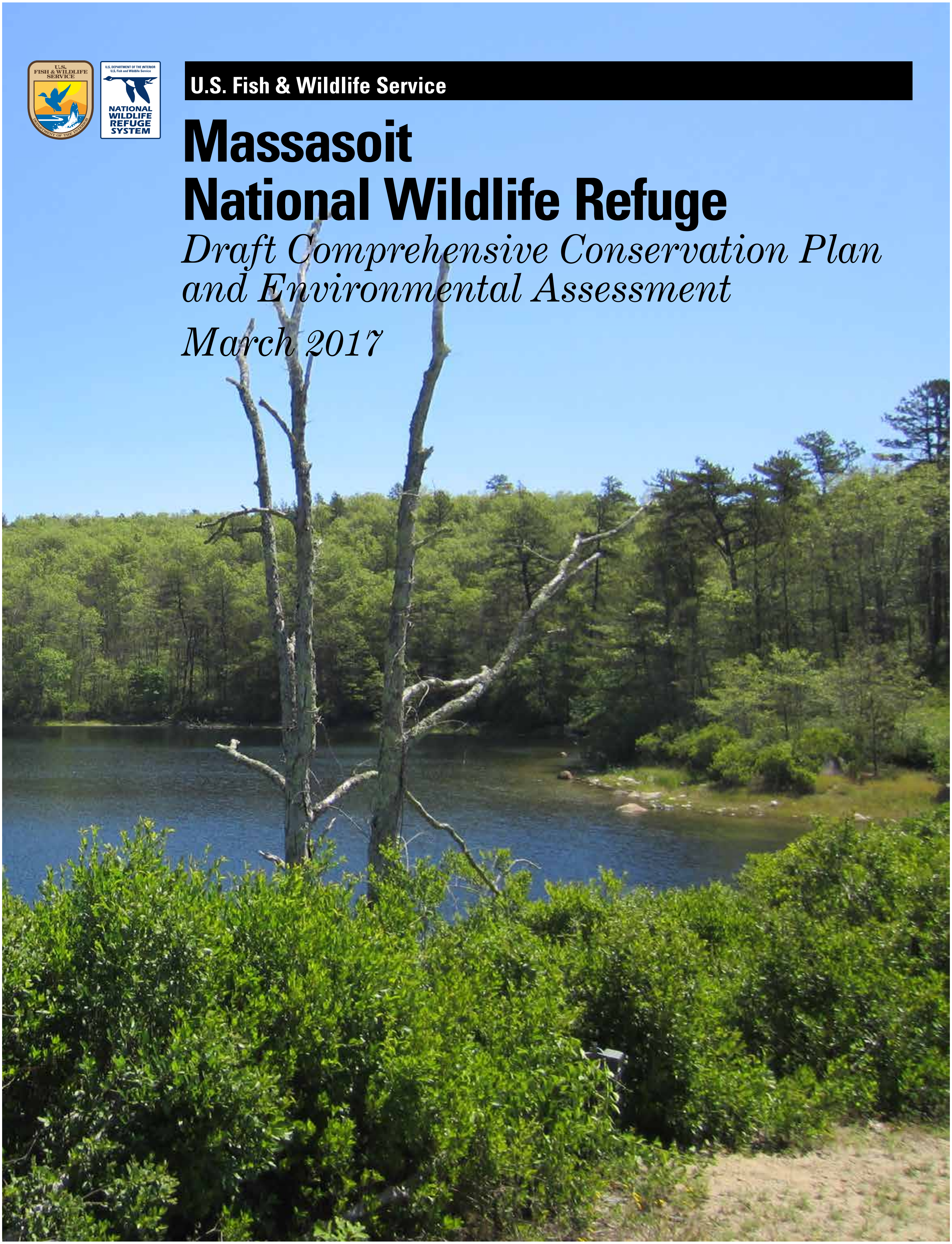
U.S. Fish & Wildlife Service

Massasoit National Wildlife Refuge

Draft Comprehensive Conservation Plan and Environmental Assessment

March 2017



Front and back covers:

Crooked Pond on Massasoit National Wildlife Refuge
Kourtnie Bouley/USFWS

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

The U.S. Fish and Wildlife Service (Service) is the principal Federal agency responsible for conserving, protecting, and enhancing fish, wildlife, plants, and their habitats for the continuing benefit of the American people. The Service manages the National Wildlife Refuge System, comprising over 850 million acres of lands and waters, including five national marine monuments, more than 565 national wildlife refuges, and 38 wetland management districts. The Service also operates national fish hatcheries and ecological services field stations. It enforces Federal wildlife laws, manages migratory bird populations, restores nationally significant fisheries, conserves, and restores wildlife habitat, administers the Endangered Species Act, and helps foreign governments with their conservation efforts. The Service oversees the Wildlife and Sport Fish Restoration Program that manages over 10 grant programs to state agencies for wildlife and fish conservation and to support hunting, sport fishing, and recreational boating opportunities.

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

U.S. Fish & Wildlife Service

Massasoit National Wildlife Refuge

Draft Comprehensive Conservation Plan

March 2017

Vision Statement

The pine-oak habitat and coastal plain ponds that comprise Massasoit National Wildlife Refuge are an integral component of the southeast Massachusetts landscape and its biodiversity, and are part of the largest contiguous pitch pine-oak habitat north of the Long Island Sound. This dynamic, fire-dependent ecosystem supports numerous invertebrate and bird species of conservation concern. The kettle-hole ponds in this system also support and contribute to the recovery of the federally endangered northern red-bellied cooter, a geographically distinct population found only in Massachusetts.

Through public and partner engagement, we promote ecologically responsible stewardship of the resources on the refuge and in the larger landscape, and foster an appreciation and understanding of the intrinsic value of these resources.

U.S. Fish & Wildlife Service

Massasoit National Wildlife Refuge

Draft Comprehensive Conservation Plan

March 2017

Summary

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

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

Location:v Massasoit National Wildlife Refuge
Plymouth, Massachusetts

Administrative Headquarters: Eastern Massachusetts National Wildlife Refuge Complex
Sudbury, Massachusetts

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This draft comprehensive conservation plan and environmental assessment analyzes two alternatives for managing the 209-acre Massasoit National Wildlife Refuge (NWR, refuge) over the next 15 years. This document also contains four appendixes (appendix A to appendix D) that provide additional information supporting our analyses. Following is a brief overview of each alternative:

Alternative A: *Current Management*—Alternative A satisfies the National Environmental Policy Act requirement of a "no-action" alternative, which we define as "continuing current management." It describes our existing management priorities and activities for Massasoit NWR, and serves as a baseline for comparing and contrasting alternative B.

Alternative B: *Expanded Management (Service-preferred Alternative)*—Alternative B represents an extension and progression of all areas of refuge management. Under alternative B, new biological program activities would be initiated. Northern red-bellied cooter habitat management and monitoring would be expanded. Management tools, such as prescribed burning and mechanical thinning, would be targeted toward increasing structural habitat and species diversity to benefit a wide array of species of conservation concern such as

eastern towhees, prairie warblers, and New England cottontail. Wildlife population and habitat monitoring surveys and inventories would be continued on an ongoing basis to provide the data needed to evaluate the effectiveness of refuge programs and practices, and to adapt management as warranted to achieve long-range refuge goals and objectives.

Under alternative B, new compatible, wildlife-dependent recreational opportunities are provided. Most of the Crooked Pond parcel would be opened for wildlife observation, photography, interpretation, and environmental education on special occasions when led by refuge staff or partners working under a special use permit. Refuge staff would also undertake a separate planning process that could result in opening the refuge to white-tailed deer and wild turkey hunting, and possibly other hunt seasons. This involves the preparation of another environmental assessment and public comment period before any decisions are made about which hunt seasons could be offered on the refuge.

Chapters

Chapters (cont.)

Chapter 4 Environmental Consequences (cont.)

Chapter 5 Planning to Protect Land and Resources

Bibliography

Glossary and Acronyms

Appendixes

Appendix A Species Known or Suspected on Massasoit National Wildlife Refuge

Appendix B Findings of Appropriateness and Compatibility Determinations

Appendixes (cont.)

Appendix C Wilderness Review

Appendix D Fire Management Program Guidance

List of Figures

List of Tables

List of Tables (cont.)

List of Maps

Chapter 1


USFWS

Crooked Pond on Massasoit National Wildlife Refuge

The Purpose of, and Need for, Action

- Introduction
- The Purpose of, and Need for, Action
- The Service and the National Wildlife Refuge System: Policies and Mandates Guiding Refuge Planning
- Conservation Plans and Initiatives Guiding our Planning
- Refuge Establishing Purpose and Land Acquisition History
- Refuge Administration
- Refuge Operational Plans ("Stepdown" Plans)
- Eastern Massachusetts Refuge Complex Vision Statement
- Refuge Vision Statement
- Refuge Goals
- The Comprehensive Conservation Planning Process
- Wilderness Review
- Issues, Concerns, and Opportunities

Introduction

Massasoit National Wildlife Refuge (NWR; refuge) is located in Plymouth, Massachusetts. The U.S. Fish and Wildlife Service (USFWS; Service) acquired the land for the refuge in 1983 to conserve the federally endangered northern red-bellied cooter. In addition, it protects other wildlife and plant species including rare moths and other native pollinators, migratory songbirds, and small mammals. The 209-acre refuge is comprised of pine-oak upland forest with varying understory, and wetlands, including open water coastal plain "kettle" ponds and associated shoreline habitats. The refuge includes three parcels: the 184-acre Crooked Pond parcel which abuts Myles Standish State Forest (MSSF), and two smaller parcels located on Island Pond (15 acres) and Hoyt Pond (10 acres; maps 1-1 and 1-2). Massasoit NWR is located within an area designated as critical habitat for the northern red-bellied cooter. It is one of eight refuges that comprise the Eastern Massachusetts National Wildlife Complex (Refuge Complex), which is headquartered in Sudbury, Massachusetts (map 1-3).

This draft Comprehensive Conservation Plan and Environmental Assessment (draft CCP/EA) for the refuge includes two documents required by Federal law as follows:

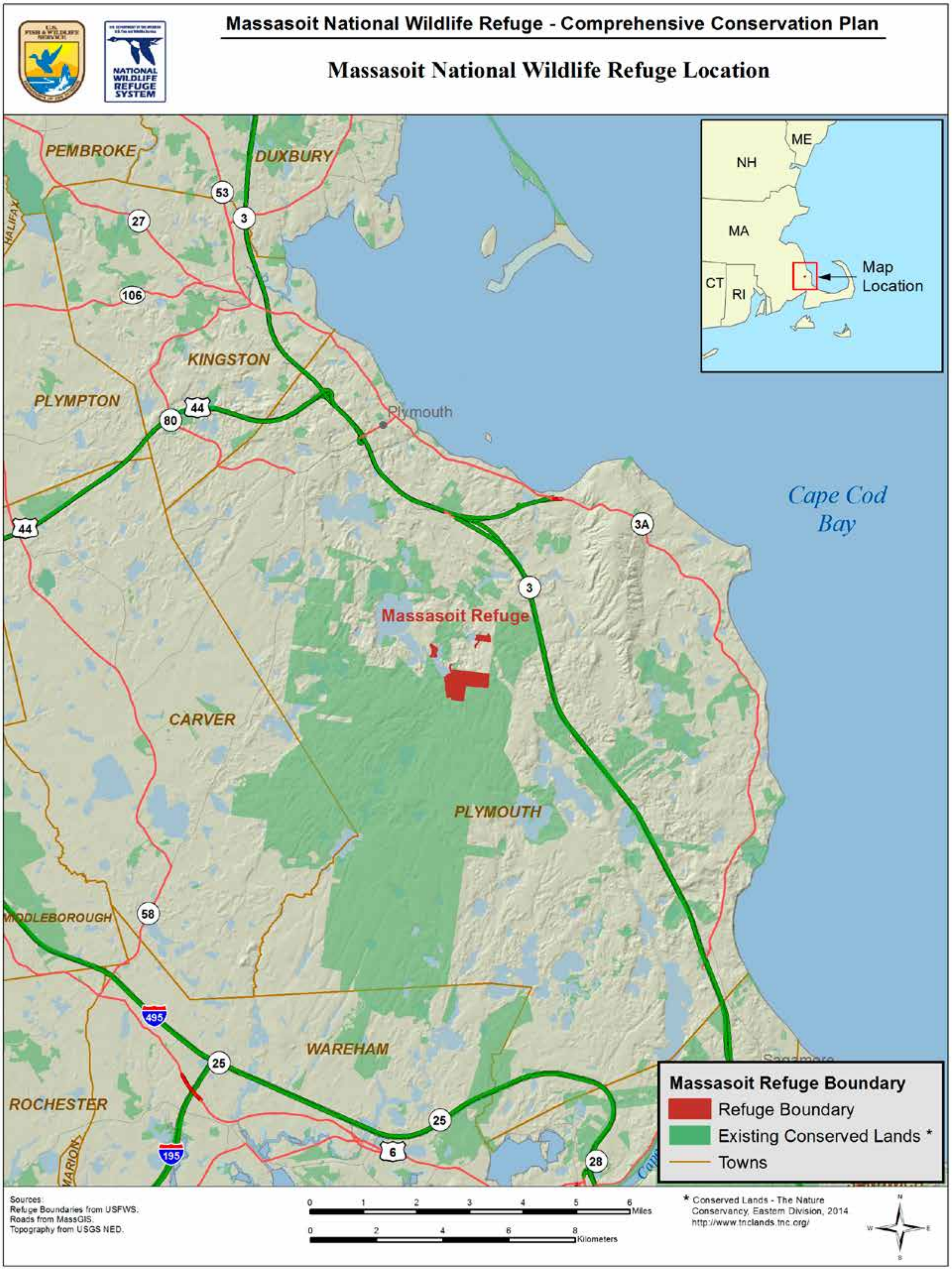
- A draft CCP, required by the National Wildlife Refuge System (Refuge System) Administration Act of 1996, as amended by the Refuge System Improvement Act of 1997 [Public Law (PL) 105-57; 111 Stat. 1253], as amended; (Improvement Act).
- An EA, required by the National Environmental Policy Act (NEPA) of 1969 (42 U.S.C. 4321 *et seq.*, 83 Stat. 852), as amended.

Following public review of this draft CCP/EA, the Service's Northeast Regional Director will select an alternative to implement based on the Service and Refuge System missions, the purpose for which the refuge was established, other legal mandates, and public and partner comments to this draft CCP/EA. The alternative selected could be the preferred alternative presented in this draft CCP/EA, the no-action alternative, or a combination of actions from these alternatives. The final decision will identify the desired combination of species protection, habitat management, public use, and administration of the refuge. The final CCP will guide refuge management decisions over the next 15 years to promote understanding of, and support for, refuge management among State agencies in Massachusetts, Tribal governments, our conservation partners, local communities, and the public.

