identified as potential habitat for this species along the floodplain, with one of these areas occurring on the refuge (Hunt 1991)

Climbing fern may be abundant where it is found, however populations are rare and localized, making this a species of special concern in Massachusetts. Climbing fern does not have the characteristic shape of most ferns. It is an evergreen, ivy-like plant which sprawls over the ground or climbs clockwise short distances up shrubs and coarse herbs. This fern grows in moist pine-oak-maple woods with an open understory, moist thickets and stream margins (MDFW undated).

Wild black currant (*Ribes americanu*m) typically occurs in floodplain thickets and swampy woods of the northeast. This species has been delisted but remains on Massachusetts' watch list. A single plant was located on the northern half of the Refuge within additional suitable habitat for this species to expand (Hunt 1991).

A single location of Northern Wild Senna (*Senna hebecarpa*) is know to occur on the northern portion of the refuge. Field inspection in 2000 indicated the plants were doing well, but that shrubby overgrowth should be periodically cleared to enhance habitat conditions for the senna (Dr. William Brumback, New England Wildflower Society, October 2000, personnel communication).

Small bur-reed occurs in shallow water throughout northern New England, but is listed as endangered in the State of Massachusetts. Small bur-reed is known to occur in only one area of the refuge. This area was initially located in 1993, with a more intensive follow up survey in 1994 for more areas of small bur-reed. No additional areas of small bur-reed were located in 1994, and there was a decline in the patch size of the small bur-reed found in 1993. This may have been caused by an actual decline in individual plants, an increase in water

Table 3-13. *Rare Plant Species on Oxbow Refuge*

Species	Common Name	State Status
Eleocharis ovata	Ovate Spike-sedge	endangered
Lygodium palmatum	Climbing Fern	special concern
Ribes americanum	Wild Black Currant	watch list
Senna hebecarpa	Wild Senna	endangered
Sparaganium natans	Small Bur-reed	endangered
Bidens discoidea	Small Beggar-ticks	watch list
Geranium bicknellii	Bicknell's cranesbill	watch list
Liatris borealis	Blazing Star	special concern

level in 1994, or an algal bloom in 1994 which made it difficult to estimate the percent coverage of the small bur-reed (Searcy et al. 1994)

The range of small beggar-ticks is from Massachusetts to Virginia, Ohio, Michigan, Louisiana, and Texas. This species typically occurs in buttonbush swamps, ponds, oxbows, forested swamps and other wetlands. In Massachusetts, small beggar-ticks is currently known to occur at four sites. One site of small beggar-ticks occurs adjacent to the Refuge, with suitable habitat identified adjacent Nashua River floodplain (Hunt 1991).

Bicknell's cranesbill typically occurs in the dry rocky woods of eastern Massachusetts, however the two areas that were identified adjacent to the refuge occur in wetlands. The species is scattered in western Massachusetts and it is unclear whether or not the population found adjacent to the refuge is native (Hunt 1991). Bicknell's cranesbill is on the State species Watch List.

Northern blazing star is found in dry clayey or sandy soils in open woods and clearings throughout New England. Although formerly common in Massachusetts, this species is now only abundant in southeastern portions of the State. Two small populations were identified in disturbed sandy soil adjacent to the refuge and it is possible that this species may also occur in similar habitat on the refuge (Hunt 1991).

Special Designations

The Oxbow Refuge and the Nashua River Corridor are listed as a priority for protection under both the North American Waterfowl Management Plan and the Emergency Wetlands Resources Act of 1986.

The refuge and the Nashua River corridor are also included with the EPA's Priority Wetlands of New England.

The eight mile length of the refuge is a key component of the Nashua River Watershed Association Nashua River Greenway designation.

The portion of the Oxbow Refuge south of Route 2 lies within the 12,900 acre Area of Critical Environmental Concern (ACEC) designated by the Massachusetts Secretary of Environmental Affairs due to its unique environmental characteristics and values. (MADEP 1998).

Oxbow Refuge, Devens Reserve, Bolton Flats Wildlife Management Area, the Nashua Greenway, Lancaster State Forest and other lands along the Nashua River have been nominated as a Massachusetts Important Bird Area (IBA) for their significance to grassland species, several of which are identified under the PIF Plan as priority species. Species present include grasshopper sparrow, Vesper sparrow, upland sandpiper, boblinks, and whip-poor-wills, and others. IBAs provide essential habitat for at least one or more species of breeding, wintering or migrating birds. The primary goals of the program are listed below.

- "To identify, nominate and designate key sites that contribute to the preservation of significant bird populations or communities.
- To provide information that will help land managers evaluate areas for habitat management or land acquisition.
- To activate public and private participation in bird conservation efforts.
- To provide education and community outreach opportunities."

(http://www.massaudubon.org/Birds_&_Beyond/IBA/iba_intro.html) These lands, along with other nominated areas, will be declared officially designated or rejected sometime this year.

Cultural Resources

Prehistoric Period

The earliest evidence of human occupation of the Nashua River drainage dates from the Paleoindian Period (12,500-9,000 BP (Before Present)). The landscape during this time is characterized as post-glacial with oak and spruce beginning to repopulate the area. This time period is when people first moved into the northeast. Archaeological data for this period near the refuge, consists of a single fluted point found on the surface adjacent to a small pond in Lancaster (Anthony 1978). No diagnostic artifacts have been directly associated with the river itself.

During the warmer and drier climate of the Early Archaic (9,000-7,500 BP), the pine-hardwood forest would have made seasonally available resources that would be predictable and abundant. Some archaeological evidence suggests that a complex multi-site settlement system had been established by this period, with different site locations indicating exploitation of varied resources and environmental settings (Johnson 1984; Ritchie 1984). Populations probably increased during this period, although known sites are poorly represented in the archaeological record. Only ten sites from

the Early Archaic period have been identified in this area, however, with further testing, more should be identified.

The population is slightly higher during the Middle Archaic (7,500-5,000 BP) in this region. The distribution of Middle Archaic sites indicates that seasonal settlement systems were firmly established (Glover 1993). Sites have been located along Muddy Brook and the Wachusett Reservoir at the headwaters of the Nashua River in West Boylston. Middle Archaic artifacts have also been found in Leominster, however, the site density is less than what is found along the Concord and Assabet drainage areas. By this time, the present seasonal migratory patterns of many bird and fish species had become established (Dincauze 1974) and important coastal estuaries were developing (Barber 1979).

Late Archaic Period (5,000-3,500 BP) settlement in the Merrimack River Basin has been documented at a number of site locations along most of the drainage's principal water courses in Massachusetts and New Hampshire. The large number of sites and artifacts attributed to the Late Archaic Period, coupled with the high density of sites and their occurrence in a wide range of habitats, has been interpreted as reflecting a dense population intensively exploiting an extremely broad spectrum of resources (Dincauze 1974; Ritchie 1985). Increase in occupation could be a possible correlation with a period of climatic warming beginning approximately 5,000 years ago (Funk 1972). Single and multi-component campsites were used for seasonal resource procurement activities. Sites from the Late Archaic are well represented in the refuge area. The majority of the sites in the refuge area appear to represent single or multi-component campsites utilized for seasonal resource procurement activities. There are also a few quarry sites in the area that were used for raw material procurement (Glover, 1993).

The Transitional Archaic Period (3,600-2,500 BP) is characterized in this area by the introduction of steatite (soapstone) vessels, and eventually ceramics, towards the end of this period (O'Steen 1987). Steatite vessels ceased to be manufactured with the introduction of ceramic technology, however, steatite was still used for making stone pipes (Ritchie 1985). Transitional Archaic sites in the refuge area are rare. Slightly more common, but still under represented, are Early Woodland sites.

The Early Woodland Period (3,000-1,600 BP) is generally under represented in the regional archaeological record suggesting a population decline and/or poorly documented tool assemblages. Evidence for Woodland occupation of the Nashua River drainage comes from a small number of Early Woodland Period sites. Along with a suspected Early Woodland deposition at several late Archaic sites, diagnostic Meadowood and Rossville projectile points have been identified in two private collections (Glover 1993).

Middle Woodland Period (1,650-1,000 BP) sites are more common indicating an increase in population, which is observed throughout New England. During this period, in this region, there were

extensive long-distance social and economic interaction spheres. Horticulture appeared during this time and ceramics were commonplace. There was also a lot of movement from people traveling throughout the Northeast at this time. The Middle Woodland Period activity in the Nashua drainage is represented solely at the Reedy Meadow Brook site in Pepperell. The deposition included diagnostic Fox Creek and Jack's Reef projectile points which were found in association with local and exotic stone debris including materials from Labrador and Pennsylvania (Mahlstedt 1985).

The Late Woodland Period (1,000-450 BP) in this region is marked by an increase in ceramic production through improvements in technology. Some populations may not be engaged in horticulture however. The Late Woodland populations appear to be moderate around the refuge. Coastal areas and semi-permanent settlements seemed to have been preferred and larger groups lived in fortified villages. Late Woodland Period artifacts represented in the archaeological record include triangular Levanna points, cord-wrapped stick impressed and incised collared ceramic vessels, and increasing amount of local stone materiels used (MHC 1985).

By the Contact Period (450-300 BP), the Nipmuck nation was established in the refuge region. Their settlement consisted of semi-permanent villages focused on river drainages and tributary systems. Political, social and economic organizations were relatively complex and underwent rapid change during European colonization. Groups during this time, and most likely earlier times, were attracted to the anadromous fish runs in the river. The area around Harvard, contained permanent camps along the River as well as smaller, temporary camps adjacent to the natural ponds. This region, particularly the northern and western sections toward New Hampshire and Vermont, also falls within the cultural boundaries of the Western Abenaki. The Squakeag subgroup inhabited the upper Nashua River Valley and became heavily involved in fur trade. The Abenaki group tended to cluster in large fortified villages (MHC 1985).

In central Massachusetts, the Contact Period is even less well documented than the rest of the prehistoric period. The inland location of the central uplands region precludes the availability of ethnohistorical counts by early colonial settlers visiting coastal sections of New England during the sixteenth century. By the time of direct contact with settlers in the seventeenth century, the effects of disease, isolated trade, and intertribal warfare had significantly changed the local population (Glover 1993).

Prior to European settlement in the first half of the seventeenth century, the Fort Devens section of the Nashua River Valley was primarily inhabited by the local subgroup of the Nipmuck known and the Nashaway, believed to have directly descended from pre-contact groups. Settlement patterns in the area continued to focus on the river drainages and their tributary streams during this period.

Subsistence systems most likely remained oriented towards hunting and gathering of seasonally available food resources. An increased dependence on horticulture is considered likely given the appearance of semi-permanent, sometimes fortified, village settlements (MHC 1985).

Although the gently rolling uphill terrain of the Nashua River drainage would have allowed a favorable range of movement, as well as an abundance and diversity of food resources, no prehistoric occupations from this period are documented in the area (MHC 1985). No primary or secondary Contact Period trails pass directly within the area encompassed by Fort Devens, however a major north-south trail passed to the immediate west through Lancaster and secondary north-south and east-west trails traversed present-day Harvard, Ayer and Shirley. The area of present-day Lancaster, at the confluence of the Nashua and North Nashua Rivers, was the site of the repeated or long-term camp of the Nashaway group, who utilized the surrounding areas from this base camp. Larger populations would also have been attracted to the area due to the presence of anadromous fish runs in the river, or to its floodplains for horticulture (MHC 1985).

Although not many sites have been reported from this region, the area has the potential to yield archaeological sites that will contribute to our understanding of prehistoric settlement in this region. Further study would supply more information about population densities and if they are found to be low for a time period, research questions can address the cause. Four prehistoric sites have been identified within the refuge boundary. The refuge area should be considered moderately to highly sensitive for archaeological resources in areas not impacted by military ordinance.

Historic Period

During the early historic period, the refuge area was inhabited by a few European families engaged in farming activities. The region was heavily affected by King Philip's War in 1675. Garrisons were constructed to provide protection to the English settlers from the aggressions of the Native Americans. Attacks in Groton and Lancaster left the settlers depleted of supplies. The settlement was abandoned shortly after, and the people retreated to Concord. By 1676, the outer frontier area had crumbled (Glover 1993) .

The refuge area was void of English settlement for several years after the end of the war. The death of Philip and the English defeat of the various native groups throughout the region in the fall of 1676 meant that repopulation of the frontier was possible. The surviving Nipmucks of the Nashua river either fled westward and northwest or went to live with other groups or were reduced to subservient status. Towards the end of the 17th century, English repopulation had begun in the Refuge area (Glover 1993).

This period of frontier resettlement was characterized by the demise of the nucleated English village and open field system. The trend

was toward consolidating land holdings and the importance of the meetinghouse center. During the early 1700s, populations in the original territories increased steadily. Larger grants were subdivided in the process of establishing a meetinghouse, forming a government and assigning town lands (Glover 1993).

Population increases and economic growth took place at different rates in the original grants and new towns. Lancaster and Groton, the two oldest towns, were the most commercially developed population centers or core areas of settlement in the Nashua River Valley. The range of non-farm employments in these towns led to clusters of dwelling radiating out from the town center. Settlement in the late 18th century in the frontier towns reflected the regional economy of animal husbandry and extensive mixed grain cultivation. By the onset of the Revolutionary War, a number of the frontier towns in central Massachusetts were on their way to becoming important commercial and industrial regional centers (Glover 1993).

The Town of Harvard was established in 1732 from parts of Lancaster, Groton, and Stow. Therefore, its historical development begins with the establishment of these colonial plantations. The Lancaster plantation was founded in 1653, followed by the Groton plantation in 1655. During the 1650's, Harvard served as outlying meadowland for the 35 families settled in Lancaster. The first documented evidence of colonial building on Harvard soil was the construction during the 1660's of John Prescott's grist mill on Nonacoicus Brook. The mill was abandoned during King Philip's War and rebuilt eastward on Stoney Brook once the territory was established (Anderson 1976).

Settlement of Harvard, which began in the late 1600's was located in the southern section of town, which remained part of Lancaster until 1732. As the population grew from 4 families in 1692 to 39 in 1723, small concentrations developed east and west of Bare Hill Pond; at Still River; at Oak Hill; and at the Old Mill. There were four garrison houses for Harvard's protection because Native American hostilities continued for several decades after the end of King Philip's War. One garrison house, which was located at Still River, was built by Major Simon Willard's son, Henry, in 1694 (MHC 1983).

By the time of Harvard's incorporation in 1732 from the eastern half of Stow Leg (the unclaimed tract of land between Groton and Lancaster plantation), the southern portion of Groton, and the northeast corner of Lancaster, there were over sixty families settled within the territory. The meetinghouse was built at the geographic center (now Harvard center) shortly after Harvard became a town (Anderson 1976). During this planning stage, a 30 acre lot was set aside to accommodate the town's pound, stocks, cemetery and any other public facilities to come, such as the Poor House (1753). Schools, taverns, and inns were also built to meet the needs of the townspeople (MHC 1983).

Harvard's predominantly agricultural economy was supplemented by a small number of artisans and support industries. Saw and grist

mills were located on Bowers Brook and at Mill Road. Other town industries included a tannery, blacksmith, trip hammer, iron works and fulling mill. A blue slate quarry began operation on Pine Hill during the mid-eighteenth century, supplying slate for grave stones. Silver mining operations began on the south slope of Oak Hill during the 1780's (Anderson 1976).

The Shaker Community in Harvard was officially established in 1793. It was divided into four families, and had a maximum approximate membership of 200 (Andrews 1963). Some of its members were native to Harvard, but the majority had been attracted to the community from other towns. The Shakers went on to acquire hundreds of acres, until they controlled most of the northeast corner of the town. The money for these real estate transaction came form the estates of new converts to the Shaker religion who settled in Harvard (Anderson 1976).

The Harvard shakers, dwindled in numbers due to lack of converts and orphan children. The community closed in 1918, after 127 years of existence in the town. The site of the Church Family is known today as the Shaker Village and consists of private homes. Like central Massachusetts during the Federal Period (1775-1830), Harvard experienced a period of population and economic growth. Between 1776 and 1830, the population increased from 1,315 to 1,600. Distinct nucleated villages developed within Harvard; at Still River, and the Shaker Village in northeast part of town, and at Harvard Center where residences concentrated around the Commons. Beyond these villages, growth patterns remained dispersed and residents engaged in agricultural pursuits, which consisted of raising sheep, cattle and grain (MHC 1983).

Despite construction of the Worcester and Nashua Railroad in 1848, and associated depots at Still River and northwest of Harvard center, Harvard remained essentially rural throughout the early industrial period (1830-1870). The primary agricultural products were hops, hay, grains, vegetables, and fruit from apple and pear orchards. Dairying, cattle and swine raising were also major industries. By 1875, agricultural goods yielded $223,892 (MHC 1983).

Harvard was the home to two stops on the Underground Railroad, hiding slaves as they made their flight north to Canada. The list of those who supported the Railroad and helped in the slaves escape is a long one and includes some of the prominent citizens of the town, including the town's reverend and deacon (Anderson 1976).

During the late Industrial Period (1870-1917), Harvard saw a rise in industry within the town. The manufacturing peak of the period was the opening of the Union Brick Co., Union Paving Co., New England Brick Co., and Haskell's Vinegar Works, each located around Still River and the railroad. A wool knitting mill and other small-scale textile plants, and machinery shop helped support the town's industrial economy until the end of the century (Anderson 1976).

Agriculture remained the town's primary income source, producing 200 products in 1905. The dairy industry continued to be an important economic asset, supported by poultry and egg production and the introduction of viticulture(grapes) (MHC 1983).

By 1917, the town of Harvard recorded a population of approximately 1,000 people, supporting themselves by commercial dairying and selling vegetable and fruit products. Manufacturing played a very minor role in the economics of the town and was further reduced when the Shaker community closed in 1918 (MHC 1983). The adoption of the automobile and improvements to local roads and highways, such as Route 111 to Concord and Boston, Route 110 to Clinton and Ayer, Route 2 and Interstate 495 have supported continued expansion of the residential, commercial and professional population as well as the increase in suburban development within Harvard (MHC 1983).

The Refuge also extends into the towns of Ayer and Shirley (Middlesex County). Ayer was incorporated into a town in 1871 from sections of Groton and Shirley, and was part of the original colonial Groton plantation. During the mid-seventeenth century, colonial settlement of Groton consisted of a reputed fur trading house run by John Tinker located at the mouth of Nod Brook and four or five families living in a linear village established along the James Brook (Wing 1981; MHC 1980). Ayer and Shirley were unused common lands of the Groton plantation, being too far removed from the center of town. In 1659, unknown to the proprietors of the plantation, a 1,000 acre tract of Groton was granted to Major Simon Willard of Lancaster, the sergeant-major of the Middlesex County militia, as a reward for military service and in settlement of a debt owned to him by John Sagamore, an Indian chief who lived near the site of Lowell (Glover 1993).

By the outbreak of King Philip's War in 1675, Groton was estimated to contain 300 inhabitants, 40 structures, including a meeting house, five garrison houses, including Willard's mansion, and a grist mill built by John Prescott in 1673 on Nonacoicus Brook (now in Harvard). Ayer and Shirley were still relatively uninhabited. After the war when the towns were resettled, although a slow process, Ayer continued to be an outlying agricultural district of Groton with limited growth and settlement until after the mid-eighteenth century. The settlement of Ayer was sparse and oriented along Nonacoicus Brook. During the late eighteenth and early nineteenth century, Ayer was designated as Groton School district #5 which covered most of Ayer after 1793 (Glover 1993).

Settlement increased with an influx of Irish immigrants after 1845, and concentrated along Main and Park Streets and their side streets. The first store opened in 1851, followed by the 1858 construction of harmony Hall which consisted of stores on the first floor and a public hall on the second. The prosperous 1850's and 60's saw the construction of five churches, new school houses and a fire house (Glover 1993).

During the Late Industrial Period (1870-1917), Ayer's economy and growth continued to be tied closely to the regional railroads, the town's principal employer. The Ayer railroad yards were said to be the largest classification yard in New England. Ayer was incorporated as a town in 1871 from a southern section of Groton and the portion of Shirley east of the Nashua River. The town's population grew steadily, increasing by 50%, with 20% foreign born (still mostly Irish) between 1870 and 1917. An Irish colony developed along the Nashua River in the late 1800's. New Construction in Ayer center included a town hall, new fire station and public library. Electric trolleys also connected the town center to Fitchburg, Shirley, and Lowell (MHC 1980).

By the 1900's, Ayer's fields were overworked and losing their fertility. There were "sprout land", reclaimed by forest. Only the land near the Nashua River remained fertile and contained large farms owned by Irish families. Ayer's population expanded in the early 1900's, then stabilized after 1920. The Army began leasing land in the town in 1917, and acquired large plots in the western section in 1920 to form Camp Devens. Economic disaster occurred in 1927 when the railroad yard moved out of Ayer and the tanner closed. Construction of the Moore Army Airfield on the North Post of Fort Devens brought air transport to the area. Settlement remained focused at the town center, and only recently have the undeveloped peripheral areas been subdivided (MHC 1980).

The first documented settlement of Shirley occurred in the 1720's when improved river crossings, such as Page's Bridge (1726) on the Fitchburg Road permitted settlement of the central areas of town along east-west oriented Fitchburg Road paralleling Mulpus Brook. Until this time, the Nashua River had served as a barrier to colonial settlement. A few farms were also scattered along the Squannoacook River and the west side of the Nahsua River. As the frontier stabilized after 1730 there was a steady increase in the number of settlers moving into the territory. In 1747, thirty-three individuals singed a petition requesting early separation from Groton. In 1753, the District of Shirley was established. Two years later Shirley was incorporated as a town from the southwest corner of Groton and later the western half of Stow Leg (Glover 1993).

Economic activities consisted primarily of farming, supplemented by lumbering and milling. In the late 18th century, the Shakers began to influence the town's structure. Throughout the nineteenth century, the Shaker community in Shirley was considered a valuable part of the town. Their approximate maximum membership was 150, divided among the families. The Shirley Shakers were most noted for their thriving business in selling "shaker apple sauce". They also had a broom shop, a mop shop, a blacksmith shop, and a house where they prepared herbs (Bolton 1914). As the numbers of the Shirley Shakers dwindled in the latter part of the nineteenth century, the few sisters and brothers subsisted mainly on money gained from selling their milk in the village (Bolton 1914). They augmented their

monetary needs by maintaining a small store in the back of the office building. By the turn-of-the century, the Shaker members of the Shirley society had nearly all passed away. The few remaining Shirley Shakers abandoned the family settlements in 1908 and went to live with the Harvard Shakers (Glover 1993).

Like Ayer, Shirley's economic base and population growth pattern was enhanced by the construction of the Fitchburg railroad along West Min Road in 1845. During the early nineteenth century, a large scale carriage, wagon and harness factory operated on Mulpus Brook in Woodsville until it burned in 1871. The factory produced military wagons, horse drawn ambulances, and baggage wagons used in the Mexican and Civil Wars. Prairie Schooners, wagons used by the pioneers crossing the prairies and Rocky Mountains as they traveled west, were also a product of the carriage factory (Glover 1993).

During the Late Industrial Period (1870-1917), Shirley experienced limited growth. The tract of land east of the Nashua River annexed to Shirley in 1789 was set off from Shirley in 1871 and annexed to the town of Ayer. After 1870, there was little new industrial development, leading to a period of economic decline. Out of the nine major factories which prospered during the mid-nineteenth century, only one cotton mill and one paper mill were still in operation by 1890. The only new industry in the 1890's were the opening of the C.A. Edgarton Suspernder Factory and a cordage works. However, transportation improved when electric trolleys connected the town center to Fitchburg and Ayer (MHC 1980).

During the Modern Period (1917-present), Shirley experienced few changes in its settlement patterns or economic base. Steady, moderate population growth along with commercial strip development has occurred in peripheral areas, due in part to suburbanization and the military presence at Fort Devens after 1917. One of the most important additions to the town in the late twentieth century was the creation of MCI Shirley south of the town center at the site of the former Shaker Village (Glover 1993).

The United States declaration of war against Germany in April 1917 launched a massive nationwide construction campaign for the training of Army troops. Camp Devens in central Massachusetts was established as one of the 16 earliest of a total of 32 new Army cantonments nationwide. The approximately 11,000 acres of land chosen for Army training in central Massachusetts shared several common features with other selected sites across the country. It consisted of two adjoining parcels of land, known today as the Main and North Posts. These lands extended across the towns of Ayer, Shirley, Harvard, and Lancaster (Glover 1993).

The U.S. Army leased the approximate 11,000 acre tract in 1917. In 1917 the leased lands comprising the Camp Devens reservation extended from Route 2A at the Ayer/Shirley town line south to Route 117 in Lancaster. The reservation was bounded on the east by the Boston and Maine Railroad the Still River in Harvard and Lancaster, with the exception of a parcel of land to the east of the

railroad bounded by Cold Spring Brook. It was also bounded on the west by hilly uplands west of Lunenburg Road (Glover 1993).

The Army purchase of land for a permanent training reservation began in June 1919 and was complete by 1921 (Anon. 1923). The lands purchased at that time were considerably less that what Camp Devens had originally leased from 1917 to 1919. This was probably due to the deactivation status of the installation following World War I. The reduced lands purchased by the Army were situated in western Ayer, eastern Shirley, western Harvard and northeast Lancaster. The South Post lands were comprised of about 50 parcels, ranging in size from 1.5 to 93 acres with over 25 different landowners (War Department 1920).