Chapter 1 "The Purpose of, and Need for, Action," explains the purpose and need for preparing a draft CCP/EA, and sets the stage for five subsequent chapters and six appendices. Specifically, chapter 1:

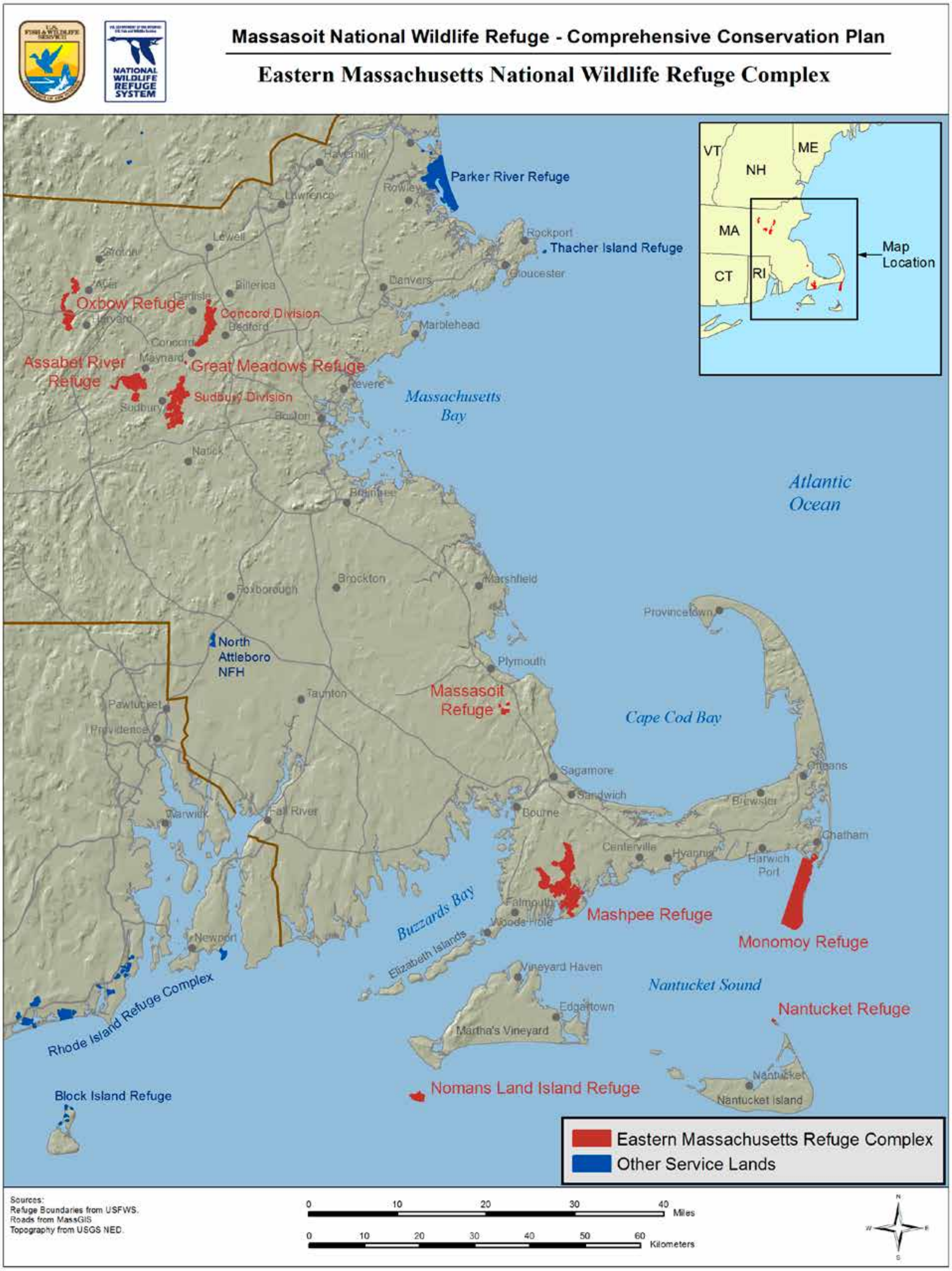
- Defines the planning analysis area.
- Presents the Service mission, policies, and mandates affecting the development of the plan.
- Identifies other conservation plans used as references.
- Highlights the purpose for which the refuge was established and its land acquisition history.
- Clarifies the vision and goals that drive refuge management.
- Describes refuge operational (or "stepdown") plans.

Map 1-1. Massasoit National Wildlife Refuge Location



Map 1-2. Massasoit National Wildlife Refuge Boundaries

Map 1-3. Eastern Massachusetts National Wildlife Refuge Complex



- Describes the planning process and its compliance with NEPA regulations.
- Identifies public and partner issues or concerns that surfaced as the plan was developed.

Chapter 2, "Affected Environment," describes the physical, biological, cultural, and socioeconomic environments of the refuge.

Chapter 3, "Alternatives Considered, Including the Service-preferred Alternative," presents two management alternatives and their respective objectives and strategies for meeting refuge goals and addressing public and partner issues. It also describes the activities expected to occur regardless of the alternative selected for the final CCP. The two alternatives include continuing the current level of management (current management), and increasing management on the refuge in the context of the broader landscape it is a part of (expanded management).

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

Chapter 5, "Consultation and Coordination with Others," summarizes how the public and partners were involved in the planning process.

Chapter 6, "List of Preparers," includes the names of the core planning team, Service personnel, and agencies involved in the preparation of this draft CCP document.

Four appendixes, a glossary with acronyms and abbreviations, and a bibliography (literature cited) provide additional documentation and references to support the narratives and analysis.

The Purpose of, and Need for, Action

The Service is developing a CCP for Massasoit NWR that best achieves the purpose, goals, and vision of the refuge and contributes to the Refuge System mission, adheres to the Service's policies and other mandates, addresses identified issues of importance, and incorporates sound principles of fish and wildlife science.

The *purpose of* a CCP is to provide strategic management direction on the refuge for the next 15 years that:

- Clearly states the desired future conditions of refuge habitat, wildlife, public access, visitor services, staffing, and facilities.
- Provides a clear explanation of the reasons for management actions to State agencies, refuge neighbors, visitors, partners, and the public.
- Ensures refuge management reflects the policies and goals of the Refuge System and legal mandates.
- Ensures the compatibility of current and future public use.
- Provides long-term continuity and direction for refuge management.
- Provides direction for staffing, operations, maintenance, and annual budget requests.
- Best achieves the refuge purpose and goals for management of the refuge, as described under the section on "Refuge Goals" at the end of this chapter.

The *need* for a CCP is because Massasoit NWR lacks a master plan with strategic management direction to guide decision-making. Secondly, the local economy and patterns of land use have changed since 1983 and the pressures for public use and access have increased. Also, new ecosystem and species conservation plans have been developed since refuge establishment that bear directly on refuge management. Third, the Improvement Act requires that all national wildlife refuges have a CCP in place to help fulfill the mission of the Refuge System. Finally, the CCP is needed to address key issues identified through the planning process by the public, partners, other agencies, and refuge staff.


Bill Thompson

Eastern towhee

Of primary concern are issues that are adversely affecting the populations and habitats of wildlife and plants within the refuge. These key issues are described in detail below in the section titled, "Issues, Concerns, and Opportunities."

This draft CCP/EA compares two alternatives for managing Massasoit NWR: alternative A is defined as "Current Management" and alternative B as "Expanded Management." The draft plan evaluates their effects on key physical, biological, cultural, and socioeconomic resources. Alternative B is the proposed action and the Service-preferred alternative. It is the CCP planning team's best professional judgment that alternative B best achieves the refuge purpose, vision, and goals; contributes to the Refuge System mission; addresses the issues and relevant mandates; and is consistent with sound principles of fish and wildlife management.

The Service and the National Wildlife Refuge System: Policies and Mandates Guiding Refuge Planning

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

As part of the Department of the Interior (Department), the Service administers the Refuge System. The Service mission is *"Working with others to conserve, protect, and enhance fish, wildlife, and plants and their habitats for the continuing benefit of the American people."*

Congress entrusts to the Service the conservation and protection of these national natural resources: migratory birds and fish, federally listed endangered or threatened species, inter-jurisdictional fish, wetlands, certain marine mammals, and national wildlife refuges. The Service also enforces Federal wildlife laws and international treaties on importing and exporting wildlife, assists states with their fish and wildlife programs, and helps other countries develop conservation programs.

The Service Manual, available online at: *http://www.fws.gov/policy/manuals* (accessed October 2015) contains the standing and continuing directives on implementing Service authorities, responsibilities, and activities. The 600 series of the Service Manual addresses land use management, and sections 601 to 609 specifically address management of national wildlife refuges. Special directives that affect the rights of citizens or the authorities of other agencies are published separately in the Code of Federal Regulations (CFR). Most of the current regulations that pertain to the Service are issued in 50 CFR, parts 1 to 99;

available online at: *http://www.gpo.gov/fdsys/pkg/CFR-2001-title50-vol1/content-detail.html* (accessed October 2015).

The National Wildlife Refuge System and its Mission and Policies

The Refuge System is the world's largest collection of lands and waters set aside specifically for the conservation of wildlife and the protection of ecosystems. More than 565 national wildlife refuges encompass more than 150 million acres of lands and waters in all 50 states and several island territories. Each year, more than 40 million visitors hunt, fish, observe and photograph wildlife, or participate in environmental education and interpretation activities on refuges.

In 1997, President Clinton signed into law the Improvement Act which established a unifying mission for the Refuge System and a new process for determining the compatibility of public uses on refuges. The Improvement Act also states that the Refuge System must focus on wildlife conservation and that the mission of the Refuge System, coupled with the purpose(s) for which each refuge was established, will provide the principal management direction on that refuge. As stated in the Improvement Act, the mission of the Refuge System is,

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

The Refuge Manual contains policy governing the operation and management of the Refuge System that the Service Manual does not cover, including technical information on implementing refuge policies and guidelines on enforcing laws. The Refuge Manual is not available online, but can be viewed at Refuge Complex headquarters in Sudbury, Massachusetts. In addition, there are a few noteworthy policies in the Service Manual that relate to the Refuge System and were instrumental in the development of this draft CCP/EA. Descriptions of those policies follow.

Policy on the National Wildlife Refuge System Mission, Goals, and Purposes (601 FW 1)
This policy sets forth the Refuge System mission noted above, how it relates to the Service mission, and explains the relationship of the Refuge System mission and goals, and the purpose(s) of each unit in the Refuge System. The policy identifies the following Refuge System goals:

- Conserve a diversity of fish, wildlife, and plants.
- Develop and maintain a network of habitats.
- Conserve those ecosystems, plant communities, and wetlands that are unique within the United States.
- Provide and enhance opportunities to participate in compatible, wildlife-dependent recreation.
- Foster public understanding and appreciation of the diversity of fish, wildlife, and plants and their habitats.

This policy also establishes management priorities for the Refuge System:

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

Policy on Refuge System Planning (602 FW 1, 2, and 3)
This policy establishes the requirements and guidance for Refuge System planning, including CCPs and stepdown management plans. It states that refuges are managed in accordance with an approved CCP that when implemented will:

- Achieve refuge purposes.

- Fulfill the Refuge System mission.

- Maintain and, where appropriate, restore the ecological integrity of each refuge and the Refuge System.

- Achieve the goals of the National Wilderness Preservation System (NWPS) and the National Wild and Scenic Rivers System.

- Conform to other applicable laws, mandates, and policies.

This planning policy provides step-by-step directions and identifies the minimum requirements for developing all CCPs including review of existing special designation areas such as wilderness and wild and scenic rivers, specifically addressing the potential for any new special designations, conducting a wilderness review, and incorporating a summary of that review into each CCP (602 FW 3). Appendix C contains the wilderness review for Massasoit NWR. A Wild and Scenic River review was not warranted for this project.

Policy on Appropriate Refuge Uses (603 FW 1)
Federal law and Service policy provide the direction and planning framework for protecting the Refuge System from inappropriate, incompatible, or harmful human activities and ensures that visitors can enjoy its lands and waters (when the refuge is open to public use). Policy 603 FW 1 provides a national framework for determining appropriate refuge uses to prevent or eliminate those that should not occur in the Refuge System. It describes the initial decision process the refuge manager follows when first considering whether to allow a proposed use on a refuge. Appendix B of this CCP/EA further describes the Service's policy on appropriate refuge uses and its relationship to the CCP process. An appropriate use must meet at least one of the following four conditions:

- The use is a wildlife-dependent recreational use as identified in the Improvement Act.

- The use contributes to fulfilling the refuge purpose(s), the Refuge System mission, or goals or objectives described in a refuge management plan approved after October 9, 1997, the date the Improvement Act became law.

- The use involves the taking of fish and/or wildlife under State regulations.

- The use has been found to be appropriate after concluding a findings process using 10 criteria specified in the policy.

This policy is available on the Website: *http://www.fws.gov/policy/603fw1.html* (accessed October 2015).

Policy on Compatibility (603 FW 2)
This Service policy complements the appropriate use policy. The refuge manager must initially find a use appropriate before undertaking a compatibility review of that use. If the proposed use is not appropriate, the refuge manager will not allow it, and a compatibility determination is unnecessary. However, the refuge manager must evaluate an appropriate use further through a compatibility determination. The compatibility determinations for Massasoit NWR are

Rare buckmoth found in pitch pine-scrub oak habitat

presented in appendix B along with additional information on the process. The direction in 603 FW 2 provides guidance on how to prepare a compatibility determination. Other guidance in that chapter is as follows:

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

This policy and its regulations, including a description of the process and requirements for conducting compatibility reviews may be reviewed on the Website: *http://www.fws.gov/policy/603fw2.html* (accessed October 2015).

Policy on Maintaining Biological Integrity, Diversity, and Environmental Health (601 FW 3)
This Service policy provides guidance on maintaining or restoring the biological integrity, diversity, and environmental health of the Refuge System, including the protection of a broad spectrum of fish, wildlife, and habitat resources in refuge ecosystems. It provides refuge managers with a process for evaluating the best management direction to prevent the additional degradation of environmental conditions and restore lost or severely degraded components of the environment. It also provides guidelines for dealing with external threats to the biological integrity, diversity, and environmental health of a refuge and its ecosystem.

This policy may be viewed on the Website: *http://www.fws.gov/policy/601fw3.html* (accessed October 2015).

Policy on Wilderness Stewardship (610 FW 1-5)
This Service policy provides guidance for managing Refuge System lands designated as wilderness under the Wilderness Act of 1964 (16 U.S.C. 1131 to 1136; PL 88–577). The Wilderness Act establishes a national system of lands that is composed of federally owned areas designated by Congress as “wilderness areas.” The act directs each agency administering designated wilderness to preserve the wilderness character of areas within the NWPS, and to administer the NWPS for the use and enjoyment of the American people in a way that will leave those areas unimpaired for future use and enjoyment as wilderness. Our wilderness stewardship policy also provides guidance on development of wilderness stewardship plans and clarifies when prohibited uses may be necessary for wilderness preservation.

Service planning policy requires that we evaluate the potential for wilderness on refuge lands during the CCP process (610 FW 1). Section 610 FW 4 of our Wilderness Stewardship Policy provides guidance on the wilderness review process. Sections 610 FW 1 to 3 provide management guidance for designated wilderness areas.

This policy may be viewed on the Website: *http://www.fws.gov/policy/610fw1.html* (accessed October 2015).

As noted previously, appendix C contains the wilderness review for Massasoit NWR.

Policy on Wildlife-dependent Recreation (605 FW 1)
This Service policy presents specific guidance about wildlife-dependent recreation programs within the Refuge System. Wildlife-dependent recreation programs are developed on refuges in consultation with state agencies and stakeholder input based on the following specific criteria:

- Promotes safety of participants, other visitors, and facilities.
- Promotes compliance with applicable laws and regulations and responsible behavior.
- Minimizes or eliminates conflict with fish and wildlife populations or habitat goals or objectives in an approved plan.
- Minimizes or eliminates conflicts with other compatible, wildlife-dependent recreation.
- Minimizes conflicts with neighboring landowners.

- Promotes accessibility and availability to a broad spectrum of the American people.
- Promotes resource stewardship and conservation.
- Promotes public understanding and increases public appreciation of America's natural resources and the Service's role in managing and conserving these resources.
- Provides reliable/reasonable opportunities to experience wildlife.
- Uses facilities that are accessible to people and blend into the natural setting.
- Uses visitor satisfaction to help define and evaluate programs.

This policy may be viewed on the Website: *http://www.fws.gov/policy/603fw1.html* (accessed October 2015).

Policy on Interpretation (605 FW 7)
This Service policy should be read concurrent with 605 FW 1 above, and defines interpretive programs as management tools to accomplish the following:

- Provide opportunities for visitors to become interested in, learn about, and understand natural and cultural resource management and our fish and wildlife conservation history.
- Help visitors understand their role within the natural world.
- Communicate rules and regulations to visitors, thereby promoting understanding and compliance to solve or prevent potential management problems.
- Help us make management decisions and build visitor support by providing insight into management practices.
- Help visitors enjoy quality wildlife experiences on the refuge.

Further, the policy provides these guiding principles for interpretive programs:

- Relate what is being displayed or described to something within the personality or experience of the visitor, and provide meaningful context.
- Reveal key themes and concepts to visitors based on information.
- Inspire and develop curiosity.
- Organize activities around theme statements.

Policy on Urban Wildlife Conservation Program (110 FW 1)
This Service policy presents specific guidance about engaging urban communities in fish and wildlife conservation, to conserve wildlife for the continuing benefit of the American people, and create a connected conservation constituency. The policy describes the designation process for Urban Wildlife Refuge Partnerships, Urban Bird Treaty cities, and Urban Wildlife Refuges and directs all Service programs to contribute to this coordinated national effort to:

- Work to expand their outreach, information, education, and strategic communication activities to raise awareness of the relevancy of conservation in urban areas and in peoples' lives.

- Create more opportunities for people in urban areas to engage in fish and wildlife conservation and restoration, either by interacting directly with urban residents or by developing partnerships with organizations that are already involved with urban communities.

- Establish methods for evaluating intended outcomes and modify practices to ensure success.

Further, the policy provides these supporting goals to achieve the overarching program goal:

- Ensuring that people who are engaged in wildlife conservation reflect the demographics of America.

- Encouraging a better understanding by urban residents of the importance of protecting and conserving habitat for wildlife by connecting them in ways that are relevant to their lives.

- Involving urban communities through environmental education and nature-based experiences that move participants up a spectrum of engagement from nature awareness and comfort to conservation action.

- Embracing traditional and new collaborations with the urban community to develop meaningful, lifelong connections to wildlife.

- Becoming a community asset, collaboratively working to help strengthen the urban community as a whole.

This policy may be viewed on the Website: *http://www.fws.gov/policy/110fw1.html* (accessed December 2015).

Fulfilling the Promise and Conserving the Future: Wildlife Refuges and the Next Generation

In the summer of 2011, the Service held a “Vision Conference”—an opportunity to create a new strategic mission for the Refuge System that would guide refuge management through the next decade. The Service now has a great opportunity to improve upon its planning legacy by incorporating a new vision and set of conservation strategies in the next generation of CCPs. This new vision requires emphasizing several principles. First, the new plans must integrate the conservation needs of the larger landscape and ensure that refuges function as a system. Second, plans must be flexible enough to address new environmental challenges and contribute to the ecological resiliency of fish and wildlife populations and their habitats. Third, plans must be written so those who read them will clearly understand what is expected and be inspired to take action to become a part of our conservation legacy. Fourth, plans should explore ways to increase recreational opportunities, working closely with regional recreation, trails, and transportation planners to leverage resources that make refuges more accessible to the public.

The 1999 report “Fulfilling the Promise, The National Wildlife Refuge System: Visions for Wildlife, Habitat, People and Leadership” (USFWS 1999c) is a culmination of a year-long process by teams of Service employees to evaluate the Refuge System nationwide. The report contains 42 recommendations packaged with three vision statements dealing with wildlife and habitat, people, and leadership. “Conserving the Future: Wildlife Refuges and the Next Generation” (USFWS 2011) is a vision designed to guide the management of the Refuge System during the next decade and beyond. This document contains 23 recommendations on themes such as the relevance of the Refuge System to a changing America, the impact of climate change, the need for conservation at a landscape-scale, the necessity of partnership and collaboration, and the absolute importance of scientific excellence. These recommendations have provided much of the guidance for developing this draft CCP/EA. The document can be found here: *https://www.fws.gov/refuges/pdfs/FinalDocumentConservingTheFuture.pdf* (accessed October 2015).

Endangered Species Act

Through Federal action, and by encouraging the establishment of state conservation programs, the 1973 Endangered Species Act (ESA) provided for the conservation of ecosystems upon which threatened and endangered species of fish, wildlife, and plants depend. The ESA:

- Authorizes the determination and listing of species as endangered and threatened.
- Prohibits unauthorized taking, possession, sale, and transport of endangered species.
- Provides authority to acquire land for the conservation of listed species, using land and water conservation funds.
- Authorizes establishment of cooperative agreements and grants-in-aid to states that establish and maintain active and adequate programs for endangered and threatened wildlife and plants.
- Authorizes the assessment of civil and criminal penalties for violating the ESA or regulations.
- Authorizes the payment of rewards to anyone furnishing information leading to arrest and conviction for any violation of the ESA or any regulation issued there under.


USFWS

Tree girdling to increase sun exposure

Native American Policy

The Service updated its Native American Policy (510 FW1) in 2016. The policy provides a framework for government-to-government relationships, and furthers the trust responsibility of the United States and the Department to federally recognized Tribes to protect, conserve, and use Tribal reserved, treaty guaranteed, or statutorily identified resources. The policy articulates the principles for interactions between the Service and Tribal governments as they related to shared interests in the conservation of fish, wildlife, and their habitats, which include Service land and the protection of cultural resources that exist on Service lands. The policy can be found here: *www.fws.gov/nativeamerican/pdf/Policy-revised-2016.pdf* (accessed June 2016).

Other Mandates

Although Service and Refuge System policy and the purpose(s) of each refuge provide the foundation for its management, other Federal laws, executive orders (EO), treaties, interstate compacts, and regulations on conserving and protecting natural and cultural resources also affect how the Service manages refuges. Federal laws require the Service to identify and preserve its important historic structures, archaeological sites, and artifacts. For example, NEPA mandates consideration of cultural resources in planning Federal actions, and the

Improvement Act requires each refuge to identify its archaeological and cultural values in a CCP.

In addition, laws relevant to Massasoit NWR are summarized below, as described in the "Digest of Federal Resource Laws of Interest to the U.S. Fish and Wildlife Service," and from the USFWS 2013 Tribal Consultation Guide.

The Antiquities Act of 1906 as amended (PL 59–209; 34 Stat. 225; 16 U.S.C. 431 to 433) is the earliest and most basic legislation for protecting cultural resources on Federal lands. It provides misdemeanor-level criminal penalties to control unauthorized uses. Appropriate scientific uses may be authorized through permits, and materials removed under a permit must be permanently preserved in a public museum. The 1906 act is broader in scope than the 1979 Archaeological Resources Protection Act (ARPA), which partially supersedes it.

The Historic Sites, Buildings and Antiquities Act (16 U.S.C. 461 to 462, 464 to 467; 49 Stat. 666) of August 21, 1935, popularly known as the Historic Sites Act, as amended by PL 89–249, approved October 9, 1965, (79 Stat. 971), declares it a national policy for the first time to preserve historic sites and objects of national significance, including those located on refuges. It provides authorization to the Secretary of the Interior through the National Park Service (NPS) to conduct archaeological surveys, and to designate, acquire, administer, protect, and purchase properties of historic significance. National Historic and Natural Landmarks are designated under the authority of this act, which are eventually incorporated into the National Historic Register under the 1966 National Historic Preservation Act (NHPA).

The Archeological and Historic Preservation Act (16 U.S.C. 469 to 469c; PL 86–523), approved June 27, 1960, (74 Stat. 220) as amended by PL 93–291, approved May 24, 1974 (88 Stat. 174), carries out the policy established by the Historic Sites Act. It directs Federal agencies to notify the Secretary of the Interior whenever they find that alteration of terrain caused by a Federal or federally assisted, licensed, or permitted project may cause the loss or destruction of significant scientific, prehistoric, or archaeological data. This expands the number of Federal agencies responsible for carrying out this law. The act authorizes the use of appropriated, donated, or transferred funds for the recovery, protection, and preservation of those data.

The NHPA (16 U.S.C. 470 to 470b, 470c to 470n), PL 89–665, approved October 15, 1966, (80 Stat. 915) and repeatedly amended, provides for the preservation of significant historical properties (buildings, objects, and sites) through a grant-in-aid program to the states. It establishes a National Register of Historic Places and a program of matching grants under the existing National Trust for Historic Preservation (16 U.S.C. 468 to 468d). This act establishes an Advisory Council on Historic Preservation, which became a permanent, independent agency in PL 94–422, approved September 28, 1976, (90 Stat. 1319), and created the Historic Preservation Fund. It directs Federal agencies, and any state, local, or private entity associated with a Federal undertaking, to conduct a Section 106 Review, or to identify and assess the effects of their actions on items or sites listed or eligible for listing on the National Register. Most importantly, this act established that archaeological preservation was an important and relevant component at all levels of modern society, and it enabled the Federal Government to facilitate and encourage archaeological preservation, programs, and activities in the state, local, and private sectors.

The NHPA also charges Federal agencies with locating, evaluating, and nominating sites on their land to the National Register of Historic Places. An inventory of known archaeological sites and historic structures is maintained in the Northeast Regional Office and file copies of the sites at each refuge. The Regional historic preservation officer in Hadley, Massachusetts, oversees compliance with the NHPA and consultations with State Historic Preservation Officers (SHPOs).

American Indian [Native American] Religious Freedom Act of 1978 as amended (PL 95–431; 92 Stat. 469; 42 U.S.C. 1996) resolves that it shall be the policy of the United States to protect and preserve for the American Indian, Eskimo, Aleut, and Native Hawaiian the inherent right of freedom to believe, express, and exercise their traditional religions, including access to religious sites, use and possession of sacred objects, and freedom to worship through ceremonial and traditional rites. Federal agencies are directed to evaluate their policies and procedures to determine if changes are needed to protect such rights and freedoms from agency practices. The act is a specific expression of First Amendment guarantees of religious freedom. It is not implemented by regulations.

The ARPA (16 U.S.C. 470aa to 470ll; PL 96–95) approved October 31, 1979, (93 Stat. 721), largely supplanted the resource protection provisions of the Antiquities Act of 1906 for archaeological items. ARPA establishes detailed requirements for issuance of permits for any excavation for, or removal of, archaeological resources from Federal or Native American lands. It also provides detailed descriptions of prohibited actions, thereby strengthening enforcement capabilities. It establishes more severe civil and criminal penalties for the unauthorized excavation, removal, or damage of those resources; for any trafficking of those resources removed from Federal or Native American land in violation of any provision of Federal law; and for interstate and foreign commerce in such resources acquired, transported or received in violation of any State or local law.

Native American Graves Protection and Repatriation Act (NAGPRA) of 1990, as amended (PL 101–601; 104 Stat. 3048; 25 U.S.C. 3001 *et seq.*) establishes rights of American Indian Tribes and Native Hawaiian organizations to claim ownership of certain cultural items, including human remains, funerary objects, sacred objects, and objects of cultural patrimony, held or controlled by Federal agencies and museums that receive Federal funds. It requires agencies and museums to identify holdings of such remains and objects, and to work with appropriate Native Americans toward their repatriation. Permits for the excavation and/or removal of cultural items protected by the act require Native American consultation, as do discoveries of cultural items made during Federal land use activities (43 CFR Part 10). In the case that human remains are discovered on the refuge, NAGPRA establishes a procedural framework to follow, and this process may also be coordinated with the Commonwealth of Massachusetts and its laws and procedural framework as necessary.

The Service also owns and cares for museum properties. The most common are archaeological, zoological, botanical collections, historical photographs, historic objects, and art. Each refuge maintains an inventory of its museum property, and a museum property coordinator in Hadley, Massachusetts, guides the refuges in caring for that property, and provides guidance with NAGPRA and Federal regulations governing Federal archaeological collections. This program ensures that collections remain available to the public for learning and research.

The Environmental Justice program, established by Presidential EO 12898 (Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations), requires Federal agencies to ensure that all environmental policies and the disposal of toxic waste do not adversely impact minority and low-income communities, including Tribes. The common concern is that these communities are exposed to unfair levels of environmental risk arising from multiple sources, often coupled with inadequate government response.

Chapter 4, "Environmental Consequences," evaluates this plan's compliance with the acts noted above, and with the Clean Water Act of 1977, as amended (33 U.S.C. 1251, *et seq.*; PL 107–303), the Clean Air Act of 1970 (CAA), as amended (42 U.S.C. 7401 *et seq.*), and the ESA of 1973 (16 U.S.C. 1531 to 1544), as amended. Finally, this draft CCP/EA complies with NEPA and the Council on Environmental Quality (CEQ) Regulations for Implementing the Procedural Provisions of NEPA (40 CFR 1500 to 1508).