Following World War I, Camp Devens had a caretaker status until 1927, maintaining a skeleton force of personnel. In the summer months, the reservation served as a training area for the National Guard, Reservists, ROTC cadets, Civilian Military Training Camp personnel, and Regular Army. In 1927 Camp Devens received federal funding to construct permanent housing and a hospital for the purpose of troop mobilization in the Northeast. The demolition of the wood-frame World War I structures and the construction of new permanent buildings began in 1928. In 1931, Camp Devens was renamed Fort Devens. The new cantonment area, built over the U-shaped system of roads form the World War I temporary camp, included a double ring of roads, new buildings, and a parade ground. Most of these buildings are now part of the Fort Devens Historic District (Glover 1993).

A complete permanent post was built at Fort Devens between 1934 and 1939. In 1941 a large tract of land was acquired by the Army south of the permanent cantonment, in the area known as the South Post. These land comprised the northeastern portion of the town of Lancaster, and were contiguous to those previously acquired west of the Nashua River and the former South Post annex. In June 1946, Fort Devens was deactivated and returned to a caretaker status. Following the Korean War, Fort Devens remained an active training center for Regular Army, ROTC, and National Guard troops.

Expansion after 1965 occurred primarily on the Main Post including the barracks area, a shopping center complex, and Cutler Army Hospital. Range buildings on the South Post and service buildings associated with the airfield and the sewage treatment plant on the North Post were constructed in the 1970's (Glover 1993). A slight reduction in the size of the South Post occurred in May, 1974, with the transfer of 662 acres of Training Area 4 to the Fish and Wildlife Service to establish the Oxbow National Wildlife Refuge. The remaining 49.03 acres of Training Area 4 (also known as the 94th ARCOM or Sylvania Building Area) was transferred to the Service as an addition to the Oxbow Refuge in February, 1988.

The Base Closure and Realignment Act of 1990 (Public Law 101-510), and the subsequent decisions by the BRAC-1991 Commission

and Congress required the closure and realignment of Fort Devens. The Army realignment action created the Devens Reserve Forces Training Area for use by Army Reserve and National Guard forces. Approximately 5160 acres of the former 9300 acre Fort Devens was retained for this purpose (the 4880 acre South Post Training Area and approximately 280 acres within the former Main Post). Approximately 1140 acres was transferred to other Federal agencies, including approximately: 836 acres to the U.S. Fish and Wildlife Service as an addition to the Oxbow Refuge, 250 acres to the Federal Bureau of Prisons for a Medical Center, 35 acres to the U.S. Department of Labor for a Jobs Corps Center, and 20 acres under the McKinney Act for facilities for the homeless. The remaining 3000+/- acres were transferred to the Commonwealth of Massachusetts, are being redeveloped as the Devens Enterprise Zone by the Massachusetts Development Finance Agency (U.S. Army 1995). In February, 1996, Congress specified (Public Law 104-106) that, if it is determined to be excess to the needs of the Department of Defense at any time in the future, the Secretary of the Army shall transfer, all but 100 acres of the 4880 acre portion of Fort Devens Military Reservation situated south of Route 2, to the Secretary of the Interior for inclusion in the Oxbow Refuge.

Oxbow Refuge has the potential to yield information significant in our understanding of early American culture such as the period during King Philip's War, the Shaker communities and the early industrial period. The refuge has resources that can provide data for research questions for several time periods during the last 11,000 years. The historic land use patterns represent a good example of rural agricultural communities in New England. The refuge should be considered moderately to highly sensitive for archaeological materials.

Socio-Economic Resources

Adjacent Communities and Land Uses

Predominant land uses and conservation areas within a one-mile radius of the Oxbow Refuge in the neighboring communities of Ayer, Harvard, Bolton, Lancaster, and Shirley are depicted in Figures 3-4 and 3-5. Uses within one mile east and northeast of the portions of the refuge in Ayer include high- and medium-density residential, downtown business and commerce, and light industrial areas. The land use profile of the remaining area is typical of an ex-urban, semi-rural area with a large supply of forest and agricultural land, low-density housing, and relatively undeveloped for industrial and commercial uses (U.S. Army 1995).

By far, forests are the most dominant land use, covering nearly 60 percent of the land. A distant second use, by area coverage, is single-family housing, which occupies approximately 12 percent of the area. Agriculture is still a key land use in the area, with about 10 percent devoted to cropland and pastureland (U.S. Army 1995).

Nearly 13 percent of the area is open space; this category includes parkland and water. Industrial and commercial land uses comprise less than one percent of the area each, as does mufti-family housing. These land uses are more prevalent in the most urbanized communities (e.g., Nashua, Fitchburg, Leominster, Ayer) (U.S. Army 1995).

Land use planning for communities adjacent to Fort Devens is regulated by the individual towns. The towns of Ayer, Groton, Harvard, and Shirley have developed master plans. Shirley and Lancaster have prepared open space and recreation plans (U.S. Army 1995):

•The Town of Ayer Strategic Planning Study Report addresses the affordable housing concerns and growth management provisions through updated zoning bylaws and improved subdivision regulations.

•The goal of the Town of Groton, as indicated in the report series Groton 2020: Planning Directions, is to continue to enhance the tradition of small town values where people fit within and do not dominate the landscape, in order to maintain a small town character and protect open spaces and the environment in preparation for the potential doubling of population over the next 75 to 100 years.

•The goals and objectives of the Harvard Town Plan (1988) are to protect environmental resources, preserve rural character, address housing needs, encourage agriculture, define the commercial area, and improve the town's management of land use.

•The goals of the Town of Shirley (1985) are to manage residential and industrial growth and balance the growth rate so there will be sufficient revenues to serve the needs of all residents. Areas of the town were targeted for protection as well as development. Since 1985, Shirley has instituted An Open Space and Recreation Plan.

•The goal of the Town of Lancaster Open Space and Recreation Plan (1993) is to preserve natural resources, maintain a balanced recreation program, and emphasize the role of agricultural land as open space. Addressed within the plan are the expansion of the Nashua River Greenway and trail system, as well as other recreational activities.

Land Use Regulation

Devens

The towns of Ayer, Harvard, Lancaster, and Shirley adopted the Devens Regional Enterprise Zone, Zoning By-Laws of November 18, 1994 (DEC 2001). These zoning by-laws govern the types of land-uses that are to be permitted within Devens Enterprise Zone being redeveloped by the Massachusetts Redevelopment Finance Agency (MassDevelopment). Permitted land uses abutting the portions of the Oxbow Refuge north of Route 2 include the following categories:

Mallards. *Photo by Bruce Flaig*

Open Space, Innovation and Technology, Residential, Environmental Business, Village Growth and Gateway. Figure 3-6 shows these areas (DEC 2001).

Six communities have lands within a one-mile radius of Oxbow Refuge: Ayer, Bolton, Groton, Harvard, Lancaster, and Shirley. The zoning designations for the areas of these communities are listed below, and indicated in Figures 3-4 and 3-5, in a simplified format (U.S. Army 1995).

Ayer

Zoning for the town of Ayer within one mile of the Refuge is designated as General, Low, and Medium Density Residential, General and Downtown Business, Light and Heavy Industrial, Water Supply Protection, and Floodplain. Descriptions of the Ayer zoning districts are listed in the "Zoning Bylaw of the Town of Ayer, Massachusetts," amended June 1988 (U.S. Army 1995).

Bolton

According to the "Town of Bolton Zoning Bylaws" (amended through May 1992), areas of the town within one mile of the refuge are designated Residential, Water Resource Protection, and Floodplain Districts. Allowed uses for the districts include municipal, rural agricultural, conservation, and/or open space. Business, commercial or industrial buildings, and outdoor storage (except for agriculture, horticulture, or floriculture) are prohibited on any lot that contains a residential structure (U.S. Army 1995).

Groton

Zoning for areas of Groton within one mile of Oxbow, according to "Zoning Bylaw of the Town of Groton, Massachusetts" (amended through March 1987), is designated as Residential-Agricultural, Conservancy, Official Open-Space, and Floodplain. A Water Resource Protection Overlay District is also designated (U.S. Army 1995).

Harvard

According to the "Town of Harvard, Massachusetts, Protective Bylaw and Related Regulations" (amended March 1991), land in Harvard within one mile of Oxbow is zoned with Agricultural-Residential, Commercial, Watershed Protection and Floodplain, and Watershed Protection and Flood Hazard Districts. Uses prohibited in all districts include anything which is " injurious, offensive, or otherwise detrimental to the neighborhood, the community, or the natural environment, including the groundwater supply, a groundwater absorption area, or other wetland resources" (U.S. Army 1995).

Lancaster

According to the "Town of Lancaster, Massachusetts Zoning Bylaws" (amended June 1991), areas in Lancaster within one mile of the refuge are by designated Floodplain and Water Resource Districts (U.S. Army 1995).

Shirley

Land in the town of Shirley within one mile of the refuge, according to the "Zoning Bylaw of the Town of Shirley, Massachusetts" (amended March 1986), is zoned with Residential Rural, Residential 1, Residential 2, Residential 3, Commercial Village, and Industrial Districts, in addition to Floodplain Protection and Water Supply Protection Overlay Districts (U.S. Army 1995).

Population and Demographic Conditions

Population trends vary considerably among the neighboring cities and towns of Ayer, Harvard, Shirley and Lancaster (U.S. Census Bureau, 2001). Overall population levels in the four towns decreased from 31,979 to 27,021 (a 14.4 percent decrease) between 1990 and 2000. The majority of this decrease occurred in Harvard due to the closure of Fort Devens (the great majority of the Fort Devens military housing and barracks areas were physically located within the Town of Harvard). The population of Harvard decreased from 12329 to 5938 (a 51.5% decrease). The largest percent population growth occurred in Lancaster (6661 to 7380 or 10.8%). Ayer increased from 6871 to 7287 (or 6.1%), and Shirley grew by 4.2% from 6118 to 6373 people (U.S. Census 2001).

The Greater Worcester Metropolitan Area grew by 33,005 people (nearly a 7% increase) to a population of 511,389 in the year 2000. The Boston-Worcester-Lawrence Metropolitan Area increased by 363, 697 people or 6.7% to a total of 5,819,100 in 2000 (U.S. Census 2001).

Schools

Ayer Schools

The town of Ayer operates three schools: two primary schools, and a Junior/Senior High School. With a total enrollment of 1178 students in the 1998-99 school year. Ayer formerly operated an elementary school on Fort Devens until the Installation closure. Ayer lost 211 students between the 1994-95 and the 1998-99 school years (MDOE 2001).

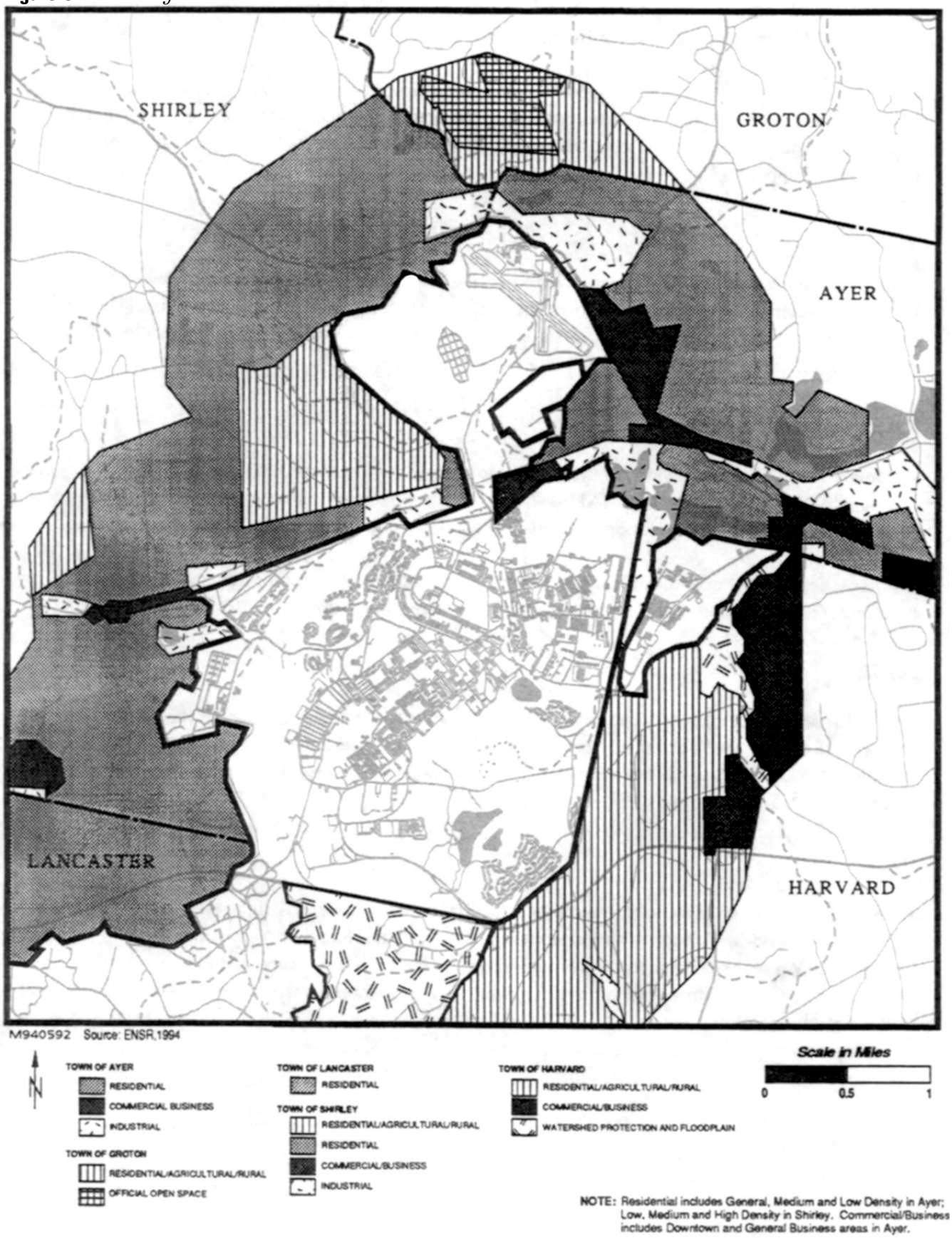
Harvard Schools

Two schools are operated within Harvard's school system: Harvard Elementary School (kindergarten through grade 6) and the Bromfield School (grades 7 through 12). Overall enrollment was 1175 students in 1998-99 (up from 1047 in the 1994-95 school year (MDOE 2001).

Shirley Schools

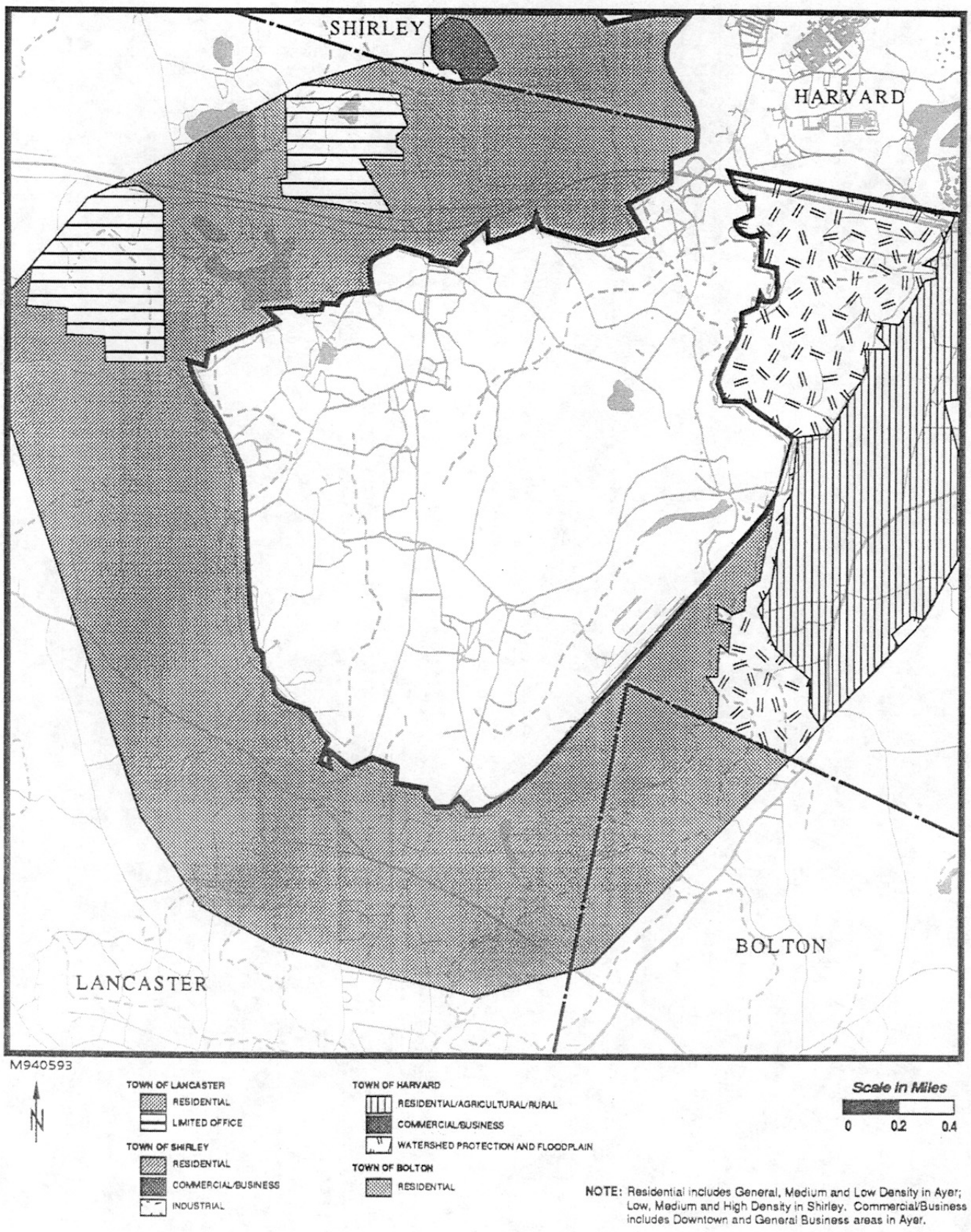
The Shirley School District operates two elementary schools. In 1998-99, these schools had 732 students, an increase of 141 students from the 1994-95 school year (MDOE, 2001). Shirley provides in-town schooling only at the elementary level. Traditionally, high school students have attended Ayer or Lunenburg schools. They now have additional options due to the School Choice Program and many have opted for Harvard or Groton schools (U.S. Army, 1995).

Figure 3-4. *Zoning within One Mile- Main and North Posts*



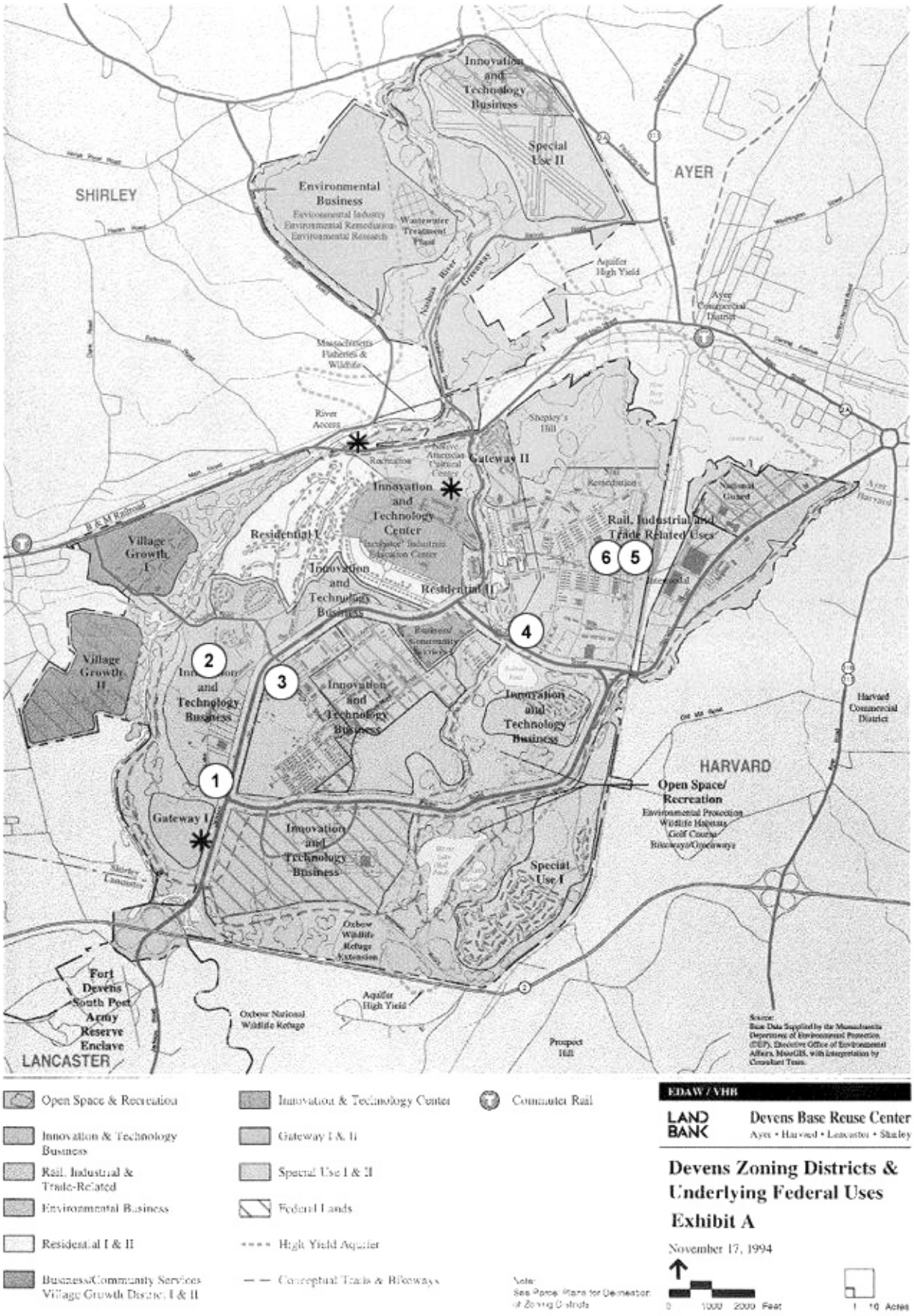
U.S. Army, 1995. Final Environmental Impact Statement, Fort Devens Disposal and Reuse. Department of the Army, Headquarters, Forces Command, Atlanta, GA. (Prepared by the New England Division, U.S. Army Corps of Engineers, Concord, MA).

Figure 3-5. *Zoning within One Mile- South Post*



U.S. Army, 1995. Final Environmental Impact Statement, Fort Devens Disposal and Reuse. Department of the Army, Headquarters, Forces Command, Atlanta, GA. (Prepared by the New England Division, U.S. Army Corps of Engineers, Concord, MA).

Figure 3-6 *Devens Zoning Districts & Underlying Federal Uses- Exhibit A*



DEC, 2001. Devens Enterprise Commission, April 21, 2001: http://www.devensec.com/bylaws/bylawstoc.htm

Chapter 4

A volunteer leads an environmental education program on the refuge.
USFWS Photo

Environmental Consequences

- Introduction
- Actions Common to All Alternatives

- Part 1: Assabet River National Wildlife Refuge
- Alternative A: Current Management
- Alternative B: Proposed Action
- Alternative C

- Part 2: Great Meadows National Wildlife Refuge
- Alternative A: Current Management
- Alternative B: Proposed Action
- Alternative C

- Part 3: Oxbow National Wildlife Refuge
- Alternative A: Current Management
- Alternative B: Proposed Action
- Alternative C

- Cumulative Impacts

Environmental Consequences

Introduction

This chapter describes the environmental consequences likely to result from implementation of each alternative management scenario presented in Chapter 2, Alternatives. This section of the EA/ CCP forms the scientific and analytical basis for comparisons of the alternatives.

Both indirect and direct effects are predicted for the 15-year planning horizon (as much as can be reasonably expected). Indirect, direct, and cumulative effects beyond 15 years may also be discussed, but are often more speculative in nature.

Red tailed hawk. *USFWS Illustration*

Most proposed management activities and projects described in Chapter 2 will be analyzed in this chapter. However, the CCP does not contain site plans and exact locations for certain projects, such as the visitor center for Great Meadows. Therefore, additional NEPA compliance and public review may be required once site-specific plans are completed, depending on the nature of the activity.

Certain management activities described in Chapter 2 may qualify as "categorical exclusions" under NEPA provided they meet certain conditions that include not adversely affecting a listed threatened or endangered species. This means they would not require review in an environmental assessment because they are actions which typically do not individually or cumulatively have a significant effect on the human environment. The following activities are considered categorical exclusions in this plan: environmental education and interpretation; wildlife observation and photography research, wildlife inventories (not involving construction), and outreach and partnering efforts. As part of the CCP process, we have identified a range of alternatives to address these issues, however we will not analyze the impacts of these alternatives in this chapter.

In the following discussion, the terms "positive", "negative", and "neutral" are used frequently as qualitative measures of how an action would likely affect resources of concern. In some of our discussions below, we are not able to quantify the effect. A "positive effect" means that the actions are predicted to enhance or benefit the resources under consideration and work towards accomplishing goals and objectives over the short or long term. A "negative effect" means that the actions are predicted to be detrimental to a resource over the short or long term, and work against achieving goals and objectives. A "neutral effect" means either a) there would be no discernible effect, positive or negative, on the resources under consideration; or b) predicted positive and negative effects cancel each other out.

We have generally described the impacts on a relatively local or "fine" geographic scale — for example, within national wildlife refuge lands. In actuality, the refuge is not isolated, and the influence of the surrounding landscape on the duration and extent of impacts may not

be adequately recognized in our text. We may have overstated both positive and negative impacts, considering the geographic context. On the other hand, many of the actions we propose are consistent with other plans identified in Chapter 1, and provide a positive, albeit incremental, contribution to these larger landscape goals. In other words, the refuge may be small, but the actions take a big step on refuge lands towards achieving Refuge System and ecosystem goals.

Each of the three alternatives are analyzed for their impact on air and water quality, wildlife and habitat, and public use and access.

Actions Common to All Action Alternatives

Fees

While administering fees is considered a routine administrative action, we acknowledge that initiating a fee program at Assabet River, Great Meadows and Oxbow refuges may be controversial. Some visitors may disapprove of the fees since many are used to accessing Great Meadows and Oxbow refuges without fees. Some people who currently use these refuges may choose not to return because of the fees and others, who have not visited before may choose not to visit because of the fees.

A recent article evaluating the Demonstration Fee Program at 14 national wildlife refuges provides some idea of what impacts can be expected from a fee program. On those refuges surveyed, only 8% of the visitors said that they would change their future plans to visit the refuge because of fees charged. Hunters and anglers were more likely to be displaced by fees and change their plans while those coming to refuges for wildlife photography and observation were less likely. Less than 13% of those surveyed chose not to visit at all, or were displaced, because of the fees. The study suggests that individuals in lower income brackets are more likely to be displaced by fees than others. Those who understood how fees would be used and their importance to maintaining quality services and enhancing economic efficiency on refuges were more likely to agree with fees (Taylor et. al 2002). Because education is such an important part of any fee program we intend to provide information to all our users about the fee program. Information distributed would explain that fees promote equity by charging those who actually use the refuge, enhance programs by generating revenue that can be used on the refuge and help recover administrative costs, especially in the case of the hunting fees, where there are specific administrative costs involved. The fees would also fund additional programs and facilities, providing new opportunities for those who use the refuges. For more information about how the fee program would be administered, see Chapter 2, Actions Common to All Action Alternatives.

Part 1. Assabet River Consequences

Alternative A — Current Management

The Current Management Alternative represents the anticipated baseline of the refuge (and associated resources) if current policies, programs and activities continue in a manner consistent with recent or foreseeable trends. While this alternative does not represent a true "status quo" condition, neither does it propose major changes in public use/wildlife management programs or facilities. The analysis will focus on anticipated changes in specific refuge management actions, and the impact of these changes on the physical, biological and socioeconomic environment. The reader is reminded that much of the rationale supporting conclusions throughout this chapter will appear in the discussion of the Current Management Alternative, and may not always be repeated under other alternatives.

Under this alternative, baseline population surveys of American woodcock, marsh birds, breeding lands birds and anurans will generate sufficient information to document trends among these species and groups. Up to seventy acres of grassland/shrub habitat will be maintained and fifty acres of degraded wetland habitat will be restored. Otherwise, the land will be left alone and allowed to evolve to various wildlife habitat types. Surrounding communities will continue to benefit from ecological functions provided by open space, such as watershed values. Continued closure of the land to public access, much as it was during military ownership, may deprive area residents and potential visitors of opportunities to enjoy nearby and unique outdoor recreation and hands-on environmental education experiences.

Sherman Bridge. *Photo by D. Mackey*

Water Quality/Hydrology

Alternative A would protect the natural hydrology of the affected areas. All alternatives would provide at least protection for hydrology since they protect all lands within the refuge boundary. These lands are important, as they are located along the wetlands associated with the Assabet River.

Refuge lands contribute to clean surface water because vegetation filters rain water that runs into lakes, rivers and ponds. Protecting land also prevents development, which can dramatically affect surface water as rainwater runs off pavement, collecting contaminants along the way. Refuge land also protects groundwater recharge areas which are important for residents who rely on wells for their water supply. The wetlands protected in all the alternatives would maintain natural catchments to hold and absorb surface waters, thereby minimizing flooding. These factors are critical to long-term protection of wetlands and water supply resources.

Invasive and Overabundant Species

In both Alternative A and B, beaver deceivers, water control structures, and periodic ditching may impact hydrology by controlling water levels, volume, and velocity and diverting water to or from areas where it is or is not needed. These methods are used to restore favorable hydrology for trust wildlife species using the refuge.

In both Alternative A and B, we propose using pesticides to control invasive, exotic and injurious species. In wetland environments water safe derivative chemicals would be used, and label directions would be carefully followed to avoid contamination of water. In all areas we would be using herbicides that have been approved for that application by the EPA. Our goal is to use the most effective tool for its purpose that has the lowest possible non-target organism effects. Some pesticides may have minimal effects on non-target organisms and a broad spectrum of herbicides need to be carefully applied to prevent killing desirable species.

We have little control over the quality of the water passing by, as we do not own or control a significant portion of the watershed.

Geology/Topography/Soils

None of the alternatives would substantially impact the local geology, topography or soils except that all the alternatives would protect, in perpetuity, soil formation processes on lands the refuge owns and acquires.

Under Alternative A, there are no significant adverse impacts expected to the general topography of the planning area. Soil formation processes on lands owned as national wildlife refuges would be perpetually protected. Temporary soil disturbance would occur during selected habitat management actions designed to adjust varying stages of vegetative succession. Some permanent alteration to soils and topography would occur at locations selected for administrative, maintenance, and visitor facilities such as visitor contact stations, trails, platforms, and related structures.

Air Quality

Good air quality is essential to ecosystem health. It is well documented that poor air quality contributes to acidification of streams and soils, eutrophication of open water areas, vegetation injury often in the form of decreased plant reproduction, increased accumulation of metals and organics in the food chain, and causes “regional haze” (Porter 1999 personal communication).

Air quality in the refuge planning area is determined by surrounding land use. The refuge has little direct control over the quality of the air surrounding the planning area, but we can all do our part by carefully managing on-the-ground activities to prevent

further degradation of air quality. As stated in Chapter 3, Assabet River Refuge currently has attainment status for air quality as required by the federal Clean Air Act of 1970. This means the area does not exceed the level of acceptable pollutants as set by the federal government in the Clean Air Act. Increased volume is one factor that could cause the area to exceed acceptable pollutant levels, however under this alternative there would be no increase in visitors or habitat management actions. Given this, and the fact no Class I air quality areas would be affected, adverse impacts to air quality from Alternative A would tend to be sporadic, of relatively short duration, and of light intensity. In other words, a neutral effect is anticipated on air quality from the No Action Alternative. In addition, implementation of Alternative A is in full compliance with the Clean Air Act.

The refuge is not conducting prescribed burns under this alternative. For additional information on this section, see section Fire Management at the beginning of Chapter 2.

Habitat and Wildlife Populations

Even a minimal effort to improve wildlife habitat conditions would allow most refuge uplands to slowly succeed to monotypic habitats that would support species groups favored by the habitats that evolve. Two exceptions to this approach would additionally benefit habitat diversity. First, maintenance of up to seventy acres of grassland/shrub habitat would perpetuate species diversity among birds and small mammals that use this habitat type. Secondly, beaver management, clearing of culverts, and installation of a water-control structure on Taylor Brook will help recover up to fifty acres of wetland habitat that had been degraded during military ownership.

The quality of approximately 500 acres of wetland habitats will likely become more degraded as encroachment of invasive plants such as purple loosestrife continues. This will likely decrease the diversity of species using these wetland areas, including use by nesting, resting and feeding birds.

Local conditions and natural succession will determine the degree of wildlife benefits. Lack of a long-term strategy to document habitat conditions and wildlife populations will prevent development of accurate accounts of these resources.

Available bat habitat will increase if the concept of encouraging bat use of three abandoned ammunition storage bunkers is successful.

Invasive and Overabundant Species

Red-wing blackbird. *Photo by Bruce Flaig*

Under this proposal we would not aggressively control most invasive species. We would continue to control species when possible. Lack of aggressive action to document the spread of invasive species and implement techniques to control their spread will likely cause certain habitats, especially wetlands, to be overtaken by exotic species. This situation could more than offset any positive benefits generated by the small amount of grassland and wetland restoration that occurs under this alternative. Wetland losses at Assabet River Refuge due to encroachment of purple loosestrife, cattail, and common reed which are the primary wetland invasives on the refuge, would continue unabated, as would losses of upland habitat to spotted knapweed and glossy buckthorn, Japanese knotweed and oriental bittersweet.

To minimize effects and insure proper use, herbicides would not be applied without an approved Pesticide Use Plan. In all applications, label instructions will be strictly followed to minimize hazards to the applicators and environment. This includes wearing proper personal protective equipment (including long sleeved clothing, gloves and eyewear) during preparation, treatment and clean up.

Broad spectrum herbicides that are considered relatively nontoxic to dogs and other domestic animals may still cause gastrointestinal irritation if large amounts of freshly sprayed vegetation are ingested. In areas where this is a high risk, proper public notification will occur. Many of these herbicides also have a strong affinity to soil particles, and once bound are unavailable to vegetative root systems. This affinity lasts until the product is biodegraded via aerobic and anaerobic conditions by microfloras in the soil.

Hunting

This section describes the impact of the Alternative A hunting proposal on habitat and wildlife. For information on Alternative A social impacts of the hunt proposal, see the following section under Public Use and Access.

Long time closure of Assabet River Refuge to white-tailed deer hunting has allowed the deer herd to increase because there are no natural population controls in this area. This persistent situation causes the growing population to exceed the capacity of its habitat that is required to sustain healthy animals and good habitat quality. As herd size increases browsing alters plant community composition. Many authors (Alverson et al. 1988, Behrend et al. 1970, Tilghman 1989, Warren 1998, McShea and Rappole 1992) have reported that vegetative species richness and the abundance of herbaceous and woody vegetation declines in areas where white-tailed deer densities exceed carrying capacity. The decline is directly attributed to the activities of deer. The loss or reduction of woody understories in forests or lack of forest regeneration decreases availability of habitats for migratory birds and other

wildlife. DeCalesta (1994) found that changes in the vegetation due to browsing by high deer densities in Pennsylvania impacted intermediate canopy-nesting songbirds and reduced species richness and abundance. Studies by the Massachusetts Division of Fisheries and Wildlife between 1997 and 1999 found that deer reproduction in eastern Massachusetts is high and that individual animals are long-lived. This, combined with loss of habitat due to land use alteration, local restrictions on use of firearms, and limited opportunities for hunters to access hunting areas has caused deer habitat to be at or near carrying capacity [personal communication, William Woytek, Massachusetts Division of Fisheries and Wildlife (MDFW)]. The current deer density in the Towns in which Assabet River Refuge is located is estimated to be 12-30 animals per square mile; MDWF recommends a density of eight per square mile to avoid habitat degradation due to over browsing. Since 1997 the State has implemented a longer archery season for deer and increased harvest of antlerless deer in an effort to reach the eight deer per square mile objective (Woytek, MDFW, personal communication).

Under this No Action Alternative the deer herd density would continue to increase. Browsing pressure will continue to reduce overall habitat quality for deer, stress the health of individual animals, and diminish diversity of habitats that sustain other wildlife species.

Fishing

Closure of the refuge to fishing would prevent shoreline erosion and eliminate disturbance to wildlife.

Public Use and Access

Hunting

Under this alternative no hunting opportunities are proposed. Continued loss of opportunities to offer safe hunting on large parcels of public land in an otherwise heavily populated area would persist. Closure of the refuge to hunting contributes to the unfilled demand for this activity and causes the Service to miss opportunities to convey national wildlife refuge messages to the hunting public and build related constituencies.

Increased negative interactions between humans and deer would occur as greater numbers of deer forage on gardens and ornamental plants in residential neighborhoods and on agricultural crops. Incidents of deer-motor vehicle collisions may increase and a larger deer population would raise the deer tick population and the associated transmission of Lyme disease.

Fishing

Continued closure of the refuge to fishing, as proposed in Alternative A, prevents use of a fishable resource that could help satisfy high demand for this activity. We also miss opportunities to convey its messages and strengthen its constituency among the fishing enthusiasts.

Wildlife Observation and Photography, Environmental Education and Interpretation, and Public and Community Outreach

These activities fall under Categorical Exclusion process described earlier in the chapter. Overall, we recognize that closure of Assabet River Refuge has precluded opportunities for these activities, which are priority public uses. We miss opportunities to convey our messages and strengthen constituencies within the communities as well as greatly diminishes the refuge manager's ability to build long-term positive relationships and support within local communities.

Resource Protection and Visitor Safety

Visitor safety will be maximized as long as the refuge remains closed to public access. Visitors entering the refuge would, in most cases, be escorted by Service personnel to assure adherence to safety practices.

The presence of 2,230 acres of protected land provides valuable ecological services to the residents of Maynard, Stow, Sudbury, and Hudson. The presence of protected lands adds to quality of life and property values. It also prevents increased costs for community services that are required when land is residentially developed.

Cultural Resource Protection

Cultural resource would be protected as a result of Federal ownership of this land. Impacts would not occur under this Alternative because land disturbance will be negligible.

Socioeconomic Resources

Projects involving removal of former military structures and restoration of wetland or upland habitats may require hiring local contractors. Economic opportunities for local businesses that could be generated through hunting, fishing, hiking and wildlife observation activities on refuge lands will not be realized under this alternative.

Alternative B — The Service's Proposed Action

Habitat restoration and management would be guided by analysis of wildlife population and habitat databases specific to the Assabet River Refuge area. Implementation of this alternative would convert the refuge's military atmosphere to one of a natural environment supporting wildlife species diversity that is indigenous to eastern Massachusetts. Restoration would eliminate safety hazards and create trails, information kiosks and wildlife viewing opportunities that would be made available to visitors. This oasis in the midst of a region that has been largely converted to residential and commercial development would become a social and economic asset to the communities of Maynard, Stow, Sudbury, and Hudson.

This Alternative offers numerous opportunities for partnering with open space, wildlife protection, and education advocates both on the refuge and in surrounding communities.

Water Quality/Hydrology

Impacts to water quality in this alternative are similar to Alternative A. All alternatives would have positive impact on water quality in streams and their receiving waters because they protect ground and surface water recharge areas and sustain natural flow patterns that reduce sediment transport and distribution of nonpoint source pollution. All of these factors contribute to maintenance of ecosystem functions.

The removal of nuisance beavers clogging water control structures may impact the hydrology of the area. This impact should be favorable to the migratory birds using the areas, as these control structures are used to provide better habitat.

As described under Alternative A, the improper use of herbicides may negatively impact water quality. See Water/Quality/Hydrology section under Alternative A for a complete discussion on the consequences of using herbicides.

Geology/Topography/Soils

Some disturbances to surface soils and topography would occur at locations selected for visitor facilities such as new kiosks, observation decks and other proposed facilities proposed in Alternative B (See Map 2-2). Establishing or expanding parking areas would result in the compaction of soil and removal of vegetation.

We may also use the hydroaxe or other mechanical means to control the spread of certain invasive species. Heavy machinery, such as the hydroaxe, used for maintenance of habitat may compact soil and temporarily displace animals using that habitat.

Air Quality

As discussed under Alternative A, air quality in the refuge planning area is driven by surrounding land use. The refuge has little direct control over the quality of the air surrounding the planning area, but we can all do our part by carefully managing on-the-ground activities to prevent further degradation of air quality. All of the alternatives would serve to maintain or improve air quality of municipalities surrounding refuge lands in direct relationship to the extent these properties are protected from development.

Under this alternative we are proposing prescribed burning. Burning is often less expensive than herbicides. It would occur under safe conditions that evaluate wind conditions and direction, existing fuel conditions, relative humidity, and appropriate fire training. Adjacent land owners would be notified prior to burning. We would also be completing our burns in compliance with Massachusetts Dept. of Environmental Protection Air Quality Permitting Requirements for prescribed burns. See section Fire Management at the beginning of Chapter 2.

Many of the management strategies and biological monitoring activities have short-term negative impacts on air quality due to emissions from motorized vehicles and equipment such as tractors, mowers, chain saws, and gas powered generators. Operating the least polluting models available, and making sure all equipment is properly operated and maintained by trained personnel can minimize these impacts.

Any visitor increase in Alternative B would not be enough to increase traffic volumes to the point where it would affect air quality.

Removal of the old buildings and wells from the refuge could create a small amount of dust in the immediate vicinity of the buildings being demolished or wells being closed, although this would be mitigated by the standard practice of use of water for dust suppression and the fact that the travel routes to all of the 26 buildings potentially to be demolished, except two, are paved. However a short- term local decrease in air quality may occur due to vehicle emissions during the work periods. The buildings to be demolished and wells to be closed are not in locations where these minor, short-term effects will impact neighboring properties or people.

Apple blossom. *Photo by Marjike Holtrop*

Habitat and Wildlife Populations

Development and implementation of species and habitat inventories, as proposed under Alternative B, would provide information bases to guide management planning and action that would increase species diversity and populations of trust species. New and improved protocols for wildlife population surveys will greatly improve management decision-making capability. Extrapolation of data from wildlife and habitat inventories that have been done for nearby and similar areas would allow refuge staff to anticipate basic planning needs prior to designing refuge specific inventories. This would ensure that inventories yield results that accurately reflect planning opportunities for Assabet River Refuge. These benefits would accrue both locally and in relation to regional and national wildlife management initiatives such as the North American Waterfowl Management Plan and Partners in Flight Plans. Management strategies guided by this information would more effectively restore, maintain, or enhance the quality and diversity of forest, grassland, shrub, wetland and other habitat types for priority wildlife species.

Increased visitation and expansion of visitor activities would generate conflicts between people and wildlife. Minor habitat alteration would occur and the presence of more visitors may disturb wildlife. In cases where this becomes problematic, areas open to visitation and related scheduling may require alteration. For example, closing portions of refuge trails to minimize human conflicts during May-October nesting seasons would help avoid potential wildlife disturbance and bolster nesting success.

Actions taken to remove the 24 buildings, close old wells, remove dangerous wire, and secure bunker doors would cause short-term and site specific wildlife and habitat disturbances, such as temporary displacement of wildlife to adjoining portions of the refuge during work periods, temporary removal of vegetation, and noise disturbance. However, they would be offset by the long-term benefits of these actions that restore approximately 15 acres to high quality habitat.

Development and implementation of the Habitat Management Plan and Forest Management Plans will assure that forest habitats appropriate to the Assabet River Refuge would be sustained. These habitats would support forest dependent species such as ruffed grouse, owls, thrushes and other neotropical migrant birds associated with New England forests. Northern hardwood-mixed forest habitats would support forest dependent species including scarlet tanager, red-eyed vireo, ovenbird, wood thrush, and eastern wood-pewee, some of which are considered priority species by PIF for this geographic area. Mammal population diversity will also be maintained. The sharing of Assabet River Refuge forest habitat management practices would encourage other area land managers and landowners to use them thereby leveraging wildlife benefits well beyond refuge boundaries.

The refuge would use fire as a management tool where appropriate. Fire is beneficial in forest management in the preparation of seedbeds, site preparation and the control of undesirable vegetation. Fire can induce vigorous sprouting and remove excess litter buildup from the forest floor which can help prevent wildfires. Burning can cause damage to rodent habitats, but unlikely to have negative long-term impacts. See section Fire Management at the beginning of Chapter 2.

The occasional use of herbicides or controlled burning could alter non-target forest ecology factors in the short-term. However, these impacts would be offset by the long-term habitat benefits they would stimulate. Species that would benefit from setting back forest succession include black and white warbler, eastern towhee, and rose-breasted grosbeak.

Sustaining grassland habitats may promote use by savannah sparrows, grasshopper sparrows, bobolink, upland sandpiper, and eastern meadowlark. Early successional habitats, such as scrub-shrub and thickets, or edge habitats would promote use by ruffed grouse, song sparrows, indigo buntings, blue-winged warbler, Eastern towhee, and rose-breasted grosbeak.

Invasive Species

Under this alternative we would aggressively control invasive species. A comprehensive invasive plant inventory would improve understanding of the prevalence of invasive species impacts and foster development and implementation of plans to respond to invasions. Application of integrated pest management practices would reduce damage caused by invasive species, while minimizing secondary impacts to refuge resources. These actions would recover significant acres of habitat that have been lost to invasion of exotic species and curtail their return.

We may use herbicides to reduce the density of some less desirable species or to control invasive plants. These herbicides would be EPA-approved and application would be contingent on details determined in the Pesticide Use Plan. See section under Alternative A: Habitat and Wildlife for herbicide impacts to wildlife.

Use of controlled burns (see section Fire Management at the beginning of Chapter 2) and herbicides to reduce the prevalence of invasive plants may temporarily diminish the quality of adjacent or nearby habitat. The temporary nature of such impacts would be offset by the long-term benefits of habitat recovery.

Release of host-specific insects to control the spread and density of invasive purple loosestrife has shown to be effective after 4-5 years of continual release of thousands of beetles. *Galerucella* beetles would feed on other plants, including some other invasive species, but it is still believed that purple loosestrife is necessary for this species to successfully reproduce. Research and release of these insects during 20 years of study have shown no major secondary impact to other plant species. A direct benefit of controlling purple loosestrife in wetlands is the subsequent return of native vegetation and better habitat for waterbirds for nesting, feeding and resting.

We are proposing lethal removal of nuisance beaver by shooting or trapping if other mechanisms, such as beaver deceivers, do not work. The Service recognizes regulated trapping as an effective tool of wildlife population management on National Wildlife Refuges (Refuge Manual Chapter 7, Section 15). Removal of these species may be beneficial for the prevention and alleviation of habitat degradation, facilitation of habitat and wildlife restoration, and the conservation and enhancement of biological and genetic diversity. (Boggess et al. 1990, Organ et al. 1996).

Removal of territorial exotic mute swans by lethal or other means from refuge impoundments, ponds, and wetlands would prevent the damage done when these exotic birds uproot native vegetation, drive native waterfowl and other bird species away from their habitats, and lower water quality. Birding opportunities would improve because more native species will be present when mute swans are not. However, some bird watchers may not approve of removal of these birds because of their aesthetic value.

Our invasive species control efforts on the refuge would comply with Executive Order 13112 (February 1999) which directs all federal agencies, subject to funding, to prevent the introduction of invasive species; detect and respond rapidly to and control populations of such species in a cost-effective and environmentally sound manner; monitor invasive species populations accurately and reliably; provide for restoration of native species and habitat conditions in ecosystems that have been invaded; and promoted public education on invasive species and the means to address them.

Hunting

This section describes the impact of the Alternative B hunting proposal on habitat and wildlife. For information on social impacts of hunting, see the following section under Public Use and Access.

Hunting and fishing would not affect the refuge's goal to maintain, restore, and enhance habitat to support a diversity of plants and animals. Hunting may encourage natural diversity by limiting the growth of the deer population on the refuge, thereby protecting preferred forage species from over-browsing. The refuge does not anticipate any adverse effects on migratory birds, fish, and endangered species as a result of establishing a hunting or fishing program.

Fish and wildlife species for which hunting and fishing would be permitted on the refuge are those that are already regulated at the State or Federal level.

Upland game and migratory bird hunting would be managed to ensure that wildlife populations are not adversely impacted or that habitat quality is not impaired. Restrictions that require the use of non-toxic shot would minimize the introduction of lead into wildlife food chains.

Although hunting removes individual birds and mammals, this activity would be controlled through appropriate regulations to ensure that no wildlife populations or species are jeopardized. Resident wildlife populations will not experience significant effects as individuals area free to move on and off refuge property. Deer hunting on refuge land in eastern Massachusetts would provide hunter access to additional land and will be a significant contribution toward achieving the carrying capacity objective for this area (Woytek, MDFW, personal communication). See discussion under Alternative A for description of the carrying capacity.

The physical impacts of hunting to the habitat should be limited, due to refuge-specific regulations prohibiting use of ATVs, off-road travel, permanent stands and blinds, and camping and fires. Impacts may include limited trampling of vegetation, creation of unauthorized trails by hunters and subsequent erosion, littering and vandalism. Indirect effects of hunting on vegetation might be neutral or positive, if habitat quality was maintained at its present or an improved level.

Archery hunting which is part of the proposal for Assabet River Refuge is compatible in urban and rural settings. In Connecticut, it was found that under controlled circumstances a well-designed archery hunt could reduce the local herd by 50% (Kilpatrick and Walter 1999 as in Kilpatrick et al 2002). Similarly, in an urban Minnesota setting, deer populations were controlled to a tolerable level using an innovative bow hunt program (McAninch 1993 as in Kilpatrick et al 2002).

Fishing

The presence of people who are fishing on or around Puffer Pond would disturb some wildlife. People walking on the Pond shoreline may damage some vegetation and cause erosion. Action to minimize these impacts would include installation of boardwalks or temporary closure of some shoreline access points. Although fishing at Assabet River Refuge would be limited to catch and release fishing, some individual fish may die.