Conservation Plans and Initiatives Guiding our Planning

Strategic Habitat Conservation

Strategic Habitat Conservation (SHC) is the conservation approach the Service is using to achieve its mission in the 21st century and represents a landscape approach that is strategic, science-driven, collaborative, adaptive, and understandable. The purpose of SHC is to coordinate and link actions that various programs and partners perform at individual sites, so that their combined effect may be capable of achieving these outcomes at the larger landscape, regional, or continental scales. In this way, conservation actions can help recover and sustain species' populations as part of whole communities and systems, together with their ecological functions and processes.

The SHC approach is built on five main components that compel the Service to align expertise, capability, and operations across our programs in a unified effort to achieve mutually aspired biological outcomes: (1) *biological planning*—working with partners to establish shared conservation targets and measurable biological objectives (i.e. population) for these outcomes, and identify limiting factors affecting our shared conservation targets; (2) *conservation design*—creating tools that allow us to direct conservation actions to most effectively contribute to measurable biological outcomes, (3) *conservation delivery*—working collaboratively with a broad range of partners to create and carry out conservation strategies with value at multiple spatial scales, (4) *outcome-based monitoring*—evaluating the effectiveness of conservation actions in reaching biological outcomes and to adapt future planning and delivery, and (5) *assumption driven research*—testing assumptions made during biological planning to refine future plans and actions. Both monitoring and research help us learn from our decisions and activities and improve them over time. SHC relies on an adaptive management framework to focus on a subset of shared conservation targets, set measurable biological objectives for them, and identify the information, decisions, delivery, and monitoring needed to achieve desired biological outcomes. SHC helps the Service, and the broader conservation community, effectively organize expertise and contributions across programs and partners, so our efforts to conserve landscapes—capable of supporting self-sustaining populations of fish, wildlife, and plants—are both successful and efficient. For more information on SHC, go to: *http://www.fws.gov/landscape-conservation/shc.html* (accessed October 2015).

New England cottontail

Meagan Racey/USFWS

North Atlantic Landscape Conservation Cooperative

In cooperation with the U.S. Geological Survey (USGS), the Service is promoting landscape conservation through a national geographic network of Landscape Conservation Cooperatives (LCCs). LCCs were created in response to the unprecedented level of large-scale pressures on natural systems (e.g., land use pressures, habitat loss and fragmentation, invasive species, and climate change) and the need for agencies and organizations to work together to find long-term solutions to these threats. Each LCC is comprised of Federal and state agencies, Tribes, universities, and public and private organizations, collectively working to sustain America's lands, waters, wildlife, and cultural resources. By functioning as an interdependent network, LCCs are able to accomplish more together than any single agency or organization alone.

LCCs are applied conservation science partnerships with two main functions. The first is to provide the science and technical expertise needed to support conservation planning at landscape scales—beyond the reach or resources of any one organization. Through the efforts of in-house staff and science-oriented partners, LCCs are generating the tools, methods, and data managers need to design and deliver conservation using the SHC approach (see below for more details). The second function of LCCs is to promote collaboration among their members in defining shared conservation goals. With these goals in mind, partners can identify where and how they will take action, within their own authorities and organizational priorities, to best contribute to the larger conservation effort. LCCs do not place limits on partners; rather, they help partners to see how their activities can "fit" with those of other partners to achieve a bigger and more lasting impact. For more information on LCCs, go to: *http://www.fws.gov/landscape-conservation/lcc.html* (accessed October 2015) and see also map 1-4.

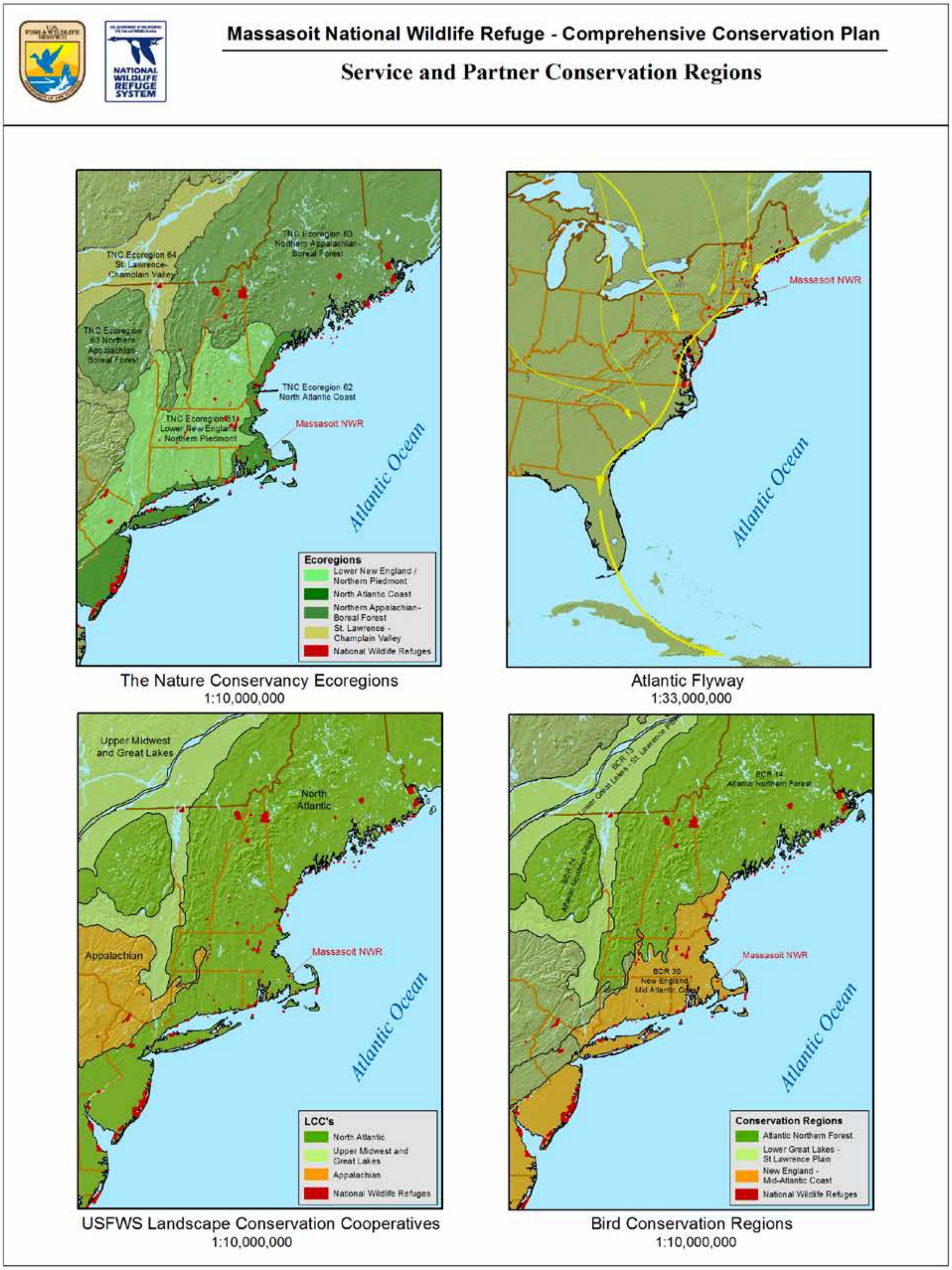
Climate Change

Secretarial Order 3289, issued on March 11, 2009, established a commitment by the Department to address the challenges posed by climate change to Tribes and to the cultural and natural resources the Department oversees. This order promotes the development and use of renewable energy on public lands, adapting land management strategies to mitigate the effects of climate change, initiating multi-agency coalitions to address issues on a landscape level, and incorporating climate change priorities in long-term planning. These and other actions will be overseen by a Climate Change Response Council which is responsible for creating a Departmentwide climate change strategy.

Department of the Interior Secretarial Order 3226 states that "there is a consensus in the international community that global climate change is occurring and that it should be addressed in governmental decision making. This Order ensures that climate change impacts are taken into account in connection with Departmental planning and decision making." Additionally, it calls for the incorporation of climate change considerations into long-term planning documents such as the CCP.

The Wildlife Society published an informative technical review report in 2004 titled "Global Climate Change and Wildlife in North America" (Inkley et al. 2004) that interprets results and details from such publications as the IPCC reports (1996-2002) and describes the potential impacts and implications on wildlife and habitats. This report notes that projecting the impacts of climate change is hugely complex because not only is it important to predict changing precipitation and temperature patterns, but to predict their rate of change, as well as the exacerbated effects of other stressors on the ecosystems. Those stressors include loss of wildlife habitat to urban sprawl and other developed land uses, pollution, ozone depletion, exotic species, disease, and other factors.

Map 1-4. Service and Partner Conservation Regions



As the principal agency responsible for the conservation of the Nation's fish, wildlife, and plant resources, the Service has drafted a *Climate Change Strategic Plan* and a *5-Year Action Plan* to jump-start implementation of the strategic plan. These plans provide a framework in which the Service works with others on a landscape scale, to promote the persistence of native species, habitats, and natural communities. Specifically, these plans are based on three overall strategies: adaptation (management actions the Service will take to reduce climate change impacts on wildlife and habitats); mitigation (consuming less energy and using less materials in administering land and resources); and, engagement (outreach to the larger community to build knowledge and share resources to better understand climate change impacts). Both plans can be found at: *http://www.fws.gov/home/climatechange/response.html* (accessed October 2015). The Service was also a member of an intergovernmental working group of Federal, state, and Tribal agency representatives who developed the new *National Fish, Wildlife, and Plants Climate Adaptation Strategy*. This strategy can be viewed at: *http://www.wildlifeadaptationstrategy.gov/* (accessed October 2015).

In October 2015, the Massachusetts Division of Fisheries and Wildlife (MassWildlife) submitted the Massachusetts State Wildlife Action Plan (SWAP) to the USFWS for final approval. This update of the 2006 Massachusetts SWAP substantially expands on the discussion of expected climate change impacts on Species of Greatest Conservation Need (SGCN) and the habitats and landscapes on which they depend from that in the original 2006 Massachusetts Comprehensive Wildlife Action Strategy discussed further below and in subsequent chapters. Results from the Climate Change Vulnerability Assessment conducted by the Manomet Center for Conservation Sciences and MassWildlife (2010) helped to identify which habitat types in Massachusetts are more vulnerable to climate change than others and the factors making them vulnerable. This information and the results from a Regional Climate Change Vulnerability Assessment (Manomet Center for Conservation Sciences and National Wildlife Federation 2012), informed priority setting for refuge habitat and landscape conservation based on how likely various habitat types are to persist within the State and across the broader New England region.

Birds of Conservation Concern 2008 Report

The Service developed this report (USFWS 2008) in consultation with leaders of ongoing bird conservation initiatives and partnerships such as Partners in Flight (PIF), the North American Waterfowl Management Plan (NAWMP) and Joint Ventures, the North American Waterbird Conservation Plan (NAWCP), and the U.S. Shorebird Conservation Plan. This report fulfills the mandate of the 1988 amendment to the Fish and Wildlife Conservation Act of 1980 (100 PL 100–653, Title VIII) that required the Secretary of the Interior, through the Service, to "identify species, subspecies, and populations of all migratory non-game birds that, without additional conservation actions, are likely to become candidates for listing under the ESA of 1973."

The report contains 46 lists that identify bird species of conservation concern at national, regional, and landscape scales. It includes a principal national list, regional lists corresponding to the regional administrative units of the Service, and species lists for each of the 35 bird conservation regions (BCRs) designated by the North American Bird Conservation Initiative (NABCI) in the United States, and two additional BCRs created that include island "territories" of the United States. NABCI defined those BCRs as ecologically based units in a framework for planning, implementing, and evaluating bird conservation.

It is hoped this report will stimulate Federal, state, and private agencies to coordinate, develop, and implement integrated approaches for conserving and managing those birds deemed most in need of conservation. This report is one of the plans considered in identifying species of concern in appendix A and in developing management objectives and strategies for goal 1 elsewhere in this CCP/EA. The specific plans referenced in developing the Birds of Conservation Concern 2008 Report are available at: *http://www.fws.gov/migratorybirds/pdf/grants/BirdsofConservationConcern2008.pdf* (accessed October 2015) and are addressed below.

North American Waterfowl Management Plan and Atlantic Coast Joint Venture Implementation Plan

Originally written in 1986, the NAWMP describes a long-term strategy between the United States, Canada, and Mexico to restore and sustain waterfowl populations by protecting, restoring, and enhancing habitat. The plan committee, including representatives from each nation, has modified the 1986 plan four times to account for biological, sociological, and economic changes that influenced the status of waterfowl and the conduct of cooperative habitat conservation. The most recent revision (NAWMP 2012) establishes three overarching goals for waterfowl conservation: (1) abundant and resilient waterfowl populations to support hunting and other uses without imperiling habitat; (2) wetlands and related habitats sufficient to sustain waterfowl populations at desired levels, while providing places to recreate and ecological services that benefit society; and (3) growing numbers of waterfowl hunters, other conservationists and citizens who enjoy and support waterfowl and wetlands conservation. The plan is available online at: *http://nawmprevision.org/* (accessed October 2015).

To convey goals, priorities, and strategies more effectively, NAWMP is comprised of two separate documents: “Strategic Guidance” and “Implementation Framework.” The former is geared towards agency administrators and policy makers who set the direction and priorities for conservation. The latter includes supporting technical information for use by biologists and land managers.

The plans are implemented at the regional level in 14 habitat Joint Ventures and 3 species Joint Ventures: Arctic goose, American black duck, and sea duck. Massasoit NWR lies in the Atlantic Coast Joint Venture (ACJV) which includes all the Atlantic Flyway States from Maine to Florida and Puerto Rico. The waterfowl goal for the ACJV is to:

“Protect and manage priority wetland habitats for migration, wintering, and production of waterfowl, with special consideration to black ducks, and to benefit other wildlife in the joint venture area.”

The ACJV 2005 plan presents habitat conservation goals and population indices for the ACJV consistent with the NAWMP update, provides status assessments of waterfowl and their habitats in the joint venture, and updates focus area narratives and maps for each state. That document is intended as a blueprint for conserving the valuable breeding, migration, and wintering waterfowl habitat present within the ACJV boundary based on the best available information and the expert opinion of waterfowl biologists from throughout the flyway. The ACJV 2005 Implementation Plan may be viewed at: *http://acjv.org/planning/waterfowl-implementation-plan/* (accessed October 2015).

North American Bird Conservation Initiative: New England/Mid-Atlantic Bird Conservation Region Implementation Plan

Massasoit NWR lies in the New England/Mid-Atlantic BCR 30 (map 1-4). BCR 30 provides important resources for migratory birds whose ranges span the western hemisphere. The habitats associated with coastal ecosystems provide the highest habitat values and critical staging areas for migratory waterfowl, waterbirds, shorebirds, and land birds. Forested upland communities are the second most important habitats for migratory birds in BCR 30. Though

Green heron at Massasoit National Wildlife Refuge

Jared Green

the 2008 plan specifically highlights the Chesapeake and Delaware Bays, the Massachusetts Cape Cod and Islands area provides crucial resources for many migrating birds as they journey from their breeding sites in the north to non-breeding sites in Mexico, Central America, the Caribbean, and South America.

Unfortunately, most of the lands in BCR 30 have been altered from their historic condition. Urban development and agriculture dominates much of the landscape. The loss or degradation of habitat (e.g., by fragmentation, agriculture, and invasive species) are the greatest threats to bird populations in BCR 30. This plan identifies the bird species and habitats in greatest need of conservation action in this region, activities thought to be most useful to address those needs, and geographic areas believed to be the most important places for those activities. This regional implementation plan is meant to start a regional bird conservation initiative by partners across BCR 30, communicating their conservation planning and implementation activities and delivering high-priority conservation actions in a coordinated manner.

The BCR 30 implementation plan may be viewed at: *http://www.acjv.org/BCR_30/BCR30_June_23_2008_final.pdf* (accessed October 2015).

Partners in Flight Bird Conservation Plans

In 1990, PIF began as a voluntary, international coalition of government agencies, conservation organizations, academic institutions, private industries, and citizens dedicated to reversing the population declines of bird species and "keeping common birds common." The foundation of PIF's long-term strategy is a series of scientifically based bird conservation plans using physiographic areas as planning units.

The goal of each PIF plan is to ensure the long-term maintenance of healthy populations of native birds, primarily non-game birds. The plan for each physiographic area ranks bird species according to their conservation priority, describes their desired habitat conditions, develops biological objectives, and recommends conservation measures. The priority ranking factors are habitat loss, population trends, and the vulnerability of a species and its habitats to regional and local threats.

Massasoit NWR lies in the North Atlantic Coast Ecoregion (see map 1-4, #62), (Dettmers and Rosenberg 2000) and includes objectives for seven habitat types and associated species of conservation concern, including early successional/pitch pine barren habitat. This plan can be accessed at: *http://www.ct.gov/csc/lib/csc/pendingproceeds/petition_980/prefiled/dettmers_rosenburg_pl_09_10.pdf* (accessed October 2015).

North American Waterbird Conservation Plan

The 2002 NAWCP (Version 1) plan (Kushlan et al. 2002) represents a partnership among individuals and institutions with interest in, and responsibility for conserving waterbirds and their habitats, and is just one element of a multi-faceted conservation program. Its primary goal is to ensure that the distribution, diversity, and abundance of populations and habitats of breeding, migratory, and non-breeding waterbirds are sustained or restored throughout the lands and waters of North America, Central America, and the Caribbean. It provides a framework for conserving and managing nesting water-dependent birds. In addition, it facilitates continentwide planning and monitoring, national, state, and provincial conservation, regional coordination, and local habitat protection and management.

In 2006, the Mid-Atlantic New England Working Group developed the *Waterbird Conservation Plan for the Mid-Atlantic/New England/Maritimes (MANEM) Region* (MANEM Waterbird Working Group 2007). It consists of technical appendixes on (1) waterbird populations including occurrence, status, and conservation needs, (2) waterbird habitats and locations within the region that are crucial for waterbird sustainability, (3) MANEM partners and regional expertise for waterbird conservation, and (4) conservation project descriptions that present current and proposed research, management, habitat acquisition, and education activities. Summarized information on waterbirds and their habitats provides a regional perspective for local conservation action. This plan is available online at *http://www.waterbirdconservation.org/manem.html* (accessed October 2015).

Partners in Amphibian and Reptile Conservation, National State Agency Herpetological Conservation Report

Northern red-bellied cooter nest

USFWS

Partners in Amphibian and Reptile Conservation (PARC) was created in response to the increasing, well-documented national declines in amphibian and reptile populations and is considered the most comprehensive effort in herpetofaunal (amphibian and reptile) conservation in the Nation. PARC members include state and Federal agencies, conservation organizations, museums, the pet trade industry, nature centers, zoos, the energy industry, universities, herpetological organizations, research laboratories, forest industries, and environmental consultants. Its five geographic regions focus on national and regional challenges in herpetofaunal conservation, and regional working groups allow for region-specific communication. The Northeast working group has developed *Model State Herpetofauna Regulatory Guidelines* which were consulted in developing this CCP. This document can be found at: *http://www.parcplace.org/publications/211-parc-model-herpetofauna-guidelines-.html* (accessed October 2015).

PARC has also released a report for the amphibian and reptile species of the Northeast titled *Habitat Management Guidelines for Amphibians and Reptiles of the Northeastern United States* that lists species of conservation concern and provides management guidelines for those species (*http://northeastparc.org/wp-content/uploads/2015/08/Final-NE-HMG.pdf*; accessed October 2015).

Massachusetts State Wildlife Action Plan

In 2002, Congress created the State Wildlife Grant Program (SWG), and appropriated $80 million in state grants to help state and Tribal fish and wildlife agencies conserve fish and wildlife species of greatest conservation need. The funds appropriated under the program are allocated to each state according to a formula that takes into account each state's size and population.

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

The Massachusetts SWAP, first released in 2005 and then updated in 2006 (MassWildlife 2006), resulted from that charge. It provides a blueprint and vision for effective and efficient wildlife conservation within Massachusetts, and stimulated other state and Federal agencies and conservation partners to think strategically about their individual and coordinated roles in prioritizing conservation.

In addressing the eight elements, the Massachusetts SWAP helps supplement the information gathered on species and habitat occurrences and their distribution, and identifies conservation threats and management strategies for species and habitats of conservation concern in the CCP. The eight elements of the Massachusetts SWAP are:

- Information on the distribution and abundance of species of wildlife, including low and declining populations that are indicative of the diversity and health of the State's wildlife.

- Descriptions of locations and relative condition of key habitats and community types essential to the conservation of species identified in element 1.

- Descriptions of problems that may adversely affect species identified in element 1 or their habitats, and priority research and survey efforts needed to identify factors which may assist in restoration and improved conservation of these species and habitats.

- Descriptions of conservation actions necessary to conserve the identified species and habitats and priorities for implementing such actions.

- Plans proposed for monitoring species identified in element 1 and their habitats, for monitoring the effectiveness of the conservation actions proposed in element 4, and for adapting those conservation actions to respond appropriately to new information or changing conditions.

- Descriptions of procedures to review the plan at intervals not to exceed 10 years.

- Plans for coordinating, to the extent feasible, the development, implementation, review, and revision of the plan strategy with Federal, State, local agencies, and Native American Tribes that manage significant areas of land and water within the State, or administer programs that significantly affect the conservation of identified species and habitats.

- Plans for involving the public in the development and implementation of plan strategies.

The 2006 Massachusetts SWAP was further updated in 2015, and following public review, was submitted to the USFWS on October 1, 2015. The goal of the Massachusetts SWAP is to keep common species common and to conserve the breadth of biodiversity of the Commonwealth of Massachusetts. Major updates included in the updated SWAP include:

- Greater discussion of climate-change impacts to SGCN;
- Identification of accomplishments towards reaching the goals of the 2005 SWAP;
- Additions and deletions to the list of SGCN, including, for the first time, State-listed and uncommon plants;
- Increased recognition of the importance of regional conservation needs and the role for MassWildlife in meeting those needs; and
- *BioMap2*, an update to the earlier *BioMap* and *Living Waters* projects.

MassWildlife has already adopted, developed, or is developing conservation plans for many species and habitats, and is implementing the planned conservation actions in coordination with their many partners, including the Service. Those plans particularly relevant to the Massasoit NWR planning process include regional plans for New England cottontail and conservation plans for shrubland and pitch pine-scrub oak habitats. MassWildlife's Natural Heritage and Endangered Species Program (NHESP) intends to prepare conservation plans that aim to secure the long-term viability of several State listed species, including Eastern box turtles, blue-spotted and Jefferson salamanders, and several moths closely associated with pitch pine-scrub oak habitats that will also be relevant for future refuge decision-making.

Coyote at Massasoit National Wildlife Refuge

Jared Greenv

Massachusetts has also been collaborating with other Northeastern state and Federal wildlife agencies and non-government conservation organizations to complete standardized surveys, assessments, and develop standardized monitoring protocols for species of conservation need and the habitats they depend upon. The consistent and widespread use of common monitoring methodologies and survey protocols will help support regional assessments of the status and trends for SGCN and their habitats, such as the Northeast Association of Fish and Wildlife Administrators (NEAFWA) Monitoring and Performance Reporting Framework (NEAFWA 2008, see *http://rcngrants.org/content/regional-monitoring-and-performance-framework*).

Some of the regional and Statewide surveys and assessments and standardized monitoring protocols completed or now in process with funding from the Regional Conservation Network (RCN) Grant Program that are relevant for coastal plain ponds, pitch pine-oak upland forests and associated savanna, shrubland, and open oak woodland habitat conservation include dragonflies and damselflies (odonates), freshwater aquatic habitats (Gawler 2008) and frogs, New England cottontail (Fuller and Tur 2012), shrubland birds (McDowell 2011), and detailed avian indicators for assessing the magnitude of threats and the effectiveness of conservation measures (Northeast Coordinated Bird Monitoring Partnership 2007). In addition, NEAFWA also funded development of a database for regional invertebrate SGCN through a partnership with the Carnegie Museum of Natural History in Pittsburgh (Fetzner 2012). A simple results chain model (Margoluis and Salafsky 1998; Foundations of Success 2009) for assessing northern red-bellied cooter headstarting effectiveness was also developed. Another more complex, multiple (parallel) conservation action results chain model for Plymouth Gentian, another indicator of coastal plain pond health (ecological integrity) has also been developed to help assess effectiveness of conservation actions. Service conservation partners continue constructing and using new results chain models that can illuminate the complexities in effecting conservation to managers, policy makers, regulators, and concerned citizens. Constructing and using results chains like these can illuminate the complexities in effecting conservation to managers, policy makers, regulators, and concerned citizens.

Natural Heritage *BioMap2*

The NHESP and The Nature Conservancy's (TNC) Massachusetts Program developed *BioMap2* (Woolsey et al. 2010), an enhanced and comprehensive biodiversity conservation plan for Massachusetts that updates and broadens the biological and conceptual scope of the original *BioMap* report published in 2001. *BioMap2* is "designed to guide strategic biodiversity conservation in Massachusetts over the next decade by focusing land protection and stewardship on the areas that are most critical for ensuring the long-term persistence of rare and other native species and their habitats, exemplary natural communities, and a diversity of ecosystems." *BioMap2* builds on the original *BioMap*, *Living Waters*, and the Massachusetts SWAP to prioritize and guide biodiversity conservation in Massachusetts in the context of continued development and the anticipated effects of climate change. It includes the latest survey information and spatial analyses, and identifies the areas of highest conservation value for a range of biodiversity elements.

BioMap2 identifies Core Habitat, key areas that are critical for the long-term persistence of rare species and other Species of Conservation Concern, as well as a wide diversity of natural communities and intact ecosystems across the State. Massasoit NWR includes the following priority natural communities: coastal plain pondshore, and pitch pine-scrub oak community. Additionally, to further focus biodiversity protection and habitat management within Massachusetts, key sites were identified based on the following criteria:

- Sites with a concentration of co-occurring rare species (5-or-more-species hotspot) listed under the Massachusetts Endangered Species Act (MESA).
- Sites with the best quality occurrences of high-priority species or natural communities (e.g., globally rare species).
- Multiple, co-occurring, landscape-level resources, as identified by *BioMap2*.
- Multiple rare species occurrences. Starting with each 5-or-more-species hotspot, the contiguous species-specific habitat areas for the MESA-listed species in the hotspot were chosen and merged with the hotspot itself.
- Tier 1 MESA species and natural communities.
- Multiple, co-occurring, landscape-level resources.

The MSSF and its surrounding landscape, including Massasoit NWR, was identified as a Key Site for focusing biodiversity conservation and habitat management actions by the Commonwealth of Massachusetts and its conservation partners. The *BioMap2* interactive map and *Summary Report* can be viewed at: *http://www.mass.gov/eea/docs/dfg/nhesp/land-protection-and-management/biomap2-summary-report.pdf* (accessed October 2015).

Plymouth Redbelly Turtle/ Northern Red-bellied Cooter *(Pseudemys rubriventris)* Recovery Plans, Reviews, and Evaluations

The Plymouth redbelly turtle (now known as the northern red-bellied cooter) was listed on the federally endangered species list in 1980. The initial recovery plan for this species was completed in 1981 and updated and revised in 1985. In 1994, the Service's recovery plan was again revised, including an updated assessment of the species status and a discussion on the revision to a subspecific taxonomy of *Pseudemys rubriventris*. The *Revised Recovery Plan for the Plymouth Redbelly Turtle* reports on recovery progress to date and completion of various tasks specified in earlier versions of the recovery plan for this endangered species (USFWS 1981, 1985). It also delineates further actions needed to protect and recover the Plymouth redbelly turtle. This plan may be viewed online at: *http://ecos.fws.gov/docs/recovery_plan/940506b.pdf* (accessed October 2015). In 2007, the Service published a 5-year review which provides updated information on the biology and habitat of the northern red-bellied cooter, headstart release sites, and the status of this species at the time of the report. *The Northern Red-Bellied Cooter (Pseudemys rubriventris) 5-Year Review: Summary and Evaluation* is available at: *http://www.fws.gov/northeast/EcologicalServices/pdf/endangered/NorthernRedBelliedCooter.pdf* (accessed October 2015). These plans are discussed in more detail in chapters 2 and 3.

Conservation Strategy for the New England Cottontail and the New England Cottontail Species Spotlight Action Plan

The *Conservation Strategy for the New England Cottontail (Sylvilagus transitionalis)* (Fuller and Tur 2012) identifies the threats to the New England cottontail, goals and actions to reduce and mitigate these threats, and measures to monitor the success of the plan. The plan identifies habitat fragmentation and habitat loss, and competition from Eastern cottontail as the major threats to New England cottontail population growth. The species is dependent on early successional habitats, such as old fields, shrub thickets, young regenerating forests, and other shrubby areas. These types of early successional habitats are currently declining throughout New England as they naturally succeed to forest. Human development has also eliminated and fragmented habitat for the New England cottontail. The refuge provides opportunities to create and maintain the early successional habitats that benefit the species, as well as other shrub-dependent wildlife. The Conservation Strategy for the New England cottontail is available online at: *http://www.newenglandcottontail.org/sites/default/files/conservation_strategy_final_12-3-12.pdf* (accessed October 2015).