Environmental Education & Interpretation, Wildlife Observation and Photography

Building kiosks, small visitor contact station and other education and outreach enhancement features would create minor site-specific soil and habitat disturbance and the presence of people at these facilities would occasionally disturb birds and mammals. These impacts would be temporary and insignificant. As described in the introduction, these activities qualify as Categorical Exclusions under NEPA, and are not evaluated further here.

Public Use and Access

Hunting

Providing hunting and fishing opportunities addresses the mandates of Executive Order 12996 and the National Wildlife Refuge System Improvement Act of 1997 by providing the public with an opportunity to engage in wildlife-dependent recreation. Hunting and fishing are recognized by the Service as a traditional forms of wildlife related outdoor recreation. Opening Assabet River Refuge to hunting would satify the demand for this activity. We anticipate a low to moderate degree of hunting and fishing pressure to occur as a result of opening the refuge for these activities.

Economic impacts would either be negligible or there would be a minimal increase in the purchase of fuel, food, lodging, and supplies, due to the potential for new hunters to be attracted to the area.

Actions proposed in this plan would increase opportunities for wildlife observation, photography, environmental education, hiking and other public uses at Assabet River Refuge. This, in combination with hunting, may generate conflict among public uses as some public may be displaced by the hunt program. As the plan is implemented, the refuge staff would work to anticipate such conflicts and, if any arise, would adjust public use activities, to ensure that visitor safety and interests of all user groups are not compromised.

As more hunters are attracted to the refuge opportunities our communication with the hunting public would increase thereby fostering greater understanding of Assabet River Refuge, the Refuge System, other FWS programs, and support for them. This would be an opportunity to build a more effective constituency base.

Under this alternative and all other alternatives that propose to open the refuge to hunting, the refuge manager may, upon annual review of the hunting program, impose further restrictions on hunting activity, recommend that the refuge be closed to hunting, or further liberalize hunting regulations within the limits of State law. Hunting noise may disturb visitors and may necessitate the closure of some areas during the hunting season.

Environmental Education. *Refuge staff provide enviornmental education programs at Oxbow Refuge. Alternative B proposes programs at Assabet River Refuge as well. USFWS photo*

Fishing

Opening Puffer Pond to catch-and-release fishing would provide a high quality sport fishing experience in a heavily populated area without impacting fish populations. Installation of one or more universally accessible fishing sites would contribute to satisfying demand for fishing opportunities by people with disabilities.

Wildlife Observation and Photography, Environmental Education and Interpretation, and Public and Community Outreach

These activities fall under the Categorical Exclusion process described earlier in the chapter. Overall, opening the refuge to these activities provides a valuable opportunity for people to observe and learn about wildlife and their habitats in their natural setting. The building of a refuge constituency that supports wildlife and habitat protection would offset the site-specific impacts that would occur.

Resource Protection and Visitor Safety

Efforts to remove unneeded buildings, structures, and other safety hazards would cause site-specific, but temporary, environmental impacts. This would, however, produce long-term benefits for habitat, wildlife, and visitors who would be able to come to enjoy and learn about Assabet River Refuge.

Historic and archaeological surveys would be conducted prior to removal or rehabilitation of former military structures to assure that important resources are protected.

Cultural Resource Protection

Cultural resources would be protected through surveys to identify these resources and avoid their disturbance during land alteration projects. Cultural resources would also be highlighted during interpretation of refuge resources.

Socioeconomic Resoources

This alternative has the potential to generate significant and unique social benefits for adjacent communities. During recent decades, communities surrounding the refuge have experienced profound loss of open space to residential and commercial development. For this area to have access to a 2,230 acre national wildlife refuge is a remarkable social benefit. The refuge would provide high quality hiking, birding, hunting, and fishing as recreational resources and hands-on natural resource education for all age groups.

The local economies may benefit from sale of recreation equipment and services for visitors that travel to the area to enjoy the refuge. Local contractors may be hired to work on refuge related projects.

Local economies would not be burdened with costs of community services such as schools, fire protection, and police that would be needed had this land been residentially developed.

Benefits for people with disabilities would be provided in the form of accessible trails, and hunting and fishing facilities.

Alternative C

Use of refuge land under this "hands-off, let nature take its course" alternative would be similar to that described in Alternative A with almost all of the land left alone to evolve into climax habitat types. Opening fewer trails to public use than would occur under Alternative B would result in fewer opportunities for the public to see portions of the land and enjoy its wildlife. This Alternative would generate little economic activity because the refuge will not be managed to attract visitors from outside the local area.

Water Quality/Hydrology

Alternative C would contribute to good water quality by protecting in perpetuity refuge lands. Other water quality consequences are similar to Alternative B.

Under this alternative, herbicide use would be limited. Impacts from herbicides (described under Alternative A, Water Quality/ Hydrology) would be reduced.

Geology/Topography/Soils

Consequences would be similar to Alternative B, however under this alternative we would limit management actions such as discing and plowing which impact soils and topography.

Air Quality

Air quality impacts are similar to Alternative B.

Habitat and Wildlife Populations

Compilation of basic wildlife surveys and preparation of a habitat cover map every five years will provide a rough overview of long-term trends of vegetative succession and population status of some species. This information would serve little purpose otherwise. These basic surveys would not provide sufficient information to guide effective habitat or population management planning.

The consequences of this alternative for habitat and wildlife are similar to those in Alternative A. However, grassland and wetland restoration that would occur under Alternative A would not be done. The 60-70 acres of grassland/shrub habitat would succeed to forest and be lost as a habitat type at Assabet River Refuge. The 40-50 acres of degraded wetland would not be restored and eventually succeed to muck or dry land habitat.

Invasive and overabundant species

Without active control efforts, invasive plant species would overtake both wetland and upland habitats and diminish their ability to benefit wildlife. Basic inventories and mapping of invasive plant encroachment would document habitat loss. These plants would continue to consume habitat that could otherwise be restored to support indigenous wildlife species.

Hunting

Hunting would occur through a program similar that proposed in Alternative B except that shotgun hunting for deer would not be allowed. Consequences related to deer, upland game, and migratory bird hunting are similar to those of Alternative B.

Fishing

By restricting fishing to two shoreline sites the impact on wildlife disturbance by people that are fishing would be minimal. However, fewer people would have opportunities to experience enjoyable fishing.

Environmental Education, Interpretation, Wildlife Observation and Photography

These activities fall under Categorical Exclusion process described earlier in the chapter.

Fewer wildlife observation opportunities would be available than under Alternative B because the trail system would be smaller. This will reduce the amount of habitat and wildlife disturbance. It would also reduce the refuge's ability to accommodate visitors, convey messages, and build supportive constituencies.

Public Use and Access and Resource Protection and Visitor Safety

Environmental consequences would be similar to those of Alternative B.

Socioeconomic Resources

Opening portions of the Refuge to public access would attract people to the area who would spend money to obtain local services. This Alternative would not generate significant social or economic benefits because opportunities for people to use the refuge would be limited to a few trails that offer opportunities to observe wildlife and other natural resources. It is not anticipated that significant numbers of people from outside the local area would be attracted to visit a refuge with such limited visitor or education features.

Cultural Resources

Cultural resources would be protected through Federal land ownership. The degree of surveys to identify culturally valuable resources would be less than that proposed under Alternative B.

Part 2: Great Meadows National Wildlife Refuge

Alternative A — Current Management Alternative

The Current Management Alternative represents the anticipated condition of the refuge (and associated resources) if current policies, programs and activities continue in a manner consistent with recent or foreseeable trends. While this alternative does not represent a true "status quo" condition, neither does it propose major changes in public use/wildlife management programs or facilities. The analysis would focus on anticipated changes in specific refuge management actions, and the impact of these changes on the physical, biological and socioeconomic environment. The reader is reminded that much of the rationale supporting conclusions throughout this chapter will appear in the discussion of the Current Management Alternative, and may not always be repeated under other alternatives.

Maintaining the level of wildlife and habitat inventories that began in 2000 would, for the first time since refuge establishment, build a foundation of natural resource information upon which to base long range management plans. Ongoing maintenance of grassland/shrub and wetland impoundment habitats combined with implementation of plans emerging from the evolving information base would ensure that wildlife and habitat diversity is maintained at Great Meadows Refuge. Existing wildlife observation facilities and education programs would accommodate visitor uses at current levels that provide social and economic benefits to area communities.

Water Quality/Hydrology

Alternative A would protect the natural hydrology of the affected areas. All alternatives would provide at least protection for hydrology since it proposes to acquire all lands within the approved refuge acquisition boundary. These lands are important as they are located along the wetlands associated with the Concord and Sudbury rivers.

Refuge lands contribute to clean surface water because vegetation filters rain water that runs into lakes, rivers and ponds. Protecting land also prevents development, which can dramatically affect surface water as rainwater runs off pavement, collecting contaminants along the way. Refuge land also protects groundwater recharge areas which are important for residents who rely on wells for their water supply. The wetlands protected in all the alternatives would maintain natural catchments to hold and absorb surface waters, thereby minimizing flooding. These factors are critical to long-term protection of wetlands and water supply resources.

Invasive and Overabundant Species

In both Alternative A and B, beaver deceivers, water control structures, and periodic ditching may impact hydrology by controlling water levels, volume, and velocity and diverting water to or from areas where it is or is not needed. These methods are used to restore favorable hydrology for trust wildlife species using the refuge.

In both Alternative A and B, we propose using pesticides to control invasive, exotic and injurious species. In wetland environments water safe derivative chemicals would be used, and label directions would be carefully followed to avoid contamination of water. In all areas we would be using herbicides that have been approved for that application by the EPA. Our goal is to use the most effective tool for its purpose that has the lowest possible non-target organism effects. Some pesticides may have minimal effects on non-target organisms and a broad spectrum of herbicides need to be carefully applied to prevent killing desirable species.

We have little control over the quality of the water passing by, as we do not own or control a significant portion of the watershed.

Geology/Topography/Soils

None of the alternatives would substantially impact the local geology, topography or soils except that all the alternatives would protect, in perpetuity, soil formation processes on lands the refuge owns and acquires.

Under Alternative A, there are no significant adverse impacts expected to the general topography of the planning area. Soil formation processes on lands owned as national wildlife refuges would be perpetually protected. Temporary soil disturbance would occur during selected habitat management actions designed to adjust varying stages of vegetative succession.

Air Quality

Good air quality is essential to ecosystem health. It is well documented that poor air quality contributes to acidification of streams and soils, eutrophication of open water areas, vegetation injury often in the form of decreased plant reproduction, increased accumulation of metals and organics in the food chain, and causes “regional haze” (Porter 1999, personal communication).

Air quality in the refuge planning area is determined by surrounding land use. The refuge has little direct control over the quality of the air surrounding the planning area, but we can all do our part by carefully managing on-the-ground activities to prevent further degradation of air quality.

As stated in Chapter 3, Great Meadows Refuge currently has attainment status for air quality as required by the federal Clean Air Act of 1970. This means the area does not exceed the level of acceptable pollutants as set by the federal government in the Clean Air Act. Increased volume of traffic is one factor that could cause the area to exceed acceptable pollutant levels. Any visitor increase in Alternative A would not be enough to increase traffic volumes to the point where it would affect air quality. Given this, and the fact no Class I air quality areas would be affected, adverse impacts to air quality from Alternative A would tend to be sporadic, of relatively short duration, and of light intensity. In other words, a neutral effect is anticipated on air quality from the No Action Alternative. In addition, implementation of Alternative A is in full compliance with the Clean Air Act.

The refuge is not conducting prescribed burns under this alternative. For additional information, see section Fire Management at the beginning of Chapter 2. The Draft Fire Management Plan/EA is available upon request.

Environmental education, refuge-related presentations, and media events would benefit air quality indirectly by educating people about the sources and causes of degraded air quality, and ways to reduce emissions or their effects.

Yellow warbler. *Photo by Bruce Flaig*

Habitat and Wildlife Populations

Ongoing wildlife inventories at Great Meadows Refuge are building the first comprehensive and uniform wildlife database specific to this Refuge. Database documentation of population status and trends for breeding landbirds, marsh and wading birds, fish, reptiles, amphibians, shorebirds, waterfowl, and rare plants, would provide a solid foundation of information upon which habitat and population management planning can be done. Sharing these databases with other land managers and landowner partners would expand their planning and management capability causing the value and usefulness of this information to go well beyond refuge boundaries Maintaining and sustaining 100 acres of successional grassland and shrub habitat within the refuge is a significant contribution toward maintenance of wildlife species that are dependent on this diminishing habitat type. This action, through hydro-axing and mowing, prevents affected land from succeeding to forest or other mature habitat types. Sustaining grassland habitats may promote use by savannah sparrows, grasshopper sparrows, bobolink, upland sandpiper, and eastern meadowlark. Early successional habitats, such as scrub-shrub and thickets, or edge habitats would promote use by ruffed grouse, song sparrows, indigo buntings, blue-winged warbler, Eastern towhee, and rose-breasted grosbeak.

Manipulation of water levels in the Sudbury and Concord impoundments ensures that several hundred acres of wetland and mudflat habitat are available to waterfowl, wading birds, shorebirds, and other wetland dependent species in a section of eastern

Massachusetts that has suffered serious degradation of wetland habitat. The consequences of managing water levels and restoring hydrology is a decrease, or at least a stabilization of the spread of invasive species such as water chestnut. This results in optimal habitat for a number of groups of birds including feeding shorebirds, waterfowl and wading birds during late summer through early winter and nesting waterbirds (rails) and waterfowl (wood ducks). Water level manipulation at the Concord Impoundments results in an increased diversity of species using the impoundments throughout the year. The impoundments are no longer managed as full water bodies that are essentially ponds of open water with vegetation around the fringes. We recognize that wetland restoration and management allows for an increase of some invasive species and as a result some increase in mechanical, chemical and biological management, but in return the refuge supports a greater diversity of wildlife and native plant species.

Approximately 500 acres of forest land at Great Meadows Refuge provide habitat for forest dependent wildlife species. Under this alternative they would not be managed to favor any particular groups of forest species. As these forests advance toward climax growth stages habitats for wildlife species that depend on young forests and open areas within forests canopies would diminish, but species favoring this habitat would likely increase. As open forest habitat succeeds to more mature stands, species such as black-and-white warbler, and American redstart, may decline, but species including scarlet tanager would likely increase.

Participation of refuge staff in programs to restore the anadromous alewife to the Concord River and its tributaries would help enhance the ecological diversity of the refuge and local watersheds. Education combined with law enforcement to reduce incidents of trail cutting, vegetation removal, and trash disposal by refuge neighbors would curtail the loss of habitat and wildlife disturbance that results from these unauthorized encroachments. Greater understanding of the variety and abundance of invasive species would allow refuge staff to plan and implement projects to control their impacts on wildlife and habitats.

The refuge land that is cooperatively farmed would provide some food source for over wintering wildlife when the cooperating farmer leaves a standing crop. This site is primarily used by resident Canada geese. This activity provides little wildlife benefit, except preventing the site from being colonized by purple loosestrife.

Invasive and Overabundant Species

Actions under this Alternative that reduce the extent of invasive plant stands, or prevent their spread, and curtail the loss of habitat value caused by competition from non-beneficial invasive species. Biological control of purple loosestrife through the annual release of up to 10,000 *Galerucella* beetles results in partial habitat recovery with no known secondary impact to other species. We believe that our current program is weak and ineffective because we are

releasing so few beetles. Manipulation of water levels help reduce the impact and spread of water chestnut in refuge impoundments. Mechanical harvesting is a management intensive action that is disruptive to wildlife in the short term but does not cause long-term harm to wildlife or habitat. We have used this method in the past, but are not actively removing water chestnut in this manner. Mowing, flooding, or use of the herbicide (Rodeo) to control small patches of loosestrife and other invasive species causes similar short-term impacts. Dense common reed stands decrease native biodiversity and impact the quality of wetland habitat, particularly for waterfowl.

Lack of action to control other invasive plants including oriental bittersweet, common reed, and common buckthorn would perpetuate the loss of habitat values they have already caused and encourage takeover of additional habitat.

To minimize effects and insure proper use, herbicides would not be applied without an approved Pesticide Use Plan. In all applications, label instructions would be strictly followed to minimize hazards to the applicators and environment. This includes wearing proper personal protective equipment (including long sleeved clothing, gloves and eyewear) during preparation, treatment and clean up.

Broad spectrum herbicides that are considered relatively nontoxic to dogs and other domestic animals may still cause gastrointestinal irritation if large amounts of freshly sprayed vegetation are ingested. In areas where this is a high risk, proper public notification would occur. Many of these herbicides also have a strong affinity to soil particles, and once bound are unavailable to vegetative root systems. This affinity lasts until the product is biodegraded via aerobic and anaerobic conditions by microfloras in the soil.

Hunting

This section describes the impact of the Alternative A hunting proposal on habitat and wildlife. For information on social impacts of hunting, see the following section under Public Use and Access.

Long time closure of Great Meadows Refuge to white-tailed deer hunting has allowed the deer herd to increase because there are no natural population controls in this area. This persistent situation causes the growing population to exceed the capacity of its habitat that is required to sustain healthy animals and good habitat quality. As herd size increases browsing alters plant community composition. Many authors (Alverson et al. 1988, Behrend et al. 1970, Tilghman 1989, Warren 1998, McShea and Rappole 1992) have reported that vegetative species richness and the abundance of herbaceous and woody vegetation declines in areas with white-tailed deer densities exceeding carrying capacity. The decline is directly attributed to the activities of deer. The loss or reduction of woody understories in forests or lack of forest regeneration decreases availability of habitats for migratory birds and other wildlife.

DeCalesta (1994) found that changes in the vegetation due to browsing by high deer densities in Pennsylvania impacted intermediate canopy-nesting songbirds and reduced species richness and abundance. Studies by the Massachusetts Division of Fisheries and Wildlife between 1997 and 1999 found that deer reproduction in eastern Massachusetts is high and that individual animals are long-lived. This, combined with loss of habitat due to land use alteration, local restrictions on use of firearms, and limited opportunities for hunters to access hunting areas has caused deer habitat to be at or near carrying capacity [personal communication, William Woytek, Massachusetts Division of Fisheries and Wildlife (MDFW)]. The current deer density in the Towns in which Great Meadows Refuge is located is estimated to be 12-30 animals per square mile; MDWF recommends a density of eight per square mile to avoid habitat degradation due to over browsing. Since 1997 the State has implemented a longer archery season for deer and increased harvest of antlerless deer in an effort to reach the eight deer per square mile objective (Woytek, MDFW, personal communication).

Under this No Action Alternative the deer herd density will continue to increase. Browsing pressure would continue to reduce overall habitat quality for deer, stress the health of individual animals, and diminish diversity of habitats that sustain other wildlife species.

Fishing. *Students learn to fish on the refuge. USFWS photo*

Fishing

Fishing is allowed in rivers flowing through the refuge. Bank fishing is not allowed on the refuge. This closure limits wildlife disturbance, especially in marshes along the river. Bank fishing is often associated with destruction of vegetation, bank erosion and litter. In addition, the refuge has limited access points for bank fishing. It is closed under all alternatives.

Public Use and Access

Hunting

Under this Alternative no hunting opportunities are proposed. Continued loss of opportunities to offer safe hunting on large parcels of public land in an otherwise heavily populated area would persist. Closure of the refuge to hunting contributes to the unfilled demand for this activity and causes the Service to miss opportunities to convey national wildlife refuge messages to the hunting public and build related constituencies.

Increased negative interactions between humans and deer would occur as greater numbers of deer forage on gardens and ornamental plants in residential neighborhoods and on agricultural crops. Incidents of deer-motor vehicle collisions may increase and a larger deer population would raise the deer tick population and the associated transmission of Lyme disease.

Fishing

Fishing in rivers flowing through the refuge contributes to satisfying demand for the activity while having little, if any, environmental consequences. Minimal impacts such as littering and wildlife disturbance may occur along river banks. Canoeing, small boat use, and fishing generate local economic benefits for businesses that cater to these activities.

Wildlife Observation and Photography, Environmental Education and Interpretation, and Public and Community Outreach

These activities fall under the Categorical Exclusion process described earlier in the chapter. These activities provide a valuable opportunity for people to observe and learn about wildlife and their habitats in their natural setting. Education effectiveness is bolstered through training assistance to area teachers and active involvement in the Urban Education Program in the Worcester and Boston school systems. Education increases local understanding of Great Meadows Refuge and its diversity of wildlife and habitat types that benefits quality of life in an urban area of metropolitan Boston.

Non-Wildlife Dependent Public Uses

Dog walking and picnicking is occurring on Great Meadows Refuge. People who walk dogs on the refuge often disturb visitors that are observing wildlife. The Concord impoundments receive significant use by these users. We receive complaints on a consistent basis from users who note that many people do not keep their dogs on leashes and do not clean up excrement. Observations made by refuge staff suggest that as many as 20% of visitors use the refuge to walk dogs.

Leashed and unleashed dogs disturb nesting birds and small mammals; foul trails with excrement; and disturb visitors engaged in priority public uses, including wildlife observation, photography, environmental education and interpretation.

Resource Protection and Visitor Safety

Law enforcement presence provides some level of protection for visitors but it is spread very thin over a large area. Maintaining and upgrading visitor use facilities reduces the potential for unsafe situations. An annual Youth Conservation Corps program provides opportunity for up to six local high school students to work on a variety of refuge projects. Students benefit by receiving eight hours of environmentally related education each week.

Cultural Resources

Cultural resources that occur on refuge lands are protected through Federal ownership and Law Enforcement presence that deters disturbance. Cultural resource surveys are conducted prior to proposed land disturbance projects to assure that sensitive sites are not compromised or that any resources to be altered are properly preserved.

Nearby residents often use refuge trails for personal recreation. Others have encroached onto refuge lands by cutting trails, clearing vegetation, and disposing of yard waste and other materials. These unauthorized activities are fairly widespread and conflict with protection of refuge habitat for wildlife.

Socioeconomic Resources

Cooperative farming on six acres of refuge land provides partial income for the farmer.

Protecting lands as national wildlife refuges may significantly increase the value of private property in its vicinity. It also eliminates local expenditures needed to pay for infrastructure and community services to accommodate residents and businesses that would occupy the land if it were developed.

Alternative B - Proposed Action

Expansion of wildlife and habitat inventory programs would generate a valuable natural resource database to be shared with other land managers and landowners. Use of the information would greatly improve the ability for refuge staff and partners to plan effective management programs that focus on restoring and sustaining species and habitat diversity. Development of an invasive species database would enhance the ability of refuge staff and partners to understand and control the spread of exotic plants. Implementation and evaluation of well-planned management actions would improve wildlife conditions. Development and implementation of a Visitor Services Plan for upgrading and expansion of visitor and education programs and accommodations ensure that high quality wildlife oriented experiences would be available to visitors. These services would generate social and economic benefits within surrounding communities.

Eastern bluebird. *Photo by Bruce Flaig*

Water Quality/Hydrology

Impacts to water quality in this alternative are similar to Alternative A, as all alternatives have positive impact on water quality in streams and their receiving waters because they protect ground and surface water recharge areas and sustain natural flow patterns that reduce sediment transport and distribution of non-point source pollution. All of these factors contribute to maintenance of ecosystem functions.

The removal of nuisance beavers clogging water control structures may impact the hydrology of the area. This impact should be favorable to the migratory birds using the areas as these structures are used to provide better habitat.

As described under Alternative A, the improper use of herbicides may negatively impact water quality. See page 4- 22 Water/Quality/ Hydrology section for a complete discussion on the consequences of using herbicides.

Geology/Topography/Soils

Some temporary and permanent disturbances to surface soils and topography would occur at locations selected for visitor facilities such as new kiosks, observation decks and canoe launches, visitor contact stations, visitor centers proposed in Alternative B (See Maps 2-10, 2-11, 2-12 and 2-13). Reestablishing parking areas would result in the compaction of soil and removal of vegetation.

We may also use the hydroaxe or other mechanical means to control the spread of certain invasive species. Heavy machinery, such as the hydroaxe, used for maintenance of habitat may compact soil and temporarily displace animals using that habitat.

Air Quality

As discussed under Alternative A, air quality in the refuge planning area is driven by surrounding land use. The refuge has little direct control over the quality of the air surrounding the planning area, but we can all do our part by carefully managing on-the-ground activities to prevent further degradation of air quality. All of the alternatives would serve to maintain or improve air quality of municipalities surrounding refuge lands in direct relationship to the extent these properties are protected from development.

Under this alternative we are proposing prescribed burning. Burning is often less expensive than herbicides. It would occur under safe conditions that evaluate wind conditions and direction, existing fuel conditions, relative humidity, and appropriate fire training. Adjacent land owners would be notified prior to burning. We would also be completing our burns in compliance with Massachusetts Dept. of Environmental Protection Air Quality Permitting Requirements for prescribed burns. Please see section Fire Management at the beginning of Chapter 2.

Many of the management strategies and biological monitoring activities have short-term negative impacts on air quality due to emissions from motorized vehicles and equipment such as tractors, mowers, chain saws, and gas powered generators. Operating the least polluting models available and making sure all equipment is properly operated and maintained by trained personnel can minimize these impacts.

Habitat and Wildlife Populations

Expansion and refinement of current wildlife and habitat inventories listed in Alternative A to include raptors and invertebrates and development of related vegetative cover-type maps would greatly improve staff ability to analyze trends in the succession of habitat types and the wildlife populations they support. Armed with this information refuge staff would have the capability to plan, implement, and evaluate long range management programs that benefit federal trust species as well as diverse resident wildlife populations. Sharing this information with partners would enhance their ability to manage land for wildlife over a much larger area than the confines of Great Meadows Refuge. An important consequence would be that refuge would support a remarkable and thriving diversity of species and habitats within the densely populated metropolitan Boston area. Analysis of the Great Meadows database in conjunction with databases from other Eastern Massachusetts refuges such as Oxbow and Assabet would provide opportunities to assess the status of habitat and wildlife throughout this area.

Development and implementation of a Habitat Management Plan would insure that forest habitats appropriate to the Great Meadows Refuge area would be sustained. These habitats would support forest dependent species such as owls, thrushes and other neo-tropical migrant birds associated with New England forests.

Termination of cooperative farming on the six acre parcel at the Sudbury Division would allow the refuge to plant native vegetation that could benefit wildlife. The refuge may have to use chemical or biological means to control invasive species if they become a problem.

The refuge would use fire as a management tool where appropriate. Fire is beneficial in forest management in the preparation of seedbeds, site preparation and the control of undesirable vegetation. Fire can induce vigorous sprouting and remove excess litter buildup from the forest floor which can help prevent wildfires. Burning can cause damage to rodent habitats, but unlikely to have negative long-term impacts. See section Fire Management at the beginning of Chapter 2.

Invasive and Overabundant Species

Executive Order 13112 (February 1999) directs all federal agencies, subject to funding, to prevent the introduction of invasive species; detect and respond rapidly to and control populations of such species in a cost-effective and environmentally sound manner; monitor invasive species populations accurately and reliably; provide for restoration of native species and habitat conditions in ecosystems that have been invaded; and promoted public education on invasive species and the means to address them.

Increased efforts to control invasive plant species such as common reed, autumn olive, Asiatic bittersweet, yellow iris, and Japanese honeysuckle would temporarily disturb sites where these plants are removed. In cases where chemicals or fire are used, secondary loss of nearby indigenous plants may occur. In all cases, recovery of native habitats from competition with exotic species would benefit wildlife species diversity and population health. Development and implementation of an Integrated Pest Management Plan, where feasible, would greatly reduce impacts that occur when mechanical of chemical methods are used.

Release of host-specific insects to control the spread and density of invasive purple loosestrife has shown to be effective after 4-5 years of continual release of thousands of beetles. *Galerucella* beetles will feed on other plants, including some other invasive species, but it is still believed that purple loosestrife is necessary for this species to successfully reproduce. Research and release of these insects during 20 years of study have shown no major secondary impact to other plant species. A direct benefit of controlling purple loosestrife in wetlands is the subsequent return of native vegetation and better habitat for waterbirds for nesting, feeding and resting.

Beaver activity generally has a positive impact on wildlife populations because it fosters rotation of diverse habitat types. Refuge action to alter beaver activity and the flooding it causes is done primarily to minimize its effect or private property, trails, roads or other human related features. These actions often

counteract wildlife benefits that are created during the evolution of beaver pond ecosystems.

Evidence of beaver. *Under the Proposed Action, beaver may be removed if they pose a threat to habitat or safety. USFWS*

We are proposing lethal removal of nuisance beaver by shooting or trapping if other mechanisms, such as beaver deceivers, do not work. The Service recognizes regulated trapping as an effective tool of wildlife population management on National Wildlife Refuges (Refuge Manual Chapter 7, Section 15). Removal of these species may be beneficial for the prevention and alleviation of habitat degradation, facilitation of habitat and wildlife restoration, and the conservation and enhancement of biological and genetic diversity. (Boggess et al. 1990, Organ et al. 1996).

Removal of territorial exotic mute swans by lethal or other means from refuge impoundments, ponds, and wetlands would prevent the damage done when these exotic birds uproot native vegetation, drive native waterfowl and other bird species away from their habitats, and lower water quality. Birding opportunities would improve because more native species would be present when mute swans are not. However, some bird watchers may not approve of removal of these birds because of their aesthetic value.

See section Alternative A, Wildlife and Habitat for a discussion of herbicide impacts to wildlife.

Hunting

This section describes the impact of the Alternative B hunting proposal on habitat and wildlife. For information on social impacts of hunting, see the following section under Public Use and Access.

Providing hunting and fishing opportunities addresses the mandates of Executive Order 12996 and the National Wildlife Refuge System Improvement Act of 1997 by providing the public with an opportunity to engage in wildlife-dependent recreation. Hunting and fishing are recognized by the Service as a traditional forms of wildlife related outdoor recreation. We anticipate a low to moderate degree of hunting and fishing pressure to occur as a result of opening the refuge for these activities. The plan to permit hunting and fishing on the refuge should not significantly affect the wildlife populations in Massachusetts, as the refuge represents only a very small portion of the overall habitat available in Eastern Massachusetts. Individual deer would remain free to move on and off refuge property. Deer hunting on refuge land in eastern Massachusetts would provide hunter access to additional land and would be a significant contribution toward achieving carrying capacity objectives described in the hunting consequences for Alternative A (Woytek, MDFW, personal communication).

Hunting and fishing would not affect the refuge's goal to maintain, restore, and enhance habitat to support a diversity of plants and animals. Hunting may encourage natural diversity by limiting the growth of the deer population on the refuge, thereby protecting

preferred forage species from over-browsing. The refuge does not anticipate any adverse effects on migratory birds, inter-jurisdictional fishes, and endangered species as a result of establishing a hunting or fishing program. Fish and wildlife species for which hunting and fishing would be permitted on the refuge are those that are already regulated at the State or Federal level.

These controlled hunts would remove some deer and waterfowl from the refuge. Removal of deer would assist in trying to keep the population within or near its habitat carrying capacity. Waterfowl hunting would remove some birds from the refuge but would not impact overall populations.

The physical impacts of hunting to the habitat should be limited, due to refuge-specific regulations prohibiting use of ATVs, off-road travel, permanent stands and blinds, and camping and fires. Impacts may also include limited trampling of vegetation, creation of unauthorized trails by hunters and subsequent erosion, littering and vandalism. Indirect effects of hunting on vegetation might be neutral or positive, if habitat quality was maintained at its present or an improved level.

Archery hunting is compatible in urban and rural settings. In Connecticut, it was found that under controlled circumstances a well-designed archery hunt could reduce the local herd by 50% (Kilpatrick and Walter 1999 as in Kilpatrick et al 2002). Similarly, in an urban Minnesota setting, deer populations were controlled to a tolerable level using an innovative bow hunt program (McAninch 1993 as in Kilpatrick et al 2002). There were several options to hunting that were analyzed and considered during the CCP process but were eliminated as nonviable management options. These include immunocontraception, steroidal implants, oral delivery of contraceptives, GNRH vaccine, sterilization, live trapping and relocation, and habitat management. Please refer to the section at the beginning of Chapter 2, Alternatives Addressed but not Considered, for their description and discussion.

The deer hunt program that is recommended in this alternative sustains a healthy deer population that is consistent with habitat carrying capacity. Deer browsing would not reach levels that damage understory habitat diversity. Habitat used by ground nesting and near ground nesting forest birds would be perpetuated.

Waterfowl hunting on a 575-acre portion of Great Meadows Refuge would be managed in compliance with State and Federal regulations. Restrictions on use of permanent hunting blinds or other structures would assure that habitat is not permanently altered by hunters and that visually obtrusive structures are not placed on the refuge. Impacts of waterfowl hunting include temporary disturbance to wildlife species in the area. Hunting dogs may cause disturbance if not under control.

Hunting is consistent with the purposes for which the refuge was established; the Service policy on hunting; the National Wildlife Refuge System Improvement Act of 1997; and the broad management objectives of the National Wildlife Refuge System. Hunters would be directed to the Eastern Massachusetts Complex Headquarters in Sudbury for a hunting permit and additional information, maps, and refuge specific regulations.

Fishing

See Alternative A.

Public Use and Access

Hunting

Opening portions of Great Meadows Refuge to archery hunting for deer and shotgun hunting for waterfowl would partially satisfy demand for these activities. Visitor activities such as trail use near hunt areas may be curtailed during deer season but this impact would be minor because firearm hunting for deer would not be permitted. Hunts would be monitored for impact on refuge resources and, if any are found, appropriate adjustments would be made to eliminate them.

We recognize that some public may be displaced by offering hunting on refuge. We've specifically targeted areas for hunting that are not currently heavy public use areas or near large human housing divisions (See Maps 2-10- 2-14).

Under this alternative and all other alternatives that propose to open the refuge to hunting, the refuge manager may, upon annual review of the hunting program, impose further restrictions on hunting activity, recommend that the refuge be closed to hunting, or further liberalize hunting regulations within the limits of State law. Hunting noise may disturb visitors and may necessitate the closure of some areas during the hunting season

Fishing

Similar consequences as discussed under Alternative A.

Wildlife Observation and Photography, Environmental Education and Interpretation, and Public and Community Outreach

These activities fall under the Categorical Exclusion process described in the introduction of this chapter. These activities provide a valuable opportunity for people to observe and learn about wildlife and their habitats in their natural setting. This alternative offers expanded programs, additional information and signing, additional outreach efforts, and more photography and wildlife observation opportunities. These activities build long-term

relationships with partners and communities. We would complete an EA and provide an opportunity for public input for site selection for this Center.

Construction and operation of a Great Meadows Refuge Complex Visitor Center would increase knowledge of, and support for, all refuges within the Eastern Massachusetts Wildlife Refuge Complex. This facility would also stimulate economic activity in the area where it is located.

Non-Wildlife Dependent Public Uses

Elimination of dog walking and picnicking and continued prohibition of other activities such as bicycling, ice skating, horseback riding, and swimming at Great Meadows Refuge would help prevent human caused conflicts with wildlife during feeding, nesting and other important life cycle processes. This action would also eliminate activities that diminish the quality of wildlife-oriented visitor experiences, such as a visitor's fear of dogs and stepping in excrement while walking on the trails. Dog walking and picnicking are not priority public uses identified in the Refuge Improvement Act, nor are they (except seeing or hearing dogs) necessary to support the safe, practical, and effective conduct of a priority public use. We acknowledge the public's desire to walk their dog and picnic in a natural setting, but these activities are not dependent on the presence of fish and wildlife, nor dependent on the expectation of encountering fish and wildlife. The purpose of wildlife refuges is protection of our wildlife resources and the habitats that support them. Refuge lands are not to be used as recreational parks.

Elimination of dog walking would prevent wildlife disturbance, prevent fouling of trails with dog excrement, and eliminate dog related conflicts with visitors who are birding or participating in environmental education programs. Dogs can disturb nesting birds, destroy eggs, or injure and kill unfledged chicks (Dahlgren and Korschgen 1992). Dogs, whether on leash or not, can be aggressive toward other dogs or toward people, causing potential injury to refuge visitors. Some people are afraid of dogs and will go to great lengths to avoid an encounter with them. This can especially be a problem on some of our narrow trails where it is difficult to avoid dogs. We estimate nearly 20% of our visitors use the refuge to walk dogs. The sheer number of users exacerbate the problems described above.

Closure of the refuge to picnicking would remove a source of animal-attracting litter and localized wildlife disturbance. This action would have a negative consequence for people accustomed to picnicking on the refuge and would cause them to seek other locations for this activity.

Uplands on the refuge.. *USFWS photo*

We recognize that prohibiting and eliminating these activities would generate an inconvenience to many who have used the refuge for these activities. Local parks where these uses are allowed would likely see an increase in these users, which may create additional conflict or use of those areas.

Resource Protection and Visitor Safety

Expanded law enforcement presence would enhance protection of wildlife resources and the level of safety afforded visitors, volunteers, and staff.

Cultural Resources

Completion of a refuge-wide cultural resource survey would allow planners and managers to ensure protection of historic and archaeological sites and artifacts. It would also improve the refuge ability to provide high quality interpretation of its cultural resources.

Socioeconomic Resources

Attraction of more visitors, including hunters, to the refuge may generate revenues for local restaurants and other businesses that cater to tourism including fuel, food, lodging, and supplies.

The land area and habitat protected by Great Meadows Refuge would continue through efforts with partners to purchase or otherwise protect land within the refuge approved acquisition boundary. Transfer of land to the refuge decreases gross property tax revenues to affected towns. However, this economic impact may be more than offset by two factors. First, annual Refuge Revenue Sharing Payments to towns in which the refuge holds land partially compensate for lost property taxes. Numerous studies have confirmed that developed land more often than not generates needs for community services that cost more than the tax revenue it generates.

Alternative C

Under this Alternative little wildlife or habitat management would occur. Great Meadows Refuge lands would succeed to climax stages or be dominated by invasive species. This would lower habitat and species diversity causing the refuge to become a less interesting place for wildlife enthusiast to visit. The focus of this alternative for this refuge is public use. Great Meadows Refuge would remain a relatively unknown natural resource within the greater Boston area.

Water Quality/Hydrology

Alternative C would contribute to good water quality by protecting in perpetuity refuge lands. However, the hydrology of the area would be altered as the refuge would not be focusing on management of impoundments for a diversity of wildlife.

Under this alternative, herbicide use would be limited. Impacts from herbicides (described under Alternative A, Water Quality/ Hydrology) would be reduced.

Geology/Topography/Soils

Consequences would be similar to Alternative B. However, under this alternative very little discing or plowing would occur, thus reducing disturbance to the soils.

Air Quality

Consequences would be similar to Alternative B.

Habitat and Wildlife Populations

Not maintaining grasslands would result in further succession to shrubs and eventually forested areas, which would result in more scrub/shrub dominated and young forest habitats which are important to ruffed grouse and American woodcock and later forest interior dwelling birds. Inventories that only generate species lists would not provide adequate accounts of habitat conditions and wildlife population trends that are needed to evaluate natural resources of Great Meadows Refuge. Habitats such as grasslands and wetland impoundments that require regular management and maintenance would quickly evolve to climax habitat stages that would not support current species diversity. Grassland/shrub dependent species such as woodcock, bobolinks, bluebirds, and meadowlark would become uncommon. Shore and marsh bird use of refuge impoundments would diminish or even cease.

Under this alternative, beaver would not be removed if they become problematic. This could result in altered hydrology of the area by damming natural flows and destroy valuable habitat for migratory birds.

Invasive and Overabundant Species

Without active control efforts, invasive plant species would overtake both wetland and upland habitats and diminish their ability to benefit wildlife. Lack of monitoring that anticipates trends in the spread of these plants would result in undocumented situations of habitat degradation on the refuge and in surrounding areas.

Hunting

Consequences will be similar to those under Alternative B.

Public Use

Hunting

Consequences related to the deer population and its impact on habitat quality would be similar to those of Alternative B. However, use of primitive firearms and shotguns for deer hunting and expansion of waterfowl hunting into additional areas would increase the potential for conflicts with refuge neighbors. More non-hunting visitor uses may be curtailed during hunting seasons. Visitor uses that could be affected include trail use and canoeing near wetland areas that would be open to waterfowl hunting.

Fishing

Similar consequences as discussed under Alternative A.

Wildlife Observation and Photography, Environmental Education and Interpretation, and Public and Community Outreach

These activities fall under the Categorical Exclusion process described earlier in the introduction of the chapter.

Non-Wildlife Dependent Public Uses

Consequences will be similar to those under Alternative B.

Resource Protection and Visitor Safety

Resource protection and visitor safety will be managed at the same level as under Alternative B.

Socioeconomic Resources

Social and economic benefits would be less than they would be under the other two alternatives because the refuge would become a less interesting place to visit. The value of wildlife experiences would diminish because habitat diversity would not be maintained. Lack of wetland impoundment management would diminish the ability of these habitats to attract most of the wildlife species that currently use them.

Part 3: Oxbow National Wildlife Refuge

Alternative A – Current Management Alternative

The Current Management Alternative represents the anticipated condition of the refuge (and associated resources) if current policies, programs and activities continue in a manner consistent with recent or foreseeable trends. While this alternative does not represent a true "status quo" condition, neither does it propose major changes in public use/wildlife management programs or facilities. The analysis would focus on anticipated changes in specific refuge management actions, and the impact of these changes on the physical, biological and socioeconomic environment. The reader is reminded that much of the rationale supporting conclusions throughout this chapter would appear in the discussion of the Current Management Alternative, and may not always be repeated under other alternatives.

Habitat management that sustains small blocks of grassland/shrub, wetland, and turtle nesting habitat would help maintain that some habitat diversity at Oxbow Refuge. Periodic release of selective insects would help reduce the spread of the invasive plant purple loosestrife. An absence of well-planned wildlife and habitat inventories would fall short of adequately accounting for these resources.

Unmet demand for hunting, fishing, hiking and other recreation opportunities would continue, as no action would be taken to expand these activities at the refuge. The ability to attract more supportive constituents is not anticipated to improve because education and outreach concerning Oxbow Refuge would only occur as an adjunct to outreach programs for the much larger Eastern Massachusetts Refuge Complex. Oxbow Refuge would continue to have only minor social or economic connection to surrounding communities.

Water Quality/ Hydrology

Alternative A would protect the natural hydrology of the affected areas. All alternatives would provide at least protection for hydrology within the refuge boundary since it protects important wetlands along the Nashua River. Refuge ownership and management maintains groundwater recharge and prevents water withdrawal. These factors are critical to long-term protection of wetlands and water supply resources.

Refuge lands contribute to clean surface water because vegetation filters rain water that runs into lakes, rivers and ponds. Protecting land also prevents development, which can dramatically affect

surface water as rainwater runs off pavement, collecting contaminants along the way. Refuge land also protects groundwater recharge areas which are important for residents who rely on wells for their water supply. The wetlands protected in all the alternatives would maintain natural catchments to hold and absorb surface waters, thereby minimizing flooding. These factors are critical to long-term protection of wetlands and water supply resources.

Invasive and Overabundant Species

In both Alternative A and B, beaver deceivers, water control structures, and periodic ditching may impact hydrology by controlling water levels, volume, and velocity and diverting water to or from areas where it is or is not needed. These methods are used to restore favorable hydrology for trust wildlife species using the refuge.

In both Alternative A and B, we propose using pesticides to control invasive, exotic and injurious species. In wetland environments water safe derivative chemicals would be used, and label directions would be carefully followed to avoid contamination of water. In all areas we would be using herbicides that have been approved for that application by the EPA. Our goal is to use the most effective tool for its purpose that has the lowest possible non-target organism effects. Some pesticides may have minimal effects on non-target organisms and a broad spectrum of herbicides need to be carefully applied to prevent killing desirable species.

We have little control over the quality of the water passing by, as we do not own or control a significant portion of the watershed.

Geology/Topography/Soils

None of the alternatives would substantially impact the local geology, topography or soils except that all the alternatives would protect, in perpetuity, soil formation processes on lands the refuge owns and acquires.

Under Alternative A, there are no significant adverse impacts expected to the general topography of the planning area. All alternatives would not have substantial adverse impact on these features. Soil formation processes on lands owned as national wildlife refuges would be perpetually protected. Temporary soil disturbance would occur during selected habitat management actions designed to adjust varying stages of vegetative succession. Some permanent alteration to soils and topography would occur at locations selected for administrative, maintenance, and visitor facilities such as visitor centers, visitor contact stations, trials, platforms, and related structures.

Virginia rail. *Photo by Bruce Flaig*

Air Quality

Good air quality is essential to ecosystem health. It is well documented that poor air quality contributes to acidification of streams and soils, eutrophication of open water areas, vegetation injury often in the form of decreased plant reproduction, increased accumulation of metals and organics in the food chain, and causes "regional haze" (Porter 1999, personal communication).

Air quality in the refuge planning area is driven by surrounding land use. The refuge has little direct control over the quality of the air surrounding the planning area, but we can all do our part by carefully managing on-the-ground activities to prevent further degradation of air quality. All of the alternatives would serve to maintain or improve air quality of municipalities surrounding refuge lands in direct relationship to the extent these properties are protected from development.

As stated in Chapter 3, Oxbow Refuge currently has attainment status for air quality as required by the federal Clean Air act of 1970. This means the area does not exceed the level of acceptable pollutants as set by the federal government in the Clean Air Act. Increased volume is one factor that could cause the area to exceed acceptable pollutant levels. Any visitor increase in Alternative A would not be enough to increase traffic volumes to the point where it would affect air quality. Given this, and the fact no Class I air quality areas would be affected, adverse impacts to air quality from Alternative A would tend to be sporadic, of relatively short duration, and of light intensity. In other words, a neutral effect is anticipated on air quality from the Current Management Alternative. In addition, implementation of Alternative A is in full compliance with the Clean Air Act.

The refuge is not conducting prescribed burns under this alternative. For additional information, see section Fire Management at the beginning of Chapter 2.

Habitat and Wildlife Populations

Ongoing wildlife inventories at Oxbow Refuge are building the first comprehensive and uniform wildlife database for this refuge. Documentation of populations status and trends for breeding landbirds, marsh and wading birds, shorebirds, waterfowl, fish reptiles and amphibians and rare birds would provide a solidly foundation of information upon which habitat and population management planning can be done. However, lack of a long-term wildlife and habitat inventory strategy would likely prevent the refuge manager and partners from fully understanding biological issues and opportunities. In the absence of good data, population and habitat management cannot effectively be planned, implemented or evaluated.

Periodic mowing, or possibly controlled burning, would maintain 25-30 acres of upland habitat in early successional stages This action, through hydro-axing and mowing, prevents affected land from succeeding to forest or other mature habitat types. Sustaining grassland habitats may promote use by savannah sparrows, grasshopper sparrows, bobolink, upland sandpiper, and eastern meadowlark. Early successional habitats, such as scrub-shrub and thickets, or edge habitats would promote use by ruffed grouse, song sparrows, indigo buntings, blue-winged warbler, Eastern towhee, and rose-breasted grosbeak.

Vegetation clearing to restore and maintain 8-10 acres of bare mineral soils near open water habitat, in addition to 15-20 acres that are currently available, would assure nesting opportunities for Blanding's turtles and other turtle species. This action has the adverse consequence of encouraging the spread of the invasive plant, spotted knapp weed.

Maintaining beaver flowages and an existing water control structure would provide additional wetland habitat for these turtles, waterfowl, and a variety of wetland dependent wildlife species. Restoration of the 25-30 acres of beaver created wetland along the North side of Route 2 would add to the diversity of wetland dependent species that use the refuge.

Monitoring and review of Fort Devens clean-up activities would alert refuge staff to related situations that could be detrimental to habitat or wildlife. When problems are anticipated the refuge manager would be in a position to recommend remedial action to reduce or eliminate these threats.

Control of public access to refuge lands ensures that the potential for human caused wildlife and habitat degradation is minimized. Banning of motorized off-road-vehicles, and confining visitors to existing trails and the Nashua River reduces related impacts. Selective removal of roads and trails would allow these sites to revert to vegetated wildlife habitats.

Invasive and Overabundant Species

Wetland quality would be restored if the refuge is able to obtain assistance from outside sources for continued release of host-specific *Galerucella* beetles into wetlands that have become dominated by purple loosestrife. Releases in a 20-acre portion of these wetlands may eventually spur a self-sustaining population of the beetles that would eventually decimate the infestation. Lack of aggressive action to reduce the prevalence and spread of purple loosestrife would likely perpetuate the loss of wetland values cause by this plant. Failure to adequately document the significance of it and other invasive species prevents the refuge manager from understanding the degree of damage they cause or to plan proper actions to control their spread. Left unchecked, invasive plants would further degrade habitat quality and reduce wildlife population density and species diversity.

Monitoring stands of spotted knapweed, glossy buckthorn, cattail, and common reed would partially document habitat lost to these invasive plants. However, lack of aggressive action to control them would perpetuate habitat degradation.

To minimize effects and insure proper use, herbicides would not be applied without an approved Pesticide Use Plan. In all applications, label instructions would be strictly followed to minimize hazards to the applicators and environment. This includes wearing proper personal protective equipment (including long sleeved clothing, gloves and eyewear) during preparation, treatment and clean up.

Broad spectrum herbicides that are considered relatively nontoxic to dogs and other domestic animals may still cause gastrointestinal irritation if large amounts of freshly sprayed vegetation are ingested. In areas where this is a high risk, proper public notification would occur. Many of these herbicides also have a strong affinity to soil particles, and once bound are unavailable to vegetative root systems. This affinity lasts until the product is biodegraded via aerobic and anaerobic conditions by microfloras in the soil.

Hunting

This section describes the impact of the Alternative A hunting proposal on habitat and wildlife. For information on social impacts of hunting, see the following section under Public Use and Access.