The *New England Cottontail Species Spotlight Action Plan* (USFWS 2009), a precursor to the Conservation Strategy, identifies the goals, measurements, and actions for the Service and its regional and State partners to address the threats to the New England cottontail. This preliminary report can be viewed online at: *http://newenglandcottontail.org/resource/appendix-g-new-england-cottontail-spotlight-species-action-plan* (accessed October 2015).

Cohesive [Wildland Fire] Strategy—Northeast Region

In the Northeast, to address changing wildland fire challenges, Federal, Tribal, state, local, and private organizations have committed to a cohesive, strategic approach toward effective wildland fire management, mitigation, and response. The *Cohesive Strategy* is a collaborative effort to manage growing wildland fire challenges across all lands regardless of ownership. Additional information on the *Cohesive Strategy* can be found at *http://www.forestsandrangelands.gov/strategy/Regional_Strategy_Committees/Northeast/index.shtml* (accessed October 2015).

Other Information Sources

The plans and resources listed below were also consulted to refine the management objectives and strategies of this CCP.

Continental or National Plans

- *National Audubon Society Watch List* (Butcher et al. 2007); available at: *http://www.audubon.org/sites/default/files/documents/watchlist2007_printable_list_populations.pdf* (accessed October 2015).

- *U.S. Geological Survey National Wetlands Research Center Strategic Plan 2010-2015*; available at: *http://www.nwrc.usgs.gov/about/5-year-plan.htm* (accessed October 2015).

- *State of the Birds 2010 Report on Climate Change* (NABCI 2010; available at: *http://www.stateofthebirds.org/2010/pdf_files/State%20of%20the%20Birds_FINAL.pdf* (accessed October 2015).

State Plans

- *State of the Birds Report-Documenting Changes in Massachusetts' Birdlife (*MassAudubon 2011); available at: *http://www.massaudubon.org/content/download/9510/156446/file/state-of-the-birds-2011-document.pdf* (accessed October 2015).

- *Living Waters Program* (NHESP 2004): available at: *https://ia801609.us.archive.org/0/items/livingwatersguid00mass/livingwatersguid00mass.pdf* (accessed October 2015).

- *Classification of the Natural Communities of Massachusetts. Version 1.3.* (Swain and Kearsley 2011); available at: *http://www.mass.gov/eea/agencies/dfg/dfw/natural-heritage/natural-communities/classification-of-natural-communities.html* (accessed October 2015).

- *Our Irreplaceable Heritage-Protecting Biodiversity in Massachusetts* (Barbour et al. 1998). This document is available for review at the Eastern Massachusetts National Wildlife Refuge Complex headquarters.

Local Plans

- *Resource Management Plan-Myles Standish Unit including Myles Standish State Forest* (Massachusetts Department of Conservation and Recreation (MADCR) 2011); available at: *http://www.mass.gov/eea/docs/dcr/stewardship/rmp/mssf-mtholyoke-wbnerr/rmp-mssf.pdf* (accessed October 2015).

Refuge Establishing Purpose and Land Acquisition History

The refuge was established in 1983 and currently encompasses 209 acres. The official refuge establishment purpose is:

". . . to conserve the federally endangered Plymouth red-bellied turtle, as well as other wildlife and plant species; 16 U.S.C. § 1534" (ESA).

On September 21, 1983, the refuge was established with the purchase of the 184-acre main parcel including Crooked Pond, and shoreline on Gunner's Exchange Pond. A 15-acre parcel was purchased in 2002 and has frontage on Island Pond. In 2006, a 10-acre parcel with shoreline on Hoyt Pond was purchased from TNC with funding from the Land and Water Conservation Fund (LWCF). Table 1-1 summarizes the land acquisition history for the refuge. No additional land can be added to the boundary without undergoing additional analysis and Washington Office approval because the Service has acquired all the land within the refuge's approved acquisition boundary.

Table 1-1. Land Acquisition History for Massasoit NWR.

Refuge Parcel	Acres	Date Acquired	Funds
Crooked Pond	184	1983	ESA
Island Pond with easement	15	2002	ESA
Hoyt Pond	10	2006	LWCF
Total Acres	209		

Refuge Administration

The Refuge Complex has 15 permanent staff, although two positions are currently vacant. Twelve are located at the Refuge Complex headquarters and include: a project leader, a deputy project leader, a wildlife refuge specialist, an administrative support assistant, two wildlife biologists, two park rangers, two Federal wildlife officers, and two maintenance workers. The other three permanent staff are located at Monomoy NWR in Chatham, Massachusetts: a refuge manager, wildlife refuge specialist, and a biologist. Additionally, term and temporary staff, interns, and volunteers work at the Refuge Complex at various times throughout the year.

Refuge Operational Plans ("Stepdown" Plans)

Refuge planning policy lists more than 25 stepdown management plans that may be required on refuges. These plans contain specific strategies and implementation schedules for achieving refuge goals and objectives. Some plans require annual revisions; others require revision every 5 to 10 years. Some require additional NEPA analysis, public involvement, and compatibility determinations before they can be implemented.

This draft CCP/EA incorporates by reference those refuge stepdown plans that are up-to-date. Chapter 3 provides more information about the additional stepdown plans needed for the refuge.

The following stepdown plans are complete, and apply to all eight refuges in the Refuge Complex:

- Avian Influenza Surveillance and Contingency Plan—completed in 2007.

- Chronic Wasting Disease Surveillance and Contingency Plan—completed in 2007.

- Fire Management Plan (FMP)—completed in 2003; will be updated by 2017. See appendix D for the current Fire Management Guidance.
- Hurricane Action Plan—updated annually.
- Continuity of Operations Plan—updated annually.
- Spill Prevention and Counter Measure Plan—updated in 2012.

Additional stepdown plans will be completed following approval of the CCP (see chapter 3).

Eastern Massachusetts Refuge Complex Vision Statement

In 2003, the staff from the Refuge Complex developed the following vision statement as a guide for all refuges within the Refuge Complex.

The Refuge Complex will contribute to the mission of the 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 Refuge 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.

Refuge Vision Statement

The following vision statement was prepared to provide a guiding philosophy and sense of purpose for the CCP effort at the Massasoit NWR:

The pine-oak habitat and coastal plain ponds that comprise Massasoit National Wildlife Refuge are an integral component of the southeast Massachusetts landscape and its biodiversity, and are part of the largest contiguous pitch pine-oak habitat north of the Long Island Sound. This dynamic, fire-dependent ecosystem supports numerous invertebrate and bird species of conservation concern. The kettle-hole ponds in this system also support and contribute to the recovery of the federally endangered northern red-bellied cooter, a geographically distinct population found only in Massachusetts.

Through public and partner engagement, we promote ecologically responsible stewardship of the resources on the refuge and in the larger landscape and foster an appreciation and understanding of the intrinsic value of these resources.

Northern red-bellied cooter

USFWS

Refuge Goals

The following refuge goals were developed after considering the vision statement, the purpose for establishing the refuge, the missions of the Service and the Refuge System, and the mandates, plans, and conservation initiatives previously discussed. These goals are intentionally broad, descriptive statements of purpose. They highlight elements of the vision for the refuge that will be emphasized in its future management. The biological goals take precedence; however, we do not present them in any particular order.

Goal 1: Perpetuate the biological integrity, diversity, and environmental health of the pitch pine-oak forest habitat type and associated coastal plain ponds and wetlands on Massasoit NWR to sustain native wildlife, especially species of conservation concern, such as the federally listed northern red-bellied cooter.

Goal 2: Promote awareness and support for the protection of sensitive resources on Massasoit NWR through community outreach and opportunities for connecting the public to the refuge's natural resources.

Goal 3: Enhance collaborations with Federal and State agencies, conservation organizations, and local communities to promote species and habitat conservation across the pitch pine-oak landscape in southeastern Massachusetts, and to support Massasoit NWR's purpose and the Refuge System and Service missions.

The Comprehensive Conservation Planning Process

Service policy establishes an eight-step CCP planning process that also facilitates compliance with NEPA (Figure 1-1), and is the process followed in developing this draft CCP/EA. For more information on the planning policies, view online at: *http://www.fws.gov/northeast/planning/policy.html (accessed July 2016).*

Since 1983, the focus has been on conserving lands within the approved refuge boundary, managing habitat for such focal species as the northern red-bellied cooter, and establishing relationships with the community and our partners. In 1999, the process described above was initiated to develop a CCP that would encompass all of the refuges in the Refuge Complex. A Notice of Intent (NOI) was published in the *Federal Register*. By 2001, a determination was made that writing a plan for eight refuges was too cumbersome, and the decision was made to focus on CCPs for the three northernmost refuges in the Refuge Complex.

After finishing three Refuge Complex CCPs and initiating three others, the Massasoit CCP was re-initiated. In January 2012, a NOI was published in the *Federal Register* announcing the start of this CCP process for Massasoit NWR.

A core team was convened in March 2012 consisting of refuge staff and representatives from MassWildlife, including the NHESP. The Wampanoag Tribe of Gay Head (Aquinnah) and the Mashpee Wampanoag Tribe were invited to join the core team as well. The core team initiated "Step A: Preplanning" with discussions on management issues, drafting of a vision statement and tentative goals, and compilation of a project mailing list of known stakeholders, interested individuals, organizations, and agencies."

In April 2012, the public was engaged during "Step B: Initiate Public Involvement and Scoping," by distributing a planning update newsletter to approximately 100 individuals, organizations, and agencies, announcing the beginning of the planning process and the upcoming public meeting in April 2012. The meeting was advertised in local papers, posted on the refuge's Website, and advertised through local partners' networks.

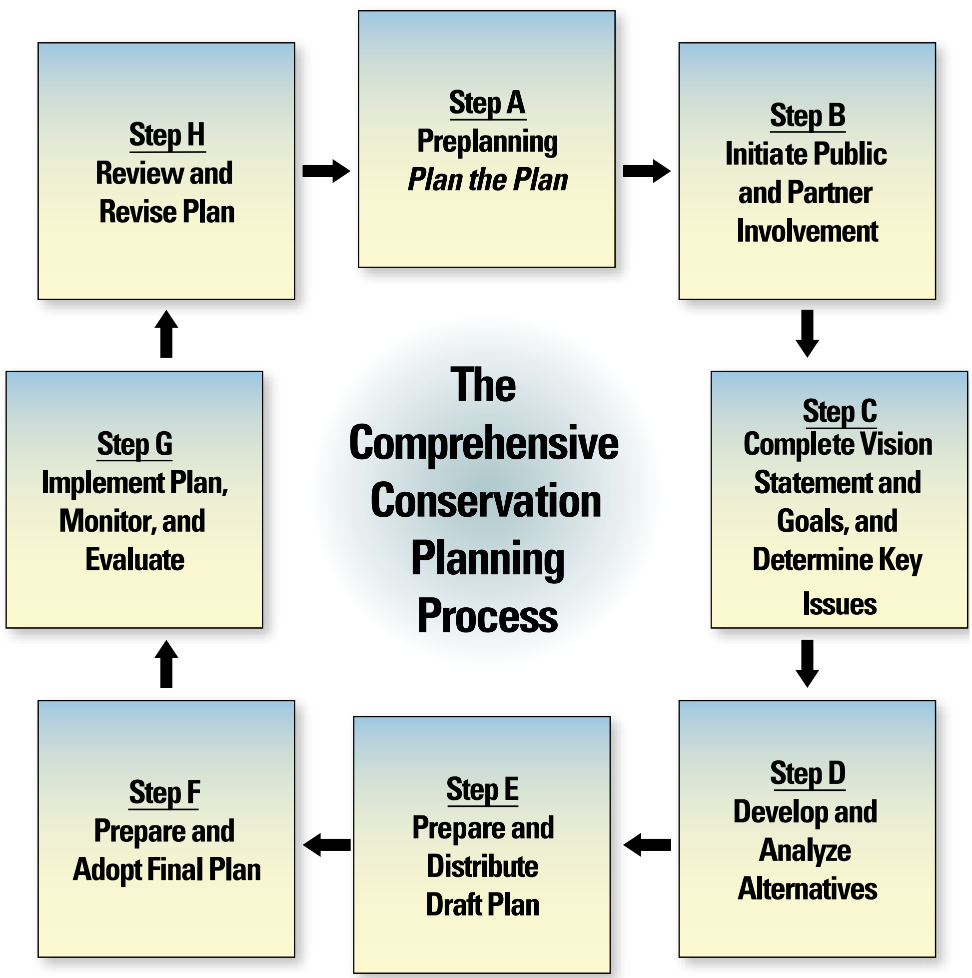
Early in April 2012, stakeholder and public scoping meetings were held in Plymouth, Massachusetts, to discuss previously identified public issues and concerns, determine whether new issues existed or previously identified issues had changed, share the draft vision statement and tentative goals, describe the planning process, and explain how people could become involved and stay informed about the process. Those meetings helped refine the partner and public concerns that would need to be addressed in the planning process. A public meeting was held that was attended by 11 members of the public. This meeting was followed by a comment period where public and partner issues and concerns were voiced through emails, letters, and comment form submissions.

The next planning team meeting was held in June 2012 where "Step C: Review Vision Statement, Goals, and Identify Significant Issues" and "Step D: Develop and Analyze Alternatives" were addressed and key issues were identified. As a result, two preliminary management alternatives were drafted along with identified strategies under each alternative.

The core team continued to meet in August 2012 and November 2012 to further develop the objectives and strategies for each alternative. Work on the draft CCP/EA continued at a slow pace while CCPs were completed for Nomans Land Island, Nantucket, and Monomoy refuges.

This draft CCP/EA represents "Step E: Prepare Draft Plan and NEPA document." A Notice of Availability (NOA) will be published in the *Federal Register* announcing release of this draft for a 60-day period of public review and comment. During the comment period, public meetings will be held and comments will also continue to be received by regular and electronic mail. After the comment period ends, all comments received will be reviewed and summarized, and responses developed and published in an appendix to the final CCP.

Figure 1-1. The Comprehensive Conservation Planning Process.



The final CCP will be submitted to the Regional Director for approval, who will determine whether it warrants a Finding of No Significant Impact (FONSI), and also if its analyses are adequate to issue a decision at that same time. The Regional Director may require a revision of the EA or may determine that there are potentially significant impacts and require preparation of an environmental impact statement. The Regional Director's final decision will be announced as a NOA in the *Federal Register*, wherein the public will be informed of the availability of the final CCP. This announcement will complete "Step F: Prepare and Adopt a Final Plan."

On approval of the Regional Director, "Step G: Implement Plan, Monitor and Evaluate" can begin. As part of "Step H: Review and Revise Plan," the final CCP will be modified and revised as warranted following the procedures in Service policy (602 FW 1, 3, and 4) and NEPA requirements. Minor revisions that meet the criteria for categorical exclusions (550 FW 3.3C) will require only an environmental action memorandum. As stipulated by the Improvement Act and Service policy, the CCP will be reviewed and revised every 15 years.

Wilderness Review

The purpose of a wilderness review is to identify and recommend for congressional designation Refuge System lands and waters that merit inclusion in the NWPS. Wilderness reviews (610 FW) are a required element of CCPs and conducted in accordance with the refuge planning process outlined in 602 FW 1 and FW 3, including public involvement and NEPA compliance. The planning team initiated a Wilderness Review, as required by refuge planning policy, to determine if any portions of Massasoit NWR warranted a proposal for designation as wilderness.

There are three phases to the wilderness review process: (1) inventory, (2) study, and (3) recommendation. Lands and waters that meet the minimum criteria for wilderness are identified in the inventory phase and are called wilderness study areas (WSAs). In the study phase, a range of management alternatives are evaluated to determine if a WSA is suitable for wilderness designation or management under an alternate set of goals and objectives that do not include wilderness designation.

The recommendation phase consists of forwarding or reporting the suitable recommendations from the Director, through the Secretary, and the President to Congress in a wilderness study report. The wilderness study report is prepared after a final CCP has been approved.

Areas recommended for designation are managed to maintain wilderness character in accordance with management goals, objectives, and strategies outlined in the final CCP until Congress makes a decision or the CCP is amended to modify or remove the wilderness proposal.

Appendix C summarizes the inventory phase of our wilderness review for Massasoit NWR. We determined that no portion of Massasoit NWR meets the eligibility criteria for further detailed study as a WSA as defined by the Wilderness Act.

Issues, Concerns, and Opportunities

An "issue" is defined as "any unsettled matter requiring a management decision." An issue can be an "initiative, opportunity, resource management problem, threat to a resource, conflict in use, or a public concern" (602 FW3). Issues arise from many sources, including Service staff and other Service programs, State agencies, other Federal agencies, partners, neighbors, user groups, or Congress. One of the distinctions among the proposed management alternatives is how each addresses those issues. The following summary provides a context for the issues that arose during the public and stakeholder scoping process.

Habitat and Species Management

The primary purpose of national wildlife refuges is the conservation of wildlife and habitats. Based on the establishing purpose for this refuge, and the discussions that took place up to the time of its establishment, the primary justifications for creating the refuge was the conservation of the federally endangered northern red-bellied cooter and other wildlife and plant species of conservation concern.

This plan addresses important issues including the best approaches to protect, restore, and coordinate the management of habitat and wildlife resources, including the cooter, on the refuge and surrounding area. The following key issues and concerns were raised regarding habitat and species management, and are addressed in the plan:

- What are the current population numbers for the northern red-bellied cooter and how effective are the efforts in recovery of the species?
- How will habitat for the northern red-bellied cooter be effectively managed while considering the management for a diversity of wildlife and plant species?
- How will protection and management of State-listed endangered and threatened species including rare moths and plants be supported?
- What opportunities are there for the protection of the New England cottontail?
- What role will prescribed burns play in habitat management?
- How will inventory and monitoring of the wildlife resources on the refuge be accomplished through the use of Service personnel, volunteers, or partners?
- Where appropriate, should the Service contribute to the inventory and monitoring of wildlife resources on conservation lands near the refuge?
- How will a healthy refuge ecosystem and the aquifer within which the refuge exists be maintained?
- Will the Service continue prescribed burning and mechanical clearing to reduce wildland fire risk?

Public Access

Refuges remain closed to the public for all uses until officially “opened” through a formal, public compatibility process. Eventually, most refuges are opened to some type of public use, but some may remain closed to maintain the conservation purpose of the refuge or to protect public safety. Massasoit NWR has been closed to the public since it was established in order to reduce disturbance to the northern red-bellied cooter. Providing compatible public use is a priority in the Improvement Act; thus, our challenge is to determine what, if any, types and amount of public use can be sustained at this small refuge.

During the partner and public scoping, the following key issues or concerns regarding public access were expressed:

- What, if any, public access will be provided given a strongly divided public reaction to opening the refuge?

- What public uses will be provided on the refuge including requested recreational uses such as walking, wildlife observation, photography, hunting, and horseback riding? Will hunting be allowed on the refuge for recreational purposes and for assisting in the management of eastern Massachusetts deer population?

- How will unauthorized use of the refuge, including off road vehicles (ORVs), fishing and swimming in Crooked Pond, dog walking, horseback riding, and other uses be enforced?

- What potential impacts are there to the northern red-bellied cooter from any public use?

- How will protection of the endangered northern red-bellied cooter be ensured if the refuge is open to public access?

- Should the refuge remain closed to public access to protect the final remaining contiguous area of the pitch pine-scrub oak habitat?

Education and Awareness

A common concern expressed by the public and stakeholders was promoting increased public awareness of the refuge, and the following are key issues or concerns expressed about education and awareness:

- What kinds of signage and interpretation can be used to increase public understanding of the resources, especially for the protection of the northern red-bellied cooter, consequences of misuse of sensitive areas on the refuge, and limitations on public access?

- What role can the Service play in promoting environmental education through a partnership with the MSSF and its associated Friends Group and the nature center that is planned on State Forest land?

- How will the educational needs of children be addressed to increase their connectivity to nature and their knowledge and awareness of the significance of the resources on the refuge?

- How do we improve outreach for the refuge to the public and potential partners and stakeholders?

Partnerships

As a relatively small refuge within the 17,000-acre Refuge Complex, it is important for the Service to utilize partnerships to the fullest extent to meet the establishing purpose of the refuge and its associated goals of the CCP. Both the public and stakeholders expressed this idea, and the following are key issues or concerns that arose about partnerships:

- How will the Service partner with the MSSF to achieve the habitat management, public use, and environmental education goals of the refuge?

- What partners will the Service coordinate with to expand the restoration, protection, and conservation efforts of the northern red-bellied cooter population in the region?

- How will volunteers, including the Friends of Myles Standish State Forest and experts on species and habitats, be utilized to achieve the refuge goals?

Land Protection

- Land protection to benefit both the management of northern red-bellied cooter populations and other wildlife and plant species was strongly supported during the scoping process.

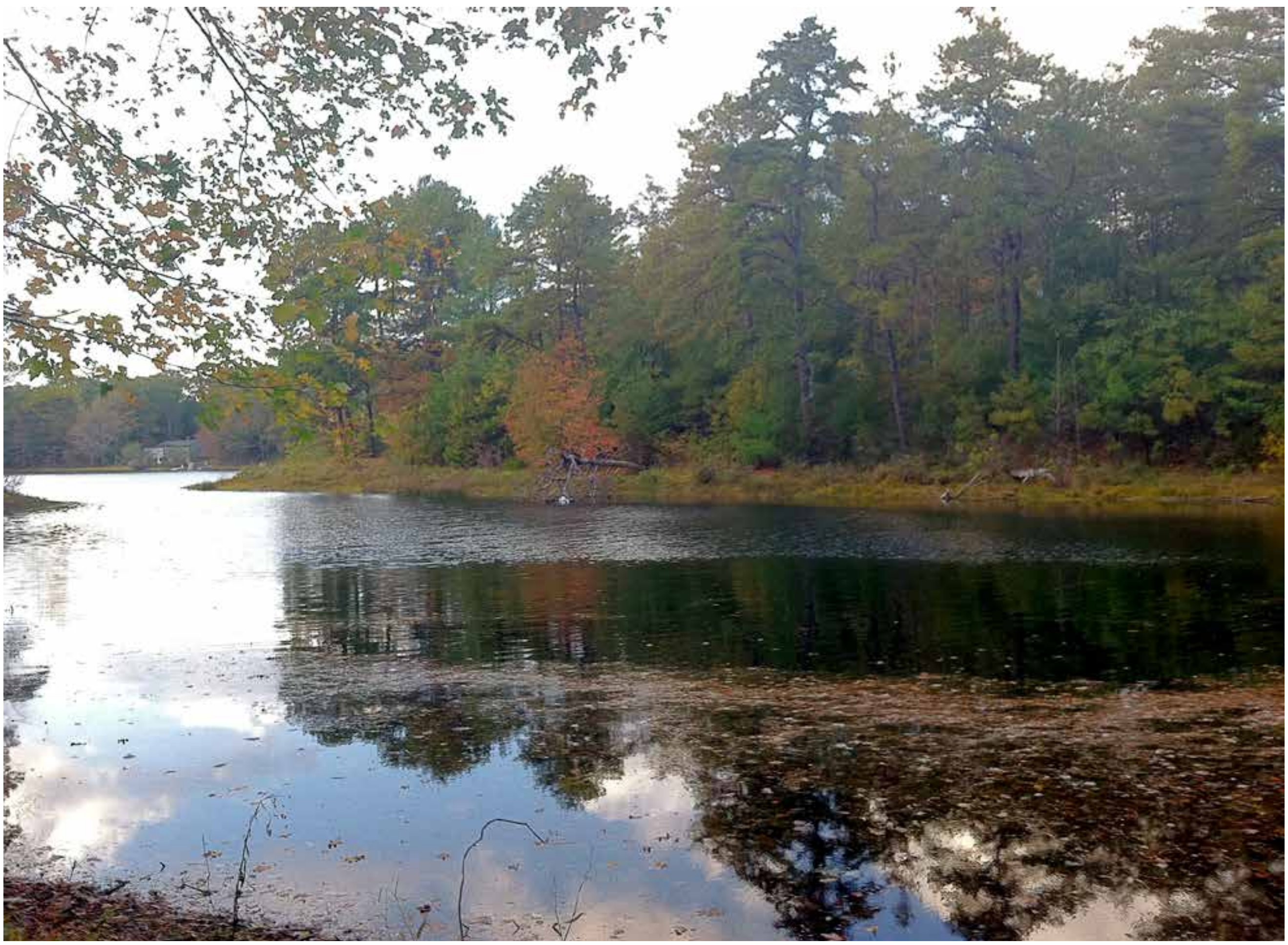
- The following are key issues and concerns that were presented regarding land protection:

- What strategic approach will the Service take in land protection to potentially expand the refuge boundaries and expand the efforts toward the northern red-bellied cooter recovery?

- Is there a potential for partnerships with the municipalities, conservation organizations, State, or Tribal government to protect additional lands and share fiscal resources in a strategic manner that achieves the purpose of the refuge?

- What partner resources will be used to promote awareness and land protection in the region?

Island Pond shoreline on Massasoit National Wildlife Refuge



USFWS


Bill Thompson

Eastern towhee

Affected Environment

- Introduction
- Physical Environment
- Geographical Setting and Landscape Context
- Major Historical Influences Shaping Landscape Vegetation
- Land Use History
- Current Conditions
- Refuge Natural Resources
- Climate Change
- Refuge Access and Public Uses
- Refuge Archeological, Historical, or Cultural Resources
- Regional Socioeconomic Setting
- Environmental Justice
- Refuge Administration
- Partnerships and Community Outreach

Introduction

This chapter describes the physical, biological, cultural, and socioeconomic environment of the refuge. In this chapter we describe the regional and refuge settings, current refuge administration, refuge resources, and programs.

Physical Environment

Setting

As previously noted in chapter 1, Massasoit NWR encompasses 209 acres and is comprised of three parcels briefly described below. The refuge has fully met its land acquisition goal within the current acquisition boundary. Under Federal regulations, refuges can acquire lands up to 1 mile from the refuge and up to 10 percent (20.9 acres) of the refuge's original acquisition boundary. The refuge has already maximized this option.

While small, Massasoit NWR is part of the largest contiguous pitch pine-scrub oak habitat north of the Long Island Sound (map 2-1), and is an integral component of the landscape's biodiversity. Together, the three parcels provide habitat that supports a diversity of native flora and fauna including the northern red-bellied cooter, neo-tropical migratory songbirds, rare moths and other native pollinators, and rare plants.

Crooked Pond Parcel

The Crooked Pond parcel is 184 acres and is the original land that was designated as Massasoit NWR in 1983. It is predominantly upland forest consisting of closed canopy mixed oaks and pine, with mixed oaks and pitch pine on the southern part of the parcel and mixed oaks and white pine dominated stands on the eastern part (AECOM 2010). The understory is fairly continuous and is mostly huckleberry and blueberry (both lowbush and highbush). This parcel also includes a 10-acre kettle pond known as Crooked Pond, and two smaller ponds, as well as about 591 feet of shoreline along Gunner's Exchange Pond. This original refuge parcel also abuts the MSSF which lies generally south and west of this refuge parcel and provides principal access routes to this and the Hoyt Pond (see below) parcel. The MSSF is Massachusetts' second largest State forest. Immediately to the north is a residential subdivision situated between this parcel and the Island Pond parcel. A powerline right-of-way (ROW), oriented northeast to southwest, transects the easternmost portion of the Crooked Pond parcel.

Island Pond Parcel

In 2002, an additional 15 acres (including easement) was added to Massasoit NWR on the east side of Island Pond, about 0.62 miles north of the Crooked Pond parcel. This parcel is also predominantly upland forest habitat (mostly white pine with some oak) and also includes about 984 feet of shoreline on the east side of Island Pond, including a small cove. The parcel fronts to the east on Long Pond Road, and its south boundary abuts the same residential subdivision described above for the Crooked Pond parcel.