Long time closure of Oxbow Refuge to deer hunting has allowed the deer herd to increase because there are no natural population controls in this area. This persistent situation causes the growing population to exceed the capacity of its habitat that is required to sustain healthy animals and good habitat quality. As herd size increases browsing alters plant community composition. Many authors (Alverson et al. 1988, Behrend et al. 1970, Tilghman 1989, Warren 1998, McShea and Rappole 1992) have reported that vegetative species richness and the abundance of herbaceous and woody vegetation declines in areas with white-tailed deer densities exceeding carrying capacity. The decline is directly attributed to the activities of deer. The loss or reduction of woody understories in forests or lack of forest regeneration decreases availability of habitats for migratory birds and other wildlife. DeCalesta (1994) found that changes in the vegetation due to browsing by high deer densities in Pennsylvania impacted intermediate canopy-nesting songbirds and reduced species richness and abundance. Studies by the Massachusetts Division of Fisheries and Wildlife between 1997 and 1999 found that deer reproduction in eastern Massachusetts is high and that individual animals are long-lived. This, combined with loss of habitat due to land use alteration, local restrictions on use of firearms, and limited opportunities for hunters to access hunting areas has caused deer habitat to be at or near carrying capacity [personal communication, William Woytek, Massachusetts Division of Fisheries and Wildlife (MDFW)]. The current deer density in

the towns in which Oxbow Refuge is located is estimated to be at 12 per square mile; the MDWF recommended density to avoid habitat degradation due to over browsing. Since 1997 the State has implemented a longer archery season for deer and increased harvest of antlerless deer in an effort to retain the 12 deer per square mile objective. Deer hunting on refuge land in eastern Massachusetts would provide hunter access to additional land and would be a significant contribution toward maintaining this objective (Woytek, MDFW, personal communication).

Under this No Action Alternative the deer herd density would continue to increase. Browsing pressure would continue to reduce overall habitat quality for deer, stress the health of individual animals, and diminish diversity of habitats that sustain other wildlife species.

Regulatory control of upland game birds, small game, and woodcock hunting combined with the low level of hunting on the refuge would assure that essentially no long-term impacts on wildlife populations occur.

Fishing

No impacts are anticipated other than riverbank erosion and litter from people seeking access to launch canoes. Potential for this impact is low because riverbanks are technically closed to visitors, so disturbance would only occur at designated boat launches. Individual fish would die due to this activity, but take is not anticipated to impact fish populations.

Public Use and Access

Hunting

Upland game bird, small game, and woodcock hunting at Oxbow Refuge under this alternative would provide a modest contribution in satisfying local demand for hunting, and provides opportunities for refuge staff to convey Service and refuge messages to hunting enthusiasts and the public. Regulatory control combined with the low level of hunting on the refuge assures that essentially no long-term impacts on wildlife populations occur.

Fishing

Fishing from small boats and canoes in the Nashua River helps satisfy demand for this activity. Potential for this impact is low because access to riverbanks is prohibited, except at designated canoe launch sites.

Vernal pool.. *USFWS photo*

Wildlife Observation and Photography, Environmental Education and Interpretation, and Public and Community and Outreach

These activities fall under the Categorical Exclusion process described earlier in the chapter. These activities provide a valuable opportunity for people to observe and learn about wildlife and their habitats in their natural setting. The limited programs offer the Service limited opportunities to build long term relationships with partners and communities.

Non-Wildlife Dependent Public Uses

Dog walking and picnicking is occurring on Oxbow Refuge. People who walk dogs on the refuge often disturb visitors that are observing wildlife. Leashed and unleashed dogs disturb nesting birds and small mammals; foul trails with excrement; and disturb visitors engaged in priority public uses, including wildlife observation, photography, environmental education and interpretation.

Resource Protection and Visitor Safety

The absence of consistent Service personnel presence at Oxbow Refuge likely influences unauthorized access to closed portions of the refuge, and increases the risk for safety related problems.

Cultural Resources

Ownership of land by the refuge combined with the negligible amount of intrusive management that occurs assures that cultural resources are not disturbed. Cultural resource surveys and clearance are obtained prior to work involving soil disturbance.

Socioeconomic Resources

Protecting lands as national wildlife refuges may significantly increase the value of private property in its vicinity. It also eliminates local expenditures needed to pay for infrastructure and community services to accommodate residents and businesses that would occupy the land if it were developed.

Alternative B – The Service's Proposed Action

Under this alternative, management of habitats and aggressive control of invasive species would ensure healthy populations of diverse wildlife species. Sharing of wildlife management and land protection information and techniques would likely encourage partners, landowners, and land managers to learn about and implement actions that benefit eastern Massachusetts wildlife resources.

New opportunities for wildlife oriented recreation, education and outreach, and visitor accommodation would enhance local knowledge of Oxbow Refuge and the wildlife, social, and economic benefits it fosters. Greater refuge visibility would foster a larger and more effective Friends of Oxbow Refuge group. Planning, implementation, monitoring, and evaluation of visitor services may further high quality experiences that have minimal impact on wildlife and its habitat.

Water Quality/ Hydrology

Impacts to water quality in this alternative are similar to Alternative A, as all alternatives have a positive impact on water quality in streams and their receiving waters because they protect ground and surface water recharge areas and sustain natural flow patterns that reduce sediment transport and distribution of nonpoint source pollution. All of these factors contribute to maintenance of ecosystem functions.

The removal of nuisance beavers clogging water control structures may impact the hydrology of the area. This impact should be favorable to the migratory birds using the areas as these structures are used to provide better habitat.

As described under Alternative A, the improper use of herbicides may negatively impact water quality. See page 4-40 Water/Quality/ Hydrology section for a complete discussion on the consequences of using herbicides.

Geology/Topography/Soils

In order to maintain appropriate habitat for species such as the State-listed Blanding's turtle, vegetation is removed in nesting areas. Methods including discing or plowing may be used. Discing disturbs the soil and has the potential to introduce invasive species. However, we would control invasive species in these areas if they establish. We may also use the hydroaxe or other mechanical means to control the spread of certain invasive species. Heavy machinery, such as the hydroaxe, used for maintenance may compact soil and temporarily displace animals using that habitat.

Under this alternative we are proposing to remove several old buildings. This would be a one-time disturbance, and in the long run

it would be a positive benefit because the areas where buildings were removed would be restored to wildlife habitat.

Additionally, some disturbance to surface soils and topography would occur at locations selected for visitor facilities such as new kiosks, observation decks and canoe launches proposed in Alternative B (See Map 2-19) Additionally, establishing parking areas would result in the compaction of soil and removal of vegetation.

The construction and placement of the visitor contact station would impact soils and vegetation. The building and surrounding infrastructure would compact soils.

Air Quality

As discussed under Alternative A, air quality in the refuge planning area is driven by surrounding land use. The refuge has little direct control over the quality of the air surrounding the planning area, but we can all do our part by carefully managing on-the-ground activities to prevent further degradation of air quality. All of the alternatives would serve to maintain or improve air quality of municipalities surrounding refuge lands in direct relationship to the extent these properties are protected from development.

Under this alternative we are proposing prescribed burning. Burning is often less expensive than herbicides. It would occur under safe conditions that evaluate wind conditions and direction, existing fuel conditions, relative humidity, and appropriate fire training. Adjacent land owners would be notified prior to burning. We would also be completing our burns in compliance with Massachusetts Dept. of Environmental Protection Air Quality Permitting Requirements for prescribed burns. Please see section Fire Management at the beginning of Chapter 2.

Many of the management strategies and biological monitoring activities have short-term negative impacts on air quality due to emissions from motorized vehicles and equipment such as tractors, mowers, chain saws, and gas powered generators. Operating the least polluting models available and making sure all equipment is properly operated and maintained by trained personnel can minimize these impacts.

Northern mockingbird.. *Photo by Bruce Flaig*

Habitat and Wildlife Populations

Development and implementation of species and habitat inventories would provide information to guide management planning and action that would increase species diversity and populations of trust species. Additional and improved protocols for ongoing wildlife surveys would greatly improve management decision-making capability. Extrapolation of data from wildlife and habitat inventories that have been done for nearby and similar areas would allow refuge

staff to anticipate basic planning needs prior to designing refuge specific inventories. Management strategies guided by this information would more effectively restore, maintain, or enhance the quality and diversity of forest, grassland, shrub, wetland and other habitat types. Implementation of habitat management plans may cause temporary environmental disturbance. Examples include forest cutting and controlled burns to create open habitat, controlled burning and plowing to stimulate grassland, and water level manipulation and sediment removal to revitalize wetland. These actions may cause temporary adverse impact where they occur. However, the long-term habitat and wildlife benefits would outweigh temporary disruption.

Controlled burns would only be used in compliance with an approved Fire Management Plan (please see section Fire Management at the beginning of Chapter 2). Fire temporarily causes the loss of some habitat values and air but several unique benefits are derived through application of this tool. These include recycling of soil nutrients, removal of invasive plant species, regeneration of native plants, reduction of wildfire fuels, and diminished human health risk caused by wildfire.

Use of chemicals on refuge lands to improve habitat conditions would conform to Environmental Protection Agency regulations, registration information labels, state pesticide laws, and Department of Interior Pesticide Use Policy. No significant impacts to air quality, water quality, or non-target resources are anticipated due to use of herbicides or pesticides. If any do occur they would be minor, temporary, and site specific.

Increased visitation and expansion of visitor activities would generate conflicts between people and wildlife. Minor habitat alteration would occur and the presence of more visitors may disturb wildlife. In cases where this becomes problematic, areas open to visitation and related scheduling may require alteration. Closing portions of refuge trails to minimize human conflicts during May-October nesting seasons would avoid wildlife disturbance and bolster nesting success. For example, opening the refuge to deer hunting with shotgun, archery, and primitive firearms may help stabilize the long-term status of the deer population.

Invasive and Overabundant Species

A comprehensive invasive plant inventory would improve understanding of the prevalence of invasive species impacts and foster development and implementation of plans to respond to invasions. Application of integrated pest management practices such as use of herbicides, burning or physical removal would reduce damage caused by invasive species while minimizing secondary impacts to refuge resources. Controlling these species would recover significant acres of habitat that have been lost to invasion of exotic species and curtail their return.

Use of controlled burns and herbicides to reduce the prevalence of invasive plants may temporarily diminish the quality of adjacent or nearby habitat. The temporary nature of such impacts would be offset by the long-term benefits of habitat recovery. See section Alternative A: Habitat and Wildlife for discussion of herbicide impact to wildlife and refer to Chapter 2: Fire Management for information on using fire as a management tool.

Release of host-specific insects to control the spread and density of invasive purple loosestrife has shown to be effective after 4-5 years of continual release of thousands of beetles. *Galerucella* beetles would feed on other plants, including some other invasive species, but it is still believed that purple loosestrife is necessary for this species to successfully reproduce. Research and release of these insects during 20 years of study have shown no major secondary impact to other plant species. A direct benefit of controlling purple loosestrife in wetlands is the subsequent return of native vegetation and better habitat for waterbirds for nesting, feeding and resting.

Beaver activity generally has a positive impact on wildlife populations because it fosters rotation of diverse habitat types. Refuge action to alter beaver activity and the flooding it causes is done primarily to minimize its effect or private property, trails, roads or other human related features. These actions often counteract wildlife benefits that are created during the evolution of beaver pond ecosystems.

We are proposing removal of nuisance beaver by trapping or shooting if other mechanisms, such as beaver deceivers, do not work. The Service recognizes regulated trapping as an effective tool of wildlife population management on national wildlife refuges (Refuge Manual Chapter 7, Section 15). Removal of these species may be beneficial for the prevention and alleviation of habitat degradation, facilitation of habitat and wildlife restoration, and the conservation and enhancement of biological and genetic diversity. (Boggess et al. 1990, Organ et al. 1996).

Removal of territorial exotic mute swans by lethal or other means from refuge impoundments, ponds, and wetlands would prevent the damage done when these exotic birds uproot native vegetation, drive native waterfowl and other bird species away from their habitats, and lower water quality. Birding opportunities would improve because more native species will be present when mute swans are not.. However, some bird watchers may not approve of removal of these birds because of their aesthetic value.

Executive Order 13112 (February 1999) directs all federal agencies, subject to funding, to prevent the introduction of invasive species; detect and respond rapidly to and control populations of such species in a cost-effective and environmentally sound manner; monitor invasive species populations accurately and reliably; provide for restoration of native species and habitat conditions in ecosystems that have been invaded; and promoted public education on invasive species and the means to address them.

Hunting

This section describes the impact of the Alternative B hunting proposal on habitat and wildlife. For information on social impacts of hunting, see the following section under Public Use and Access.

Hunting and fishing would not affect the refuge's goal to maintain, restore, and enhance habitat to support a diversity of plants and animals. Hunting may encourage natural diversity by limiting the growth of the deer population on the refuge, thereby protecting preferred forage species from over-browsing. The refuge does not anticipate any adverse effects on migratory birds, fish, and endangered species as a result of establishing a hunting or fishing program. Fish and wildlife species for which hunting and fishing would be permitted on the refuge are those that are already regulated at the State or Federal level.

The deer hunt program recommended in this Alternative sustains a healthy deer population that is consistent with habitat carrying capacity. Deer browsing would not reach levels that damage understory habitat diversity. Habitat used by ground nesting and near ground nesting forest birds will be perpetuated. Human conflicts with deer would also be avoided because the deer herd would not overpopulate the refuge.

The Service does not anticipate significant effects to the resident wildlife population as individuals are free to move on and off refuge property.

The physical impacts of hunting to the habitat should be limited, due to refuge-specific regulations prohibiting use of ATVs, off-road travel, permanent stands and blinds, and camping and fires. Impacts may also include limited trampling of vegetation, creation of unauthorized trails by hunters and subsequent erosion, littering and vandalism. Indirect effects of hunting on vegetation might be neutral or positive, if habitat quality was maintained at its present or an improved level.

Archery hunting is compatible in urban and rural settings. In Connecticut, it was found that under controlled circumstances a well-designed archery hunt could reduce the local herd by 50% (Kilpatrick and Walter 1999 as in Kilpatrick et al 2002). Similarly, in an urban Minnesota setting, deer populations were controlled to a tolerable level using an innovative bow hunt program (McAninch

1993 as in Kilpatrick et al 2002). These include immunocontraception, steroidal implants, oral delivery of contraceptives, GNRH vaccine, sterilization, live trapping and relocation, and habitat management. Please refer to the section at the beginning of Chapter 2, Alternatives Addressed but not Considered, for their description and discussion.

Waterfowl hunting on the Nashua River South of Route 2 of Oxbow Refuge would be managed in compliance with State and Federal regulations. Restrictions on use of permanent hunting blinds or other structures would assure that habitat is not permanently altered by hunters and that visually obtrusive structures are not placed on the refuge. Impacts of waterfowl hunting include temporary disturbance to wildlife species in the area. Hunting dogs may cause disturbance if not under control.

Fishing

River bank erosion may result causing the refuge staff to adjust time periods for their use or installing boardwalks or other erosion control features. People who are fishing would cause site-specific disturbance of wildlife but the public use benefits derived from this action would offset this minor impact. Individual fish would die due to this activity, but take is not anticipated to impact fish populations.

Environmental Education & Interpretation, Wildlife Observation and Photography

Building kiosks, small visitor contact station and other education and outreach enhancement features will create minor site-specific soil and habitat disturbance and the presence of people at these facilities would occasionally disturb birds and mammals. These impacts would be temporary and insignificant. As described in the introduction, these activities qualify as Categorical Exclusions under NEPA, and are not evaluated further here.

Public Use and Access

Hunting

Providing hunting and fishing opportunities addresses the mandates of Executive Order 12996 and the National Wildlife Refuge System Improvement Act of 1997 by providing the public with an opportunity to engage in wildlife-dependent recreation. Hunting and fishing are recognized by the Service as a traditional forms of wildlife related outdoor recreation. We anticipate a low to moderate degree of hunting and fishing pressure to occur as a result of opening the refuge for these activities.

Actions proposed in this Alternative would increase opportunities for wildlife observation, education, hiking and other public uses at Oxbow Refuge. This, in combination with hunting, may generate conflict among public uses as some public may be displaced by the hunt program. As the plan is implemented, the refuge staff would work to anticipate such conflicts and, if any arise, will adjust public use activities, to ensure that visitor safety and interests of all user groups are not compromised. We recognize that some public may be displaced by offering hunting on refuge. We've specifically targeted areas for hunting that are not heavy public use areas or near large human housing divisions.

Opening portions of Oxbow Refuge to shotgun, primitive firearms, and archery hunting for deer and shotgun hunting for small game and upland birds would partially satisfy demand for these activities.

Under this alternative and all other alternatives that propose to open the refuge to hunting, the refuge manager may, upon annual review of the hunting program, impose further restrictions on hunting activity, recommend that the refuge be closed to hunting, or further liberalize hunting regulations within the limits of State law. Hunting noise may disturb visitors and may necessitate the closure of some areas during the hunting season.

Fishing

Opening universally accessible riverbank fishing sites on refuge land would contribute to satisfying the local demand for recreational fishing and provide fishing opportunities for people with disabilities. Added refuge and natural resource interpretation at fishing sites will convey messages to the fishing public and encourage constituency groups to support the refuge and its programs.

Wildlife Observation and Photography, Environmental Education and Interpretation, and Public and Community and Outreach

These activities fall under the Categorical Exclusion process described earlier in the chapter. These activities provide a valuable opportunity for people to observe and learn about wildlife and their habitats in their natural setting. The building of a refuge constituency that supports wildlife and habitat protection would offset the site-specific impacts that will occur.

The addition of a visitor contact station specific to Oxbow Refuge would greatly enhance the quality and effectiveness of education and outreach aimed at refuge visitors and potential advocates.

Closing portions of refuge trails to minimize human conflicts during May-October nesting seasons would avoid wildlife disturbance and bolster nesting success.

Non-Wildlife Dependent Public Uses

Elimination of dog walking and picnicking and continued prohibition of other activities such as bicycling, horseback riding, and swimming at Oxbow Refuge would prevent human caused conflicts with wildlife during feeding, nesting and other important life cycle processes. This action would also eliminate activities that diminish the quality of wildlife-oriented visitor experiences, such as a visitor's fear of dogs and stepping in excrement while walking on the trails. Dog walking and picnicking are not priority public uses identified in the Refuge Improvement Act, nor are they (except seeing or hearing dogs) necessary to support the safe, practical, and effective conduct of a priority public use. We acknowledge the public's desire to walk their dog and picnic in a natural setting, but these activities are not dependent on the presence of fish and wildlife, nor dependent on the expectation of encountering fish and wildlife. The purpose of wildlife refuges is protection of our wildlife resources and the habitats that support them. Refuge lands are not to be used as recreational parks.

Elimination of dog walking would prevent wildlife disturbance, prevent fouling of trails with dog excrement, and eliminate dog related conflicts with visitors who are birding or participating in environmental education programs. Dogs can disturb nesting birds, destroy eggs, or injure and kill unfledged chicks (Dahlgren and Korschgen 1992). Dogs, whether on leash or not, can be aggressive toward other dogs or toward people, causing potential injury to refuge visitors. Some people are afraid of dogs and will go to great lengths to avoid an encounter with them. This can especially be a problem on some of our narrow trails where it is difficult to avoid dogs.

Closure of the refuge to picnicking would remove a source of animal-attracting litter and localized wildlife disturbance. This action would have a negative consequence for people accustomed to picnicking on the refuge and would cause them to seek other locations for this activity.

We recognize that prohibiting and eliminating these activities would generate an inconvenience to many who have used the refuge for these activities. Local parks would likely see an increase in these users, which may create additional conflict and use of those areas.

Resource Protection and Visitor Safety

Refuge trails, river access sites, interpretive features, and other facilities would be built and maintained to emphasize visitor and staff safety. Increased presence of refuge staff would provide an additional margin of visitor service.

Closing portions of refuge trails to minimize human conflicts during May-October nesting seasons may generate complaints among visitors.

Cultural Resources

Cultural resource surveys of sites managed to improve habitat or accommodate visitors would minimize the potential for disturbing these resources and guide planners to avoid land disturbances in sensitive areas. The potential for disturbance at sites to be open for public access would be minimal because most of this work would occur in areas that were disturbed during military use of the land.

Socioeconomic Resources

Two additional interpretive kiosks, a photo blind, and canoe access will inform more visitors about refuge values and generate additional interest in the social services they provide. A visitor contact station would become a magnet that attracts people and groups to a site where they can participate in hands on education programs and events.

Economic impacts would either be negligible or there would be a minimal increase in the purchase of fuel, food, lodging, and supplies, due to the potential for new hunters to be attracted to the area.

Wildflowers. *USFWS photo*

Alternative C

Termination of habitat management actions under this "hands off, let nature take it course" approach could cause habitat and wildlife diversity to diminish.

Although some recreation opportunities and facilities would be added and publicized, they likely will not be adequate to accommodate the increased level of visitation that may occur. This could cause over use of trails and other facilities and require development and implementation of a complicated public use control program including temporary closures and a reservation system to schedule hours of use.

Water Quality/ Hydrology

Alternative C would contribute to good water quality by protecting in perpetuity refuge lands.

The elimination of water control structures may result in large ponds and depletion of wetland areas associated with the Nashua River. These areas provide important habitat for migratory birds as well as a variety of amphibians.

Under this alternative, herbicide use would be limited. Impacts from herbicides (described under Alternative A, Water Quality/ Hydrology) would be reduced.

Geology/Topography/Soils

Consequences would be similar to Alternative A, however under this alternative we would limit management actions such as discing and plowing which impact soils and topography.

Air Quality

Air quality impacts are similar for Alternative B and C.

Habitat and Wildlife Populations

Compilation of basic wildlife surveys and preparation of a habitat cover type map every five years would provide a rough overview of long-term trends of vegetative succession and population status of some species. This information would serve little purpose otherwise. These basic surveys would not provide sufficient information to guide habitat or population management planning.

Wetland habitats would be expected to evolve slowly through stages leading to shrub and forested wetlands. Uplands would evolve toward mature forest dominated by relatively few tree species. Dry and sandy sites that currently favor turtle nesting would succeed fairly quickly to more mature habitat types. Over time the mature forest would become increasingly susceptible to fire.

Invasive and Overabundant Species

Basic inventories and mapping of invasive plant encroachment would document habitat loss. However, without active control efforts, invasive plant species would overtake both wetland and upland habitats and diminish their ability to benefit wildlife. These invasive species would continue their rapid domination of natural habitat types and thereby diminish wildlife species diversity and population numbers.

Hunting

Consequences related to hunting under this Alternative would be similar to those under Alternative B except areas north of Shirley Road would receive no disturbance from hunters and there would be no impacts from waterfowl hunters as it would not be allowed.

Fishing

The consequences of fishing under this alternative would the same as Alternative B, except there would be fewer areas open for fishing and therefore, a potential for less disturbance to habitat and wildlife.

Wildlife Observation and Photography, Environmental Education and Interpretation, and Public and Community and Outreach

These activities fall under the Categorical Exclusion process described earlier in the chapter.

Public Use and Access

Hunting

Potential for hunting related conflicts with other public uses would be less than those in Alternative B because there would be fewer opportunities for visitors to access and enjoy the refuge in non-hunting activities.

Fishing

The consequences of fishing under this alternative would be similar to those under Alternative B but at a reduced scale. Fewer anglers would have opportunities to access the Nashua River or participate in riverbank fishing because fewer sites would be offered and the refuge north of Shirley Road would be closed.

Wildlife Observation and Photography, Environmental Education and Interpretation, and Public and Community and Outreach

These activities fall under the Categorical Exclusion process described earlier in the chapter. These activities provide a valuable opportunity for people to observe and learn about wildlife and their habitats in their natural setting. The reduction of these activities under Alternative C would reduce our communications with communities and limit our opportunity to work with community members and partners and limit our education and interpretive opportunities.

Non-Wildlife Dependent Public Uses

Consequences will be similar to those under Alternative B.

Resource Protection and Visitor Safety

Consequences are similar to those of Alternative B. Even though visitor services would increase slightly during implementation of this alternative, they would not be sufficient to serve enough additional visitors to generate noticeable economic consequences. The level of improvements suggested in this alternative could generate a negative reaction among potential constituents by raising false hopes. Visitors would come to enjoy the new services only to find out that they are less than adequate to satisfy demand for good quality refuge experiences.

Cultural Resources

Cultural resource consequences would be similar to those under Alternative A.

Cumulative Impacts

Cumulative impacts are those impacts on the physical, biological, and human environment resulting from the incremental impact of the proposed actions when added to other past, present, and reasonably foreseeable future actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time.

This cumulative impacts assessment includes actions that may be generated from other agencies or organizations if they are interrelated and influence the same environment. Thus, this analysis considers the interaction of activities at Assabet River, Great Meadows and Oxbow National Wildlife Refuges with other actions occurring over a larger spatial and temporal frame of reference. Potential cumulative impacts for the proposed alternatives are described below.

Air Quality

None of the proposed alternatives are expected to have significant cumulative adverse impacts on air quality in Massachusetts. Some short term deterioration in air quality would be expected from management-ignited prescribed burns. However, the effect of refuge related activity, as well as other management activities, to overall air quality in the study area is relatively insignificant compared to the contributions of the industrial centers, power plants, and automobiles in the area.

Soils, Hydrology, Wetlands ,and Water Quality

The greatest past, present and reasonable foreseeable future adverse impact to these resources in the area is from increasing residential and commercial development. As development along the rivers and streams continues to expand, the threats to refuge resources will increase dramatically. A cooperative, watershed-level approach to protection and management for these resources would offer the greatest opportunity to cumulatively improve conditions.

The Service can contribute to improved watershed conditions in three ways: refuge acquisition of habitats threatened with development; cooperative land protection of important habitat areas; and technical information exchange with landowners throughout the watersheds.

The Service will work with other conservation partners to cooperatively develop protection strategies for ecologically significant lands as described in Chapter 1. When combined with actions by other Federal, state, and local organizations working in Massachusetts, the proposed alternatives are expected to have a positive cumulative effect on soils, hydrology, wetlands, and water quality within the watershed.

Biological Resources

All alternatives are intended to maintain or improve biological resources on the refuges and within the state. The combination of Refuge actions with other organization's actions could result in significant, beneficial cumulative effects by: 1) increasing protection and management for state threatened and endangered species; 2) improving riparian and wetland habitats which are regionally declining; and 3) reducing invasive, exotic plants and other species.

The cumulative effects on the neotropical migratory birds, waterfowl, fish and other fish and wildlife of the area are expected to be very positive as a result of specific management actions, monitoring and programs.

Cultural Resources

None of the alternatives are expected to have significant adverse cumulative impact on cultural resources. Beneficial impacts would occur at various levels, depending on the alternative, because of proposed environmental education and interpretation programs and additional surveys and inventories on the refuges, and increased field surveys.

Human Resources

None of the alternatives are expected to have a significant adverse cumulative impact on the economy of the area. State and local agencies offer non-wildlife dependent public uses on their lands; thus, the proposed alternatives are not expected to cumulatively affect non-wildlife dependent public uses in the area.

The proposed alternatives would cumulatively increase priority, wildlife-dependent recreation throughout the eastern part of the state. This would supplement recreational opportunities offered by other state and private organizations. We expect increased visitation, as a result of more programs and facilities, to bring revenue to local communities through increased tourism to the area. However, we do not predict a significant increase in overall revenue in any area. The refuges would provide a unique experience from other parks and open spaces, because they provide a natural setting with wildlife observation experiences unmatched anywhere else in the area.

As the communities continue to expand, there is increased development pressure and recreational demands on the ecosystem. The state's and local parks already receive the majority of recreational users. As open spaces are converted to residential homes, the capacity of the existing State and local lands to provide outdoor recreation is threatened. The refuges provide additional open space that would be perpetually maintained as natural habitat, and provide an alternative destination for those looking to escape from the everyday bustle. In this way, the refuges become not only a "refuge" for wildlife, but humans as well.

Relationship Between Short-term Uses of Man's Environment and Enhancement of Long-term Productivity

This section evaluates the relationship between local short-term uses of the human environment and maintenance of long-term productivity of the environment. By long-term we mean that the impact would extend beyond the 15-year planning horizon of this Comprehensive Conservation Plan/Environmental Assessment. Conversely, short-term would be less than 15 years.

All of the alternatives are clearly aimed at enhancing the long-term productivity and sustainability of natural resources on the refuges. To varying degrees, the alternatives propose to implement actions that promote watershed or ecosystem-wide partnerships and additional planning. Outreach and environmental education are a priority to encourage refuge visitors to be better stewards of our environment.

Our Proposed Action and Alternative C propose eliminating existing non-wildlife-dependent uses determined to be incompatible in order to reduce impacts on wildlife and habitats. It would enhance long-term productivity on the refuges, with a corresponding trade-off of non-wildlife-dependent public use.

The construction of new refuge facilities, such as visitor contact stations, trails, observation platforms and kiosks will result in both short- and long-term impacts to soils and vegetation. These impacts would be localized and confined to the immediate construction sites. Increased attention to environmental education wildlife recreation programs will result in more audiences being involved with these activities, and development of a more positive ethic of land stewardship within the refuge communities and those towns immediately adjacent.

Short-term uses of refuge lands include wetlands restoration or enhancement, exotic plant control, fishing, hunting, management for selected species, wildlife inventories, maintaining and developing water control structures, and construction of administration and public use facilities. These activities would be implemented with the primary goal of assuring the sustained productivity of refuge resources.

Unavoidable Adverse Impacts

None of the alternatives would result in an unavoidable adverse environment impact. Biological monitoring would be undertaken as part of all alternatives to enable refuge staff to adapt management actions and address any unforeseen situations.

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 the extinction of a species. Once gone, the species can never be replaced.

In comparison, irretrievable commitments of resources are those that are lost for a period of time. An example of an irretrievable commitment is the conversion of shrubland to grassland. If management for grassland were to be terminated for some reason, the habitat would gradually revert back to shrub land.

Refuge land acquisition removes acreage from private ownership, and any potential development benefits associated with it. However, such land, once placed in public ownership under the National Wildlife Refuge System, provides a new set of wildlife-dependent recreational uses which benefit a much broader group of people. The concept of "public lands" precludes individual freedom to use those lands according to individual desires. Traditional public uses may change, since public uses on a refuge must be shown to be compatible with the purposes for which land is acquired. Structural improvements that are purchased with any land may be declared surplus to Government needs, and sold or demolished on site. Federal ownership may affect surrounding land-use patterns, local economies, and municipal tax revenues. Generally these changes are positive: property located adjacent to refuge lands increase in value, landscapes are protected, revenue to local service businesses increase and costs to municipalities for services decreases.

Only a few actions proposed in the alternatives would result in an irreversible commitment of resource. One such action is the land that would be committed to construction of the new Refuge Headquarters and Visitor Contact Station. This action is proposed in alternatives for Great Meadows National Wildlife Refuge. The site specific evaluation of constructing this facility will be evaluated in a separate environmental assessment.

Management of refuge facilities will result in an irreversible and irretrievable commitment of funding for operations, administration, and management. Funding and personnel commitments by the Service to purchasing and managing refuge lands and facilities will render those resources unavailable for other Service programs and projects.

Any wetland restoration projects would be considered irreversible. Following restoration, the Clean Water Act and, in some cases, state statutes would make it very difficult to reconvert wetlands on a national wildlife refuge to a drained condition.

Under the No Action Alternative, the current land uses and development are expected to continue and expand. Many of these activities result in the permanent conversion of lands from natural areas and open space to such uses as subdivisions and development for other commercial/industrial real estate development proposals. These land uses represent an irreversible and irretrievable commitment of resources if soil erosion occurs.

Acquisition of land in fee title or easement and management as a refuge would preclude any significant land development. Potential adverse impacts associated with potential development, crop farming or grazing would be reduced or eliminated. These reductions or prohibitions on land use would represent an irretrievable loss of economic income from these activities. Such economic losses could be offset by increase in other economic benefits or opportunities (i.e., tourism). Management of the refuge lands will result in an irretrievable and irreversible commitment of staffing and funding for acquisition and management of the refuge.

Table 4-1. Summary of Environmental Consequences

Issue	Alternative A Current Management	Alternative B Service's Proposed Action	Alternative C
Water Quality/ Hydrology	Positive impact by protecting land, use of beaver deceivers and periodic ditching Possible minimal negative impacts to nontarget organisms from pesticides and herbicides used to control invasive and exotic species	Same as Alternative A	Negative impacts to hydrology and habitat from no control of beaver (nonlethal or lethal)
Geology/ Topography/ Soils	Overall, no impact to local geology, topography or soils Temporary disturbance may occur during habitat management practices such as discing and plowing Small scale permanent alteration will occur at locations for administrative, maintenance, and visitor facilities	Same as Alternative A	Same as Alternative A, except minimized impacts to soil due to reduced habitat management and public use (Assabet River and Oxbow refuges) Same as Alternative A at Great Meadows Refuge
Air Quality	No impact on air quality. All three refuges have attainment status required by the Clean Air Act	Same as Alternative A, except short term negligible impacts from small scale prescribed burning (See Chapter 2, Fire Management EA)	Same as Alternative A
Habitat and Wildlife Populations	Positive impacts to wetland habitats from restoration of natural hydrology and native species Positive impact on grassland habitat and species from managing 70 acres Positive impacts on all other habitats from land conservation	Same as Alternative A, except positive impact to the sustainability of habitat and wildlife on the refuges from additional surveying and planning	Negative impacts to wetland habitats that are not restored Negative impact to grasslands and grassland species as these lands succeed to shrub and forest Positive affect on forest birds as lands succeed to forest

Table 4-1. Summary of Environmental Consequences

		Alternative A Current Management	Alternative B Service's Proposed Action	Alternative C
Habitat and Wildlife Populations (Continued)	Invasive Species	Negative impact and loss of native habitat and wildlife that use that habitat from limited invasive species control	Positive impacts to all habitat types from the removal of invasive and exotic species, including purple loosestrife, common reed and water chestnut Negligible short term impacts to wildlife and native species from proposed burning and pesticide use (see Chapter 2, Fire Management EA) Positive impact to wetland habitat and native wildlife from the removal of aggressive and territorial mute swans	Negative impact to native habitat and wildlife from limited invasive species control program
	Hunting	Deer herd continues to increase, resulting in potential negative impact on plant composition and species richness and abundance of herbaceous and woody vegetation understory available for migratory birds	Potential positive impact on plant composition and species richness from deer hunting Potential negative impacts to habitat from trampling of vegetation, creation of unauthorized trails by hunters and subsequent erosion, littering and vandalism Negligble impacts to non-target fauna from hunters	Same as Alternative B, except fewer deer would likely be removed under this alternative, except at Great Meadows where the hunt program would be expanded under this alternative
	Fishing	No impacts to fish or habitat at Assabet River Refuge, where fishing is closed Negligble impacts to fish and habitat at Great Meadows and Oxbow where limited fishing is allowed	Negligble impacts to fish and habitat (at all three refuges) by opening or expanding fishing opportunities. Individual fish may die (even in catch and release areas) but no real affect on the overall population is anticipated Potential negative impacts to habitat from trampling of vegetation, creation of unauthorized trails and subsequent erosion, littering and vandalism (impacts to habitat will be minimal in areas where access points designated and fishing platforms are provided)	Same as Alternative B

Table 4-1. Summary of Environmental Consequences

Issue	Alternative A Current Management	Alternative B Service's Proposed Action	Alternative C
Public Use	Negative impact on public use opportunities due to closure of Assabet River Refuge Positive impact on public use at Great Meadows and Oxbow where refuges are open to wildlife observation and photography, environmental education and interpretation	Positive impacts to public use opportunities at Assabet River Refuge- refuge open to all priority public uses and uses expanded at Great Meadows and Oxbow refuges Potential positive impact on appreciation of public land by offering additional outreach and public use opportunities	Same as Alternative B, except fewer opportunities Same as Alternative B at Great Meadows, except increased programs beyond Alternative B for wildlife observation and photography, environmental education and interpretation and fishing and hunting
Hunting (for impacts of this activity on habitat and wildlife, see previous section)	No hunting opportunities occur at Assabet River and Great Meadows Negative interactions between humans and deer occur (road kill, Lyme disease, damage to residential neighborhoods and agricultural crops) Positive impacts to hunters at Oxbow Refuge- hunting opportunities provided	Positive impact on hunters by offering hunting opportunities Potential negative interactions between non-hunters and hunters during hunting seasons	Same as Alternative B at Assabet River and Oxbow Refuges, except fewer opportunities Same as Alternative B for Great Meadows, except shotgun deer opportunities offered, potentially creating additional negative interactions between non-hunters and hunters
Fishing (for impacts of this activity on habitat and wildlife, see previous section)	No fishing opportunities occur at Assabet River Refuge Positive impacts on fishing opportunities at Great Meadows and Oxbow by offering river fishing	Positive impact on fishermen/women by offering fishing opportunities on Puffer Pond at Assabet River Refuge and other new opportunities at Oxbow Refuge Same as Alternative A for Great Meadows	Same as Alternative B, except fewer opportunities for Assabet and Oxbow refuges Same as Alternative A for Great Meadows
Non-wildlife dependent recreational uses (Great Meadows and Oxbow refuges, Assabet River Refuge would not be open to these uses under any alternative)	Dog walking and picnicking would remain open at Great Meadows and Oxbow despite contradicting refuge purposes Negative impacts from dogs disturbing or killing wildlife. Negative impacts from feces left on trail, impacting aesthetic value Negative impacts to bird observers and photographers (disrupting wildlife) from unleashed dogs	Positive impacts on priority public uses by eliminating non-wildlife dependent uses which interfere with these uses and disturb wildlife and habitat Positive impact on nesting birds and resident flora and fauna from eliminating dog walking Positive impact on wildlife by eliminating attraction of nuisance wildlife to human food sources from eliminating picnicking Negative impacts to users who utilize the refuge for non-wildlife dependent uses	Same as Alternative B

Table 4-1. Summary of Environmental Consequences

	Alternative A Current Management	Alternative B Service's Proposed Action	Alternative C
Resource Protection and Visitor Safety	Safety maximized since the refuge is closed to the public at Assabet River Negative impacts at all refuges from limited enforcement	Positive impact on resources and visitor safety from providing consistent enforcement and outreach and additional staff on refuges	Same as Alternative B
Cultural Resources	Cultural resource reviews occur when required	Positive impacts to cultural resources by completing a comprehensive cultural resource review on all refuges	Same as Alternative A
Socioeconomic	Negligible impacts from habitat management and public use on the refuges Positive impact from land conservation in local towns	Same as Alternative A. Positive impacts to towns from potential increase in visitors	Same as Alternative B

Chapter 5

The Concord impoundments at Great Meadows Refuge offer visitors an opportunity to view birds that use the Complex. *USFWS Photo*

Coordination With Others

- Introduction
- Public Involvement Summary
- Coordination with State and Other Partners
- Mailings
- Federal Register Notices
- Core Planning Team
- Other Assistance
- Addresses

Coordination With Others

Introduction

This chapter summarizes the efforts made by the Service to coordinate with and consult with others, including open houses, planning mailings, and meetings with partners to develop this Comprehensive Conservation Plan (CCP).

Public Involvement Summary

January 22 and 23, 1999 Devens Conference Center, Devens, MA
Purpose: To collect information from Federal and State agencies about the refuges
Number of Non-FWS Participants: 14
Participants: Commonwealth of Massachusetts Division of Fish and Wildlife and Department of Environmental Management, National Marine Fisheries Service, and National Park Service employees with expertise on Complex resources
Topics discussed: Current management strategies, potential management strategies, invasive species control, threatened and endangered species, State-listed species, habitat diversity, habitat restoration opportunities, key species for each refuge, partnership opportunities, State role at the refuges

1999 Select Board meetings:

January	12	Carlisle
	19	Harvard
		Concord
	20	Lancaster
	25	Ayer
		Hudson
		Wayland
	26	Stow
	28	Framingham
February	1	Shirley
		Lincoln
	8	Billerica
		Sudbury
	9	Maynard
	16	Bedford
April	1	Bolton

Purpose: To brief town councils and boards about the CCP process and encourage their involvement
Audience: Town Select Board members
Topics discussed: CCP process and opportunities for the Town involvement in planning

March 3, 1999, Open House, Harvey Wheeler Community Center, West Concord, MA
Purpose: Collect public comments on potential issues and explain the CCP process
Number of Non-FWS Participants: 19
Audience: Public
Topics discussed: Planning process, need for more education and outreach, improvements in interpretive and informational signs, cooperative educational programs, dog walking, hunting, biking, jogging, fishing, water quality, water chestnut, protection of wetlands, staff presence, land acquisition, law enforcement, bulletin board for posting bird information

March 4, 1999, Great Meadows Refuge Headquarters, Sudbury, MA
Purpose: Collect public comments on potential issues and explain the CCP process
Number of Non-FWS Participants: 13
Audience: Public
Topics discussed: Planning process, programs at the visitor center, interpretive displays at visitor center, jet skis, canoes, law enforcement particularly of hunting laws, dog walking, purple loosestrife, land protection, need for more staff, education and outreach, traffic on the road

March 24, 1999, Town Building, Ayer, MA
Purpose: Collect public comments on potential issues and explain the CCP process
Number of Non-FWS Participants: 49
Audience: Public
Topics discussed: Planning process, land transfer, poaching, hunting, volunteers, education center, law enforcement, illegal access, land protection, new gate, contaminants, fishing, trails, recreational uses, overpopulation of deer

March 25, 1999, Town Hall, Maynard, MA
Purpose: Collect public comments on potential issues and explain the CCP process
Number of Non-FWS Participants: 100
Audience: Public
Topics discussed: Planning process, water supply wells, access points, public safety, illegal activities, law enforcement, cultural resources, contaminants, bunkers, recreational activities, hunting, bike trail, uses of the land transferred

April 7, 1999, Bromfield High School Cafeteria, Harvard, MA
Purpose: Collect public comments on potential issues and explain the CCP process
Number of Non-FWS Participants: 40
Audience: Public
Topics discussed: Planning process, trail system, hunting, education and interpretive opportunities, land protection, access for

non-motorized recreation, wildlife diversity, purple loosestrife control, cooperative management with South Post, Nashua River Corridor, need for staff

February 15, 2000 Great Meadows National Wildlife Refuge Headquarters, Sudbury, MA
Purpose: Brief members of the Eastern Massachusetts National Wildlife Refuge Complex Land about the CCP process and discuss other Service related issues.
Number of Non-FWS Participants: 20
Audience: Organizations currently protecting land for the Complex
Topics discussed: Land protection and CCP

September 20, 2000 L. Knife & Son, Inc./ Sheehan Family Foundation Plymouth, MA
Purpose: Brief members of the Eastern Massachusetts National Wildlife Refuge Complex Land about the CCP process and discuss other Service related issues.
Number of Non-FWS Participants: 18
Audience: Organizations currently protecting land for the Complex
Topics discussed: Land protection and CCP

March 16, 2001, Great Meadows National Wildlife Refuge
Purpose: Receive comments and feedback from the Commonwealth of Massachusetts on the draft alternatives submitted for their review and the draft land protection maps
Number of Non-FWS Participants: 2
Topics discussed: Draft alternatives for the Complex, particular discussion regarding the hunting proposals, land protection proposals and habitat management proposals


Prarie warbler. *Photo by Bruce Flaig*

August 17, 2001, Great Meadows National Wildlife Refuge
Purpose: Brief the State Director of The Commonwealth of Massachusetts Department of Fisheries and Wildlife on the CCP process and discuss other Service related issues.
Number of Non-FWS Participants: 2
Topics Discussed: Briefed director on proposed action, and other issues important to the Complex

November 20, 2002, Sudbury Valley Trustees
Purpose: Brief members of the Eastern Massachusetts National Wildlife Refuge Complex Land about the CCP process and discuss other Service related issues.
Number of Non-FWS Participants: 12
Audience: Organizations currently protecting land for the Complex
Topics discussed: Land protection and CCP

February 5, 2003, Great Meadows National Wildlife Refuge
Purpose: Brief members of the Eastern Massachusetts National Wildlife Refuge Complex Land about the CCP process and discuss other Service related issues.
Number of Non-FWS Participants: 12
Audience: Organizations currently protecting land for the Complex
Topics discussed: Land protection and CCP

March 18, 2003, Regional Office, Hadley, Massachusetts
Purpose: Brief members of the Gulf of Maine Rivers Ecosystem Team on the CCP
Number of Non-FWS Participants: 4
Audience: Members of the Gulf of Maine Rivers Ecosystem Team
Topics discussed: The CCP timeline and alternatives

March 26, 2003, Great Meadows National Wildlife Refuge
Purpose: Brief members of the Friends of the Assabet River National Wildlife Refuge on the CCP process and draft alternatives
Number of Non-FWS Participants: 28
Audience: The Friends of the Assabet River Refuge
Topics discussed: The CCP process and draft alternatives

Coordination with State and Other Partners

During our planning effort, we consulted with a number of State agencies, with particular focus on the Massachusetts Division of Fisheries and Wildlife. In many cases, these meetings regarded specific management efforts on refuges or land protection efforts associated with refuges in the Complex. We consulted with the following State agencies:

Massachusetts Division of Fisheries and Wildlife
Massachusetts Coastal Zone Management
Buzzards Bay Project Office
Massachusetts District Commission
Massachusetts Natural Heritage Office
Massport-Hanscom
Massachusetts Department of Environmental Management
Massachusetts Land Protection Task Force
Massachusetts GIS representatives
Massachusetts Executive Office of Environmental Affairs: Boston Harbor Watershed Team, Buzzards Bay Watershed Team, Cape and Islands Watershed Team, Ipswich and Parker Rivers Watershed Team, Merrimack and Shawsheen Watershed Team, Nashua River Watershed Team, North Coastal Watershed Team, South Coastal Watershed Team, Tauton River Watershed Team, Ten Mile River and Narragansett Bay Watershed Team, and the Concord/ Assabet/ Sudbury Rivers Watershed Team

Additionally, refuge staff and Service biologists met with other partners gathering information and providing briefings and updates on our CCP and land protection efforts. Many of these groups work toward protecting land and natural resources in the vicinity of the Complex. These groups include:

Sudbury Valley Trustees,
Nashua River Watershed Association,
Organization for the Assabet River,
The Nature Conservancy- Massachusetts Chapter,
The Trust for Public Land,
Massachusetts Audubon Society,
Merrimack River Watershed Council,

Berries. *Photo by Joan Rolfe*

Massachusetts Watershed Coalition,
Harvard Conservation Foundation,
Conservation Commissions: Town of Concord, Town of Billerica, Town of Bedford, Town of Carlisle.

Mailings

Spring 1999, Issues Workbook
Purpose: To collect information about what issues and activities were important to visitors to the refuge
Number of recipients: over 8,000
Audience: Refuge mailing list, visitors to the refuge headquarters, local town halls, and libraries

Summer 1999, Planning Update
Purpose: To inform the public of the issues identified by the refuge staff, from Issues Workbook, and during Open Houses
Number of recipients: 2,000
Audience: Refuge mailing list, visitors to the refuge headquarters, local town halls, and libraries

Spring 2002, Planning Update
Purpose: To inform the public of our draft alternatives
Number of recipients: 2,000
Audience: Refuge mailing list, visitors to the refuge headquarters, local town halls, and libraries

Federal Register Notices

February 24, 1999
Purpose: Notice of Intent to Prepare a CCP/EIS
Audience: National
Notice Included: Announcing initiation of an EIS for the Complex and public scoping period.

February 15, 2001
Purpose: Notice of Intent to Prepare a Comprehensive Conservation Plan and Environmental Documents
Audience: National
Notice Included: Announcing an EA for Assabet River, Oxbow, Great Meadows, Mashpee, and Massasoit Refuges and EIS for Monomoy, Nomans Land Island and Nantucket Refuges and public scoping period.

Core Planning Team

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Waterfowl at Great Meadows Refuge. *USFWS Photo*

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Other Assistance from Partners

Chuck Bell, District Manager Northeast District, Division of Fisheries and Wildlife,
Commonwealth of Massachusetts Fish and Wildlife
Review and comment for the State

Debbie Dineen, Natural Resources, Town of Sudbury
Provided biological information regarding Assabet River Refuge

Curt Laffin, Planning Consultant
Wrote Environmental Consequences

Jack Lash, Planning and Ecology Director, Department of Environmental Management, Commonwealth of Massachusetts
Review and comment for the State

Tom Poole, Natural Resource Manager, Army at Devens Reserve Forces Training Area
Provided biological information regarding Assabet River Refuge

Bill Woytek, Division of Fisheries and Wildlife, Commonwealth of Massachusetts
Information regarding deer populations

Bruce Flaig and Marijke Holtrop
Generously allowed the refuge to use their photographs, many of which were used in this plan

Other Service Assistance

Nicole Allison, Former Wildlife Biologist, Refuges and Wildlife
Drafted affected environment for Assabet River Refuge

William Archambault, Fisheries Supervisor South, Former Regional NEPA Coordinator
Reviewed document for NEPA compliance

Melissa Brewer, Former Fisheries Biologist
Research and collection of aquatic information for affected environment

John Eaton, Cartographer
Created maps for alternatives

Andrew French, Realty Officer
Provided guidance on land protection strategies

Thomas Bonetti- Refuge Planner
Former Team Leader for this project.

Victoria Jacobson, Archeologist
Drafted the cultural resource sections of the affected environment

Rick Jorgensen, Realty Specialist
Provided guidance regarding land protection planning

Wendy Lilly-Hanson, Former Wildlife Biologist, Great Meadows National Wildlife Refuge
Assisted with affected environment chapter for Great Meadows Refuge

Janet Kennedy - Refuge Manager Parker River National Wildlife Refuge (Former Deputy Refuge Manager for Eastern Massachusetts National Wildlife Refuge Complex)
Assisted with early development of the plan

Deborah Long - Deputy Refuge Manager Forsythe National Wildlife Refuge, Former Monomoy Refuge Manager
Former core team member

Lisa Plagge, Former Bio-technician, Great Meadows, Oxbow, and Assabet NWRs
Species list and information

Pamela Rooney- Engineering Supervisor, Former Planning Team Leader
Lead the project for the first two years.

Rick Schauffler, Wildlife Biologist and Cartographer
Created and edited all land protection planning maps

Janith Taylor- Regional Biologist, Refuges and Wildlife
Review and comment on biology

Sharon Ware - Refuge Manager Sachuest Point National Wildlife Refuge (Former Refuge Manager at Monomoy National Wildlife Refuge)
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Mike Amaral, Senior Endangered Species Specialist
Provided information and guidance Northern red-bellied cooter management and Karner blue butterfly

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Glossary

accessibility- the state or quality of being easily approached or entered, particularly as it relates to the Americans With Disabilities Act

accessible facilities- structures accessible for most people with disabilities without assistance; ADA-accessible[E.g., parking lots, trails, pathways, ramps, picnic and camping areas, restrooms, boating facilities (docks, piers, gangways), fishing facilities, playgrounds, amphitheaters, exhibits, audiovisual programs, and wayside sites.]

adaptive management- responding to changing ecological condiditions so as to not exceed productivity limits of spaecific place. For example, when crop growth slows, a good farmer learns to recognize ecological signs that tell either to add more manure or to allow a field to lie fallow. Adaptive management becomes impossible when managers are forced to meet the demands of outsiders who are not under local ecological constraints (from Dodson et al., 1998)

agricultural land- nonforested land (now or recently orchards, pastures, or crops)

alternative- a reasonable way to fix an identified problem or satisfy a stated need [40 CFR 1500.2 (cf. "management alternative")]

amphidromous fish- fish that can migrate from fresh water to the sea or the reverse, not only for breeding, but also regularly at other times during their life cycle

anadromous fish- fish that spend a large portion of their life cycle in the ocean and return to freshwater to breed

aquatic growing in, living in, or dependent upon water

aquatic barrier any obstruction to fish passage

appropriate use- a proposed or existing use of a national wildlife refuge that (1) supports the Refuge System Mission, the major purposes, goals or objectivies of the refuge; (2) is necessary for the safe and effective conduct of a priority general public use on the refuge; (3) is otherwise determined under Service Manual Chapter 605 FW 1 (draft), by the Refuge Manager and Refuge Supervisor to be appropriate

area of biological significance- cf. "special focus area"

best management practices- land management practices that produce desired results [N.b. Usually describing forestry or agricultural practices effective in reducing non-point source pollution, like reseeding skidder trails or not storing manure in a flood plain. In its broader sense, practices that benefit target species.]

biological or natural diversity- the variety of life in all its forms

breeding habitat- habitat used by migratory birds or other animals during the breeding season

buffer zones- land bordering and protecting critical habitats or water bodies by reducing runoff and nonpoint source pollution loading; areas created or sustained to lessen the negative effects of land development on animals, plants, and their habitats

breeding habitat- habitat used by migratory birds or other animals during the breeding season

candidate species- species for which we have sufficient information on file about their biological vulnerability and threats to propose listing them

carrying capacity- the size of the population that can be sustained by a given environment

catadromous fish- fish that spend most of their lives in fresh water, but migrate to sea to reproduce

categorical exclusion- [CE, CX, CATEX, CATX] pursuant to the National Environmental Policy Act (NEPA), a category of Federal agency actions that do not individually or cumulatively have a significant effect on the human environment [40 CFR 1508.4]

CFR- the Code of Federal Regulations

Challenge Cost Share Program- a Service-administered grant program that provides matching funds for projects supporting natural resource education, management, restoration, or protection on Service lands, other public lands, and private lands

community- the locality in which a group of people resides and shares the same government

community type- a particular assemblage of plants and animals, named for its dominant characteristic

compatible use- "The term 'compatible use' means a wildlife-dependent recreational use or any other use of a refuge that, in the sound professional judgment of the Director, will not materially interfere with or detract from the fulfillment of the mission of the System or the purposes of the refuge."—National Wildlife Refuge System Improvement Act of 1997 [Public Law 105-57; 111 Stat. 1253]

compatibility determination- a required determination for wildlife-dependent recreational uses or any other public uses of a refuge before a use is allowed

Comprehensive Conservation Plan- a document mandated by the National Wildlife Refuge System Improvement Act of 1997 that describes desired future conditions for a refuge unit, and provides long-range guidance for the unit leader to accomplish the mission of the System and the purpose(s) of the unit [P.L. 105-57; FWS Manual 602 FW 1.4]

concern- cf. "issue"

conservation- managing natural resources to prevent loss or waste [N.b. Management actions may include preservation, restoration, and enhancement.]

conservation agreements - voluntary written agreements among two or more parties for the purpose of ensuring the survival and welfare of unlisted species of fish and wildlife or their habitats or to achieve other specified conservation goals.

conservation easement- a legal agreement between a landowner and a land trust (e.g., a private, nonprofit conservation organization) or government agency that permanently limits uses of a property to protect its conservation values

cool-season grass- introduced grass for crop and pastureland that grows in spring and fall and is dormant during hot summer months

cooperative agreement- the legal instrument used when the principal purpose of a transaction is the transfer of money, property, services, or anything of value to a recipient in order to accomplish a public purpose authorized by Federal statute, and substantial involvement between the Service and the recipient *is* anticipated (cf. "grant agreement")

cultural resource inventory- a professional study to locate and evaluate evidence of cultural resources present within a defined geographic area [N.b. Various levels of inventories may include background literature searches, comprehensive field examinations to identify all exposed physical manifestations of cultural resources, or sample inventories for projecting site distribution and density over a larger area. Evaluating identified cultural resources to determine their eligibility for the National Register follows the criteria in 36 CFR 60.4 (cf. FWS Manual 614 FW 1.7).]

cultural resource overview- a comprehensive document prepared for a field office that discusses, among other things, project prehistory and cultural history, the nature and extent of known cultural resources, previous research, management objectives, resource management conflicts or issues, and a general statement of how program objectives should be met and conflicts resolved [An overview should reference or incorporate information from a field offices background or literature search described in section VIII of the Cultural Resource Management Handbook (FWS Manual 614 FW 1.7).]

dedicated open space- land to be held as open space forever

designated wilderness area- an area designated by Congress as part of the National Wilderness Preservation System [FWS Manual 610 FW 1.5 (draft)]

diadromous- fish that migrate from freshwater to saltwater or the reverse; a generic term that includes anadromous, catadromous, and amphidromous fish

easement- an agreement by which landowners give up or sell one of the rights on their property [E.g., landowners may donate rights-of-way across their properties to allow community members access to a river (cf. "conservation easement").]

ecosystem- a natural community of organisms interacting with its physical environment, regarded as a unit

ecotourism- visits to an area that maintains and preserves natural resources as a basis for promoting its economic growth and development

ecosystem approach- a way of looking at socio-economic and environmental information based on the boundaries of ecosystems like watersheds, rather than on geopolitical boundaries

ecosystem-based management- an approach to making decisions based on the characteristics of the ecosystem in which a person or thing belongs [N.b. This concept considers interactions among the plants, animals, and physical characteristics of the environment in making decisions about land use or living resource issues.]

emergent wetland- wetlands dominated by erect, rooted, herbaceous plants

endangered species- a Federal- or State-listed protected species that is in danger of extinction throughout all or a significant portion of its range

environmental education- "…education aimed at producing a citizenry that is knowledgeable about the biophysical environment and its associated problems, aware of how to help solve these problems, and motivated to work toward their solution."—Stapp et al. 1969

Environmental Assessment- (EA) a concise public document that briefly discusses the purpose and need for an action, its alternatives, and provides sufficient

evidence and analysis of its impacts to determine whether to prepare an environmental impact statement or finding of no significant impact (q.v.) [cf. 40 CFR 1508.9]

Environmental Impact Statement- (EIS) a detailed, written analysis of the environmental impacts of a proposed action, adverse effects of the project that cannot be avoided, alternative courses of action, short-tern uses of the environment versus the maintenance and enhancement of long-term productivity, and any irreversible and irretrievable commitment of resources [cf. 40 CFR 1508.11]

estuaries- deepwater tidal habitats and adjacent tidal wetlands that are usually semi-enclosed by land but have open, partly obstructed or sporadic access to the ocean, and in which ocean water is at least occasionally diluted by freshwater runoff from land

estuarine wetlands- "The Estuarine system consists of deepwater tidal habitats and adjacent tidal wetlands that are usually semi-enclosed by land but have open, partly obstructed, or sporadic access to the open ocean, and in which ocean water is at least occasionally diluted by freshwater runoff from the land."—Cowardin et al. 1979

exemplary community type- an outstanding example of a particular community type

extirpated- no longer occurring in a given geographic area

Federal land- public land owned by the Federal Government, including national forests, national parks, and national wildlife refuges

Federal-listed species- a species listed either as endangered, threatened, or a species at risk (formerly, a "candidate species") under the Endangered Species Act of 1973, as amended

Finding of No Significant Impact- (FONSI) supported by an environmental assessment, a document that briefly presents why a Federal action will have no significant effect on the human environment, and for which an environmental impact statement, therefore, will not be prepared [40 CFR 1508.13]

fish passage project- providing a safe passage for fish around a barrier in the upstream or downstream direction

focus areas- cf. "special focus areas"

forbs- flowering plants (excluding grasses, sedges, and rushes) that do not have a woody stem and die back to the ground at the end of the growing season

forested land- land dominated by trees

forested wetlands- wetlands dominated by trees

geographic information system- (GIS) a computerized system to compile, store, analyze and display geographically referenced information [E.g., GIS can overlay multiple sets of information on the distribution of a variety of biological and physical features.]

grant agreement- the legal instrument used when the principal purpose of the transaction is the transfer of money, property, services, or anything of value to a recipient in order to accomplish a public purpose of support or stimulation authorized by Federal statute and substantial involvement between the Service and the recipient is *not* anticipated (cf. "cooperative agreement")

grassroots conservation organization- any group of concerned citizens who come together to actively address a conservation need

habitat fragmentation- the breaking up of a specific habitat into smaller, unconnected areas [N.b. A habitat area that is too small may not provide enough space to maintain a breeding population of the species in question.]

habitat conservation- protecting an animal or plant habitat to ensure that the use of that habitat by the animal or plant is not altered or reduced

habitat- the place where a particular type of plant or animal lives

hydrologic or flow regime- characteristic fluctuations in river flows

important fish areas- the aquatic areas identified by private organizations, local, state, and federal agencies that meet the purposes of the Conte Act

informed consent- "…the grudging willingness of opponents to go along with a course of action that they actually oppose."—Bleiker

Intergrated Pest Management (IPM)- sustainable approach to managing pests by combining biological, cultural, physical, and chemical toos in a way that minimizes economic, health, and environmental risks

interjurisdictional fish- populations of fish that are managed by two or more States or national or tribal governments because of the scope of their geographic distributions or migrations

interpretive facilities- structures that provide information about an event, place, or thing by a variety of means, including printed, audiovisual, or multimedia materials [E.g., kiosks that offer printed materials and audiovisuals, signs, and trail heads.]

interpretive materials- any tool used to provide or clarify information, explain events or things, or increase awareness and understanding of the events or things [E.g., printed materials like brochures, maps or curriculum materials; audio/visual materials like video and audio tapes, films, or slides; and, interactive multimedia materials, CD-ROM or other computer technology.]

interpretive materials projects- any cooperative venture that combines financial and staff resources to design, develop, and use tools for increasing the awareness and understanding of events or things related to a refuge

introduced invasive species- non-native species that have been introduced into an area and, because of their aggressive growth and lack of natural predators, displace native species

issue- any unsettled matter that requires a management decision [E.g., a Service initiative, an opportunity, a management problem, a threat to the resources of the unit, a conflict in uses, a public concern, or the presence of an undesirable resource condition.]

Issues Workbook- a packet of questions distributed in order to solicit public comments on the Refuge Complex and the planning process. Basic information on the Refuge Complex was bundled with the Issues Workbooks. Workbooks were not randomly distributed, nor were questions intended to have statistical significance.

lacustrine wetlands- "The Lacustrine system includes wetlands and deepwater habitats with all of the following characteristics: (1) situated in a topographic depression or a dammed river channel; (2) lacking trees, shrubs, persistent emergents, emergent mosses or lichens with greater than 30% areal coverage; and (3) total area exceeds eight ha (20 acres)."—Cowardin et al. 1979

land trusts organizations dedicated to conserving land by purchase, donation, or conservation easement from landowners

limiting factor- an environmental limitation that prevents further population growth

local land- public land owned by local governments, including community or county parks or municipal watersheds

local agencies- generally, municipal governments, regional planning commissions, or conservation groups

long-term protection- mechanisms like fee title acquisition, conservation easements, or binding agreements with landowners that ensure land use and land management practices will remain compatible with maintaining species populations over the long term

management alternative
a set of objectives and the strategies needed to accomplish each objective [FWS Manual 602 FW 1.4]

management concern- cf. "issue"; "migratory nongame birds of management concern"

management opportunity- cf. "issue"

management plan- a plan that guides future land management practices on a tract

management strategy- a general approach to meeting unit objectives [N.b. A strategy may be broad, or it may be detailed enough to guide implementation through specific actions, tasks, and projects (FWS Manual 602 FW 1.4).]

mesic soil- sandy-to-clay loams containing moisture-retentive organic matter, well drained (no standing matter)

migratory nongame birds of management concern- species of nongame birds that (*a*) are believed to have undergone significant population declines; (*b*) have small or restricted populations; or (*c*) are dependent upon restricted or vulnerable habitats

mission statement- a succinct statement of the purpose for which the unit was established; its reason for being

mitigation- actions taken to compensate for the negative effects of a particular project [E.g., wetland mitigation usually restores or enhances a previously damaged wetland or creates a new wetland.]

National Environmental Policy Act of 1969- (NEPA) requires all Federal agencies to examine the environmental impacts of their actions, incorporate environmental information, and use public participation in planning and implementing environmental actions [Federal agencies must integrate NEPA with other planning requirements, and prepare appropriate NEPA documents to facilitate better environmental decision-making (cf. 40 CFR 1500).]

National Wildlife Refuge Complex- (Complex) an internal Service administrative linking of refuge units closely related by their purposes, goals, ecosystem, or geopolitical boundaries.

National Wildlife Refuge System- (System) all lands and waters and interests therein administered by the Service as wildlife refuges, wildlife ranges, wildlife management areas, waterfowl production areas, and

other areas for the protection and conservation of fish and wildlife, including those that are threatened with extinction

native plant- a plant that has grown in the region since the last glaciation and occurred before European settlement

non-consumptive, wildlife-oriented recreation- wildlife observation and photography and environmental education and interpretation (cf. "wildlife-oriented recreation")

non-point source pollution- nutrients or toxic substances that enter water from dispersed and uncontrolled sites

nonforested wetlands wetlands dominated by shrubs or emergent vegetation

Notice of Intent- (NOI) an announcement we publish in the Federal Register that we will prepare and review an environmental impact statement [40 CFR 1508.22]

objective- a concise statement of what we want to achieve, how much we want to achieve, when and where we want to achieve it, and who is responsible for the work. Objectives derive from goals and provide the basis for determining strategies, monitoring refuge accomplishments, and evaluation the success of strategies. Make objectives attainable, time-specific, and measurable.

occurrence site- a discrete area where a population of a rare species lives or a rare plant community type grows

old fields - areas formerly cultivated or grazed, where woody vegetation has begun to invade
[N.b. If left undisturbed, old fields will eventually succeed into forest. Many occur at sites marginally suitable for crops or pasture. They vary markedly in the Northeast, depending on soil and land use and management history.]

outdoor education project- any cooperative venture that combines financial and staff resources to develop outdoor education activities like labs, field trips, surveys, monitoring, or sampling

outdoor education- educational activities that take place in an outdoor setting

palustrine wetlands- "The Palustrine system includes all nontidal wetlands dominated by trees, shrubs, persistent emergents, emergent mosses or lichens, and all such wetlands that occur in tidal areas where salinity due to ocean-derived salts is below 0%."—Cowardin et al. 1979

Partners for Wildlife Program- a voluntary, cooperative habitat restoration program among the Service, other government agencies, public and private organizations, and private landowners to improve and protect fish and wildlife habitat on private land while leaving it in private ownership

partnership- a contract or agreement among two or more individuals, groups of individuals, organizations, or agencies, in which each agrees to furnish a part of the capital or some service in kind (e.g., labor) for a mutually beneficial enterprise

Planning Updates- newsletters distributed, primarily through mailing lists,m in order to update the interested public on the status of the CCP project.

population monitoring- assessing the characteristics of populations to ascertain their status and establish trends on their abundance, condition, distribution, or other characteristics

prescribed fire- the application of fire to wildland fuels, either by natural or intentional ignition, to achieve identified land use objectives [FWS Manual 621 FW 1.7]

private land- land owned by a private individual or group or non-government organization

private landowner- cf. "private land"

private organization- any non-government organization

Proposed Action (or alternative)- activies for which an Environmental Assessment is being written; the alternative containing the actions and strategies recommended by the planning team. The proposed action is, for all proactival purposes, the draft CCP for the refuge.

protection- mechanisms like fee title acquisition, conservation easements, or binding agreements with landowners that ensure land use and land management practices will remain compatible with maintaining species populations at a site (cf. "long-term ~")

public- individuals, organizations, and non-government groups; officials of Federal, State, and local government agencies; Native American tribes, and foreign nations—includes anyone outside the core planning team, those who may or may not have indicated an interest in the issues and those who do or do not realize that our decisions may affect them

public involvement- offering to interested individuals and organizations that our actions or policies may affect an opportunity to become informed; soliciting their opinions.

public involvement plan- long-term guidance for involving the public in the comprehensive planning process

public land- land owned by the local, State, or Federal Government

rare species- species identified for special management emphasis because of their uncommon occurrence

rare community types- plant community types classified as rare by any State program [As used in CCP's, includes exemplary community types.]

recommended wilderness- areas studied and found suitable for wilderness designation by both the Director (FWS) and Secretary (DOI), and recommended by the President to Congress for inclusion in the National Wilderness System [FWS Manual 610 FW 1.5 (draft)]

Record of Decision- (ROD) a concise public record of a decision by a Federal agency pursuant to NEPA [N.b. A ROD includes:•the decision; •all the alternatives considered; •the environmentally preferable alternative; •a summary of monitoring and enforcement, where applicable, for any mitigation ; and, •whether all practical means have been adopted to avoid or minimize environmental harm from the alternative selected (or if not, why not).]

refuge goals- "…descriptive, open-ended, and often broad statements of desired future conditions that convey a purpose but do not define measurable units."—Writing Refuge Management Goals and Objectives: A Handbook

refuge purposes- "The terms 'purposes of the refuge' and 'purposes of each refuge' mean the purposes specified in or derived from the law, proclamation, executive order, agreement, public land order, donation document, or administrative memorandum establishing, authorizing, or expanding a refuge, refuge unit, or refuge subunit."—National Wildlife Refuge System Improvement Act of 1997

refuge lands- lands in which the Service holds full interest in fee title or partial interest like an easement

restoration- the artificial manipulation of habitat to restore it to its former condition [E.g., restoration may involve planting native grasses and forbs, removing shrubs, prescribed burning, or reestablishing habitat for native plants and animals on degraded grassland.]

riparian- of or relating to the banks of a stream or river

riparian agricultural land- agricultural land along a stream or river

riparian forested land- forested land along a stream or river [cf. note above]

riparian habitat- habitat along the banks of a stream or river [cf. note above]

riverine- within the active channel of a river or stream

riverine wetlands- generally, all the wetlands and deepwater habitats occurring within a freshwater river channel not dominated by trees, shrubs, or persistent emergents

runoff- water from rain, melted snow, or agricultural or landscape irrigation that flows over a land surface into a water body (cf. "urban runoff")

sandplain grassland- dry grassland that has resisted succession due to fire, wind, grazing, mowing, or salt spray [N.b. Characterized by thin, acidic, nutrient-poor soils over deep sand deposits, sandplains primarily occur on the coast and off-coast islands, or inland, where glaciers or rivers have deposited sands.]

Service presence- Service programs and facilities that it directs or shares with other organizations; public awareness of the Service as a sole or cooperative provider of programs and facilities

site improvement- any activity that changes the condition of an existing site to better interpret events, places, or things related to a refuge. [E.g., improving safety and access, replacing non-native with native plants, refurbishing footbridges and trail ways, and renovating or expanding exhibits.]

special focus area- an area of high biological value [N.b. We normally direct most of our resources to SFA's that were delineated because of: 1.the presence of Federal-listed endangered and threatened species, species at risk (formerly, "candidate species"), rare species, concentrations of migrating or wintering waterfowl, or shorebird stopover habitat; 2.their importance as migrant landbird stopover or breeding habitat; 3.the presence of unique or rare communities; or 4.the presence of important fish habitat.]

special habitats- as used in CCP's; wetlands, vernal pools, riparian habitat, and unfragmented rivers, forests and grasslands [N.b. Many rare species are dependent on specialized habitats that, in many cases, are being lost within a watershed.]

special riparian project- restoring, protecting, or enhancing an aquatic environment in a discrete riparian corridor within a special focus area

Refuge mailing list- the "original" Great Meadows Refuge Complex mailling list which preceded the CCP process. This list contained names and addresses of people with an interest in the Refuge. As part of the planning process, the list was continually updated to include conservation agencies, sporting clubs, Congressionals, workbook respondents, open house/focus group attendees, etc.

species at risk- a species being considered for Federal listing as threatened or endangered (formerly, "candidate species")

species of concern- species not Federal-listed as threatened or endangered, but about which we or our partners are concerned

State agencies- generally, natural resource agencies of State governments

State land- State-owned public land

State-listed species- cf. "Federal-listed species" [N.b. This is how to write the phrase "Federal- and State-listed species".]

step-down management plan- a plan for dealing with specific refuge management subjects, strategies, and schedules, e.g., cropland, wilderness, and fire [FWS Manual 602 FW 1.4]

stopover habitat- habitat where birds rest and feed during migration

telecommunications- communicating via electronic technology

telecommunications project- any cooperative venture that combines financial and staff resources to develop and use computer-based applications for exchanging information about a watershed with others

threatened species- a Federal-listed, protected species that is likely to become an endangered species in all or a significant portion of its range

tiering- incorporating by reference the general discussions of broad topics in environmental impact statements into narrower statements of environmental analysis by focusing on specific issues [40 CFR 1508.28]

tributary- a stream or river that flows into a larger stream, river, or lake

trust resource- a resource that the Government holds in trust for the people through law or administrative act [N.b. A Federal trust resource is one for which responsibility is given wholly or in part to the Federal Government by law or administrative act. Generally, Federal trust resources are nationally or internationally important no matter where they occur, like endangered species or migratory birds and fish that regularly move across state lines. They also include cultural resources protected by Federal historic preservation laws, and nationally important or threatened habitats, notably wetlands, navigable waters, and public lands like state parks and national wildlife refuges.]

unfragmented habitat- large, unbroken blocks of a particular type of habitat

unit objective- desired conditions that must be accomplished to achieve a desired outcome

upland- dry ground (i.e., other than wetlands)

upland meadow or pasture- areas maintained in grass for livestock grazing; hay production areas [N.b. Meadows may occur naturally in tidal marshes and inland flooded river valleys or, more frequently, at upland sites where vegetation has been cleared and grasses planted. Eventually, meadows will revert to old fields and forest if they are not mowed, grazed, or burned. Grasses in both managed meadows and pastures usually are similar, but pasture herbs often differ because of selective grazing.]

urban runoff water from rain, melted snow, or landscape irrigation flowing from city streets and domestic or commercial properties that may carry pollutants into a sewer system or water body

vernal pool- depressions holding water for at least two months in the spring or early summer, is absent of fish, and is important for amphibians during the breeding season.

vision statement- a concise statement of what the unit could achieve in the next 10 to 15 years

visitor center- a permanently staffed building offering exhibits and interpretive information to the visiting publc. Some visitor center are co-located with refuge offices, others include additional facilities such as classrooms or wildlife viewing areas

visitor contact station- compared to a visitor center, a contact station is a smaller facility which may not be permanently staffed

warm-season grass- native prairie grass that grows the most during summer, when cool-season grasses are dormant

watchable wildlife- all wildlife is watchable [N.b. A watchable wildlife program is one that helps maintain viable populations of all native fish and wildlife species by building an active, well informed constituency for conservation. Watchable wildlife programs are tools

for meeting wildlife conservation goals while at the same time fulfilling public demand for wildlife-dependent recreational activities (other than sport hunting, sport fishing, or trapping).]

watershed- the geographic area within which water drains into a particular river, stream, or body of water; land and the body of water into which the land drains

well protected- a rare species or community type 75 percent or more of its occurrence sites are on dedicated open space

wet meadows- meadows located in moist, low-lying areas, often dominated by large colonies of reeds or grasses [N.b. Often they are created by collapsed beaver dams and exposed pond bottoms. Saltmarsh meadows are subject to daily coastal tides.]

wetlands- "Wetlands are lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water."—Cowardin et al 1979

wilderness- cf. "designated wilderness"

wildfire- a free-burning fire requiring a suppression response; all fire other than prescribed fire that occurs on wildlands [FWS Manual 621 FW 1.7]

wildland fire- every wildland fire is either a wildfire or a prescribed fire [FWS Manual 621 FW 1.3]

wildlife management- manipulating wildlife populations, either directly by regulating the numbers, ages, and sex ratios harvested, or indirectly by providing favorable habitat conditions and alleviating limiting factors

wildlife-oriented recreation- recreational experiences in which wildlife is the focus ["The terms 'wildlife-dependent recreation' and 'wildlife-dependent recreational use' mean a use of a refuge involving hunting, fishing, wildlife observation and photography, or environmental education and interpretation."—National Wildlife Refuge System Improvement Act of 1997]

working landscape- the rural landscape created and used by traditional laborers [N.b. Agriculture, forestry, and fishing all contribute to the working landscape of a watershed (e.g., keeping fields open by mowing or by grazing livestock).]