Hoyt Pond Parcel

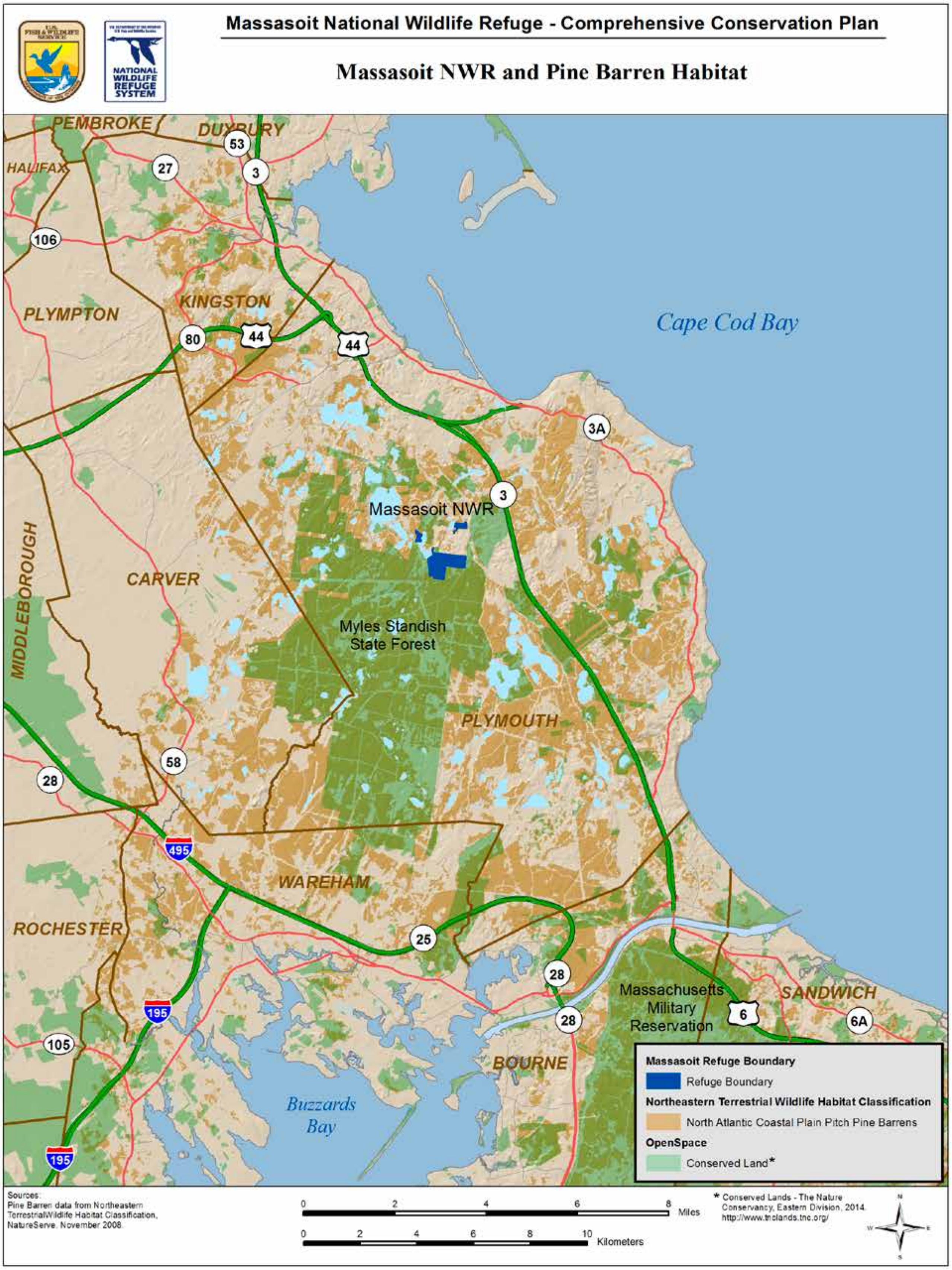
In 2006, an additional 10 acres was added to Massasoit NWR on the west side of Hoyt Pond, about one-half mile northwest of the original designation. This parcel is also predominantly upland habitat (mostly white pine with some oak) and also includes about 1,148 feet of shoreline on the west side of Hoyt Pond, which is connected to Gunner's Exchange Pond at times of high water levels. This parcel fronts to the west on Snake Hill Road, which serves as the primary overland access route to the parcel.

Geographical Setting and Landscape Context

Watershed

The refuge falls within the Plymouth watersheds, part of the regional South Coastal watershed, one of 11 eastern Massachusetts discharging directly into the Atlantic Ocean. The Plymouth watersheds consist of 12 individual watersheds

Map 2-1 Massasoit National Wildlife Refuge and Pine Barren Habitat



that contain 343 ponds including 32 globally rare coastal plain ponds. The Eel River is the most significant river system in the Plymouth area (map 2-2), at approximately 15.4 square miles. Within the Eel River watershed there are shallow glacially formed coastal plain ponds fed primarily by groundwater flowing through the Plymouth-Carver aquifer. The Plymouth-Carver aquifer is the second largest aquifer in Massachusetts, spanning nearly 200 square miles and storing more than 500 billion gallons of water (Town of Plymouth 2009).

The surface water bodies above this aquifer are largely fed by the aquifer itself, rather than from runoff. The Plymouth-Carver aquifer is designated as a sole-source aquifer by the U.S. Environmental Protection Agency (USEPA), to protect the water supply (map 2-3 and *http://www3.epa.gov/region1/eco/drinkwater/plymcarv.html*; accessed October 2015). The surficial geology in the watershed consists of unconsolidated stratified glacial materials deposited during the last glacial retreat approximately 15,000 years ago. Deposits of fine-to-coarse sand and gravel with occasional, limited lenses of silts and clay underlie the Plymouth watersheds. The lower portion of these stratified materials is saturated with water fed by direct infiltration of precipitation. Groundwater table elevations range from sea level to 125 feet above sea level, with the saturated thickness of the aquifer greater than 160 feet in many areas (Watershed Action Alliance 2006).

Geomorphic Region

Geomorphic regions or “physiographic provinces” are broad-scale subdivisions based on terrain texture, rock type, and geologic structure and history. Massasoit NWR lies in the Sea Island Section of the Atlantic Coastal Plain delineated by the USGS (2003). The southeastern part of Massachusetts marks the southern limit of the last glacial maximum (15,000 to 20,000 years ago), where terminal moraines of clay-rich, poorly sorted glacial materials were deposited.

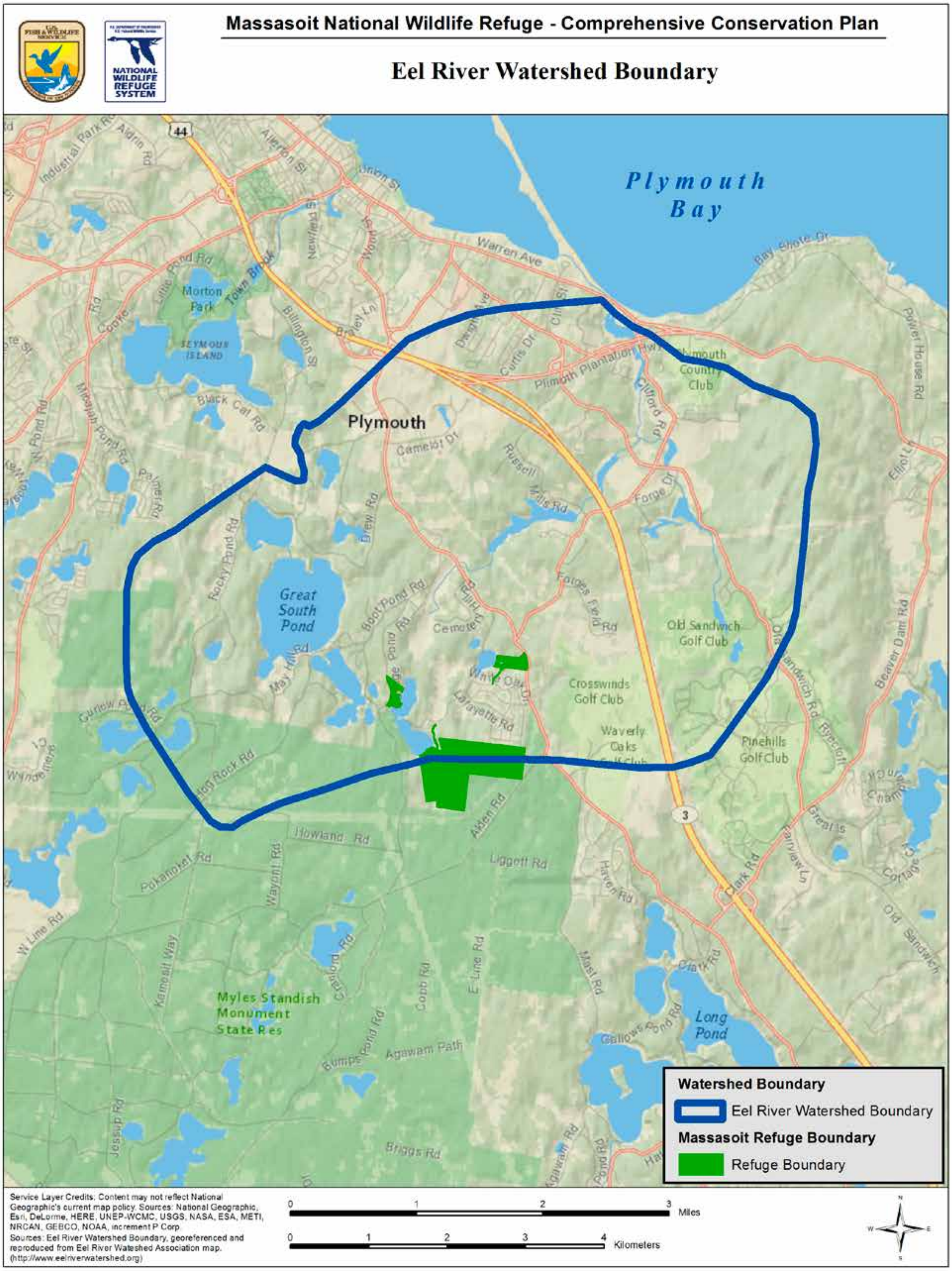
Biophysical Ecoregion 2-3—North Atlantic Coast

TNC has divided the continental United States into 63 ecoregions which are large geographic areas that share similar geologic, topographic, ecological, and climatic characteristics. These ecoregions are modified from the U.S. Forest Service (USFS) “Bailey System” (Bailey 1995). TNC has developed Ecoregional Conservation Plans that identify conservation targets and prioritize conservation actions for each ecoregion.

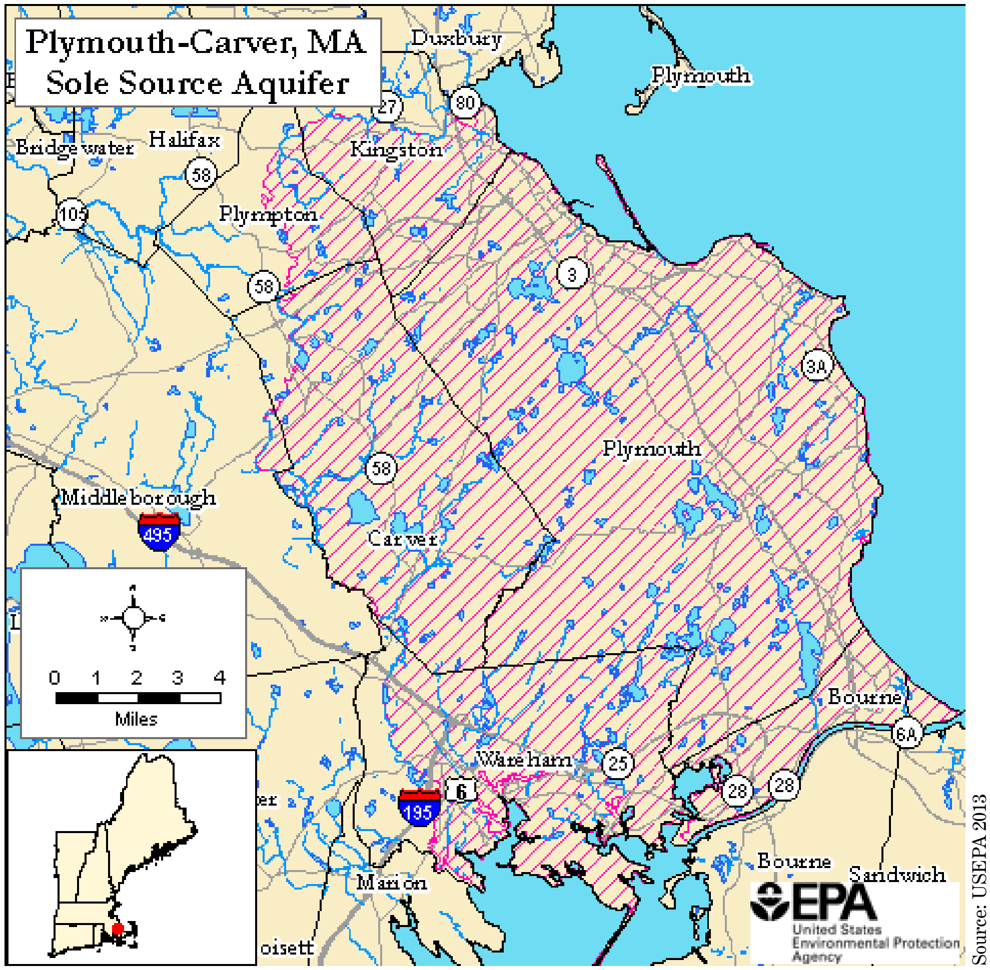
Massasoit NWR is in the North Atlantic Coast ecoregion as described by TNC (map 1-4). This ecoregion extends from Pemaquid Point in Maine south to Delaware Bay. Flat topography, low elevations (less than 600 feet), scattered moraines, large rivers draining into estuaries and bays, and a mild, humid climate characterize this region. Rocky coasts dominate the shore in the north, grading into salt marsh communities to the south. The once extensive forest graded from white pine-oak-hemlock forest in the north, to dry oak-heath forests, to mesic coastal oak forests in the south. Wetlands, beaver meadows, pine barren, and heathlands were embedded in this forested landscape. Hundreds of years of land clearing, agriculture, and widespread development have fragmented the landscape and eliminated large areas of forest. Smaller ecological systems remain, including barrier beaches and dunes, salt marshes, and freshwater wetlands (TNC 2006).

Atlantic Flyway

Massasoit NWR is within the Atlantic Flyway (map 1-4).Waterfowl follow distinct, traditional migration corridors, or flyways, in their annual travels between breeding and wintering areas. Flyways have been used for many years in North America as the unit for managing continental waterfowl populations, because they allow land managers to link efforts to conserve migratory bird species and their habitats on breeding, migration, and wintering grounds. The Atlantic Flyway Council is composed of the states of Connecticut, Delaware, *Map 2-2. Eel River Watershed Boundary*



Map 2-3. Plymouth-Carver Sole Source Aquifer



Florida, Georgia, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, North Carolina, Pennsylvania, Rhode Island, South Carolina, Vermont, Virginia, and West Virginia; the Canadian territory of Nunavut and provinces of Newfoundland, New Brunswick, Nova Scotia, Ontario, Prince Edward Island, and Quebec; plus the U.S. territories of Puerto Rico and U.S. Virgin Islands. The Atlantic Flyway Council contains representatives (usually administrators) from all the agencies with management responsibility for migratory bird resources in the Flyway.

The Council determines actions required for sound migratory game bird management and makes recommendations to the Service. The ACJV (refer to chapter 1—*North American Waterfowl Management Plan* and *Atlantic Coast Joint Venture Implementation Plan*) area includes the entire U.S. Atlantic Coast lying completely within the Atlantic Flyway. In this large area, the ACJV partners work together to assess the status, trends, and needs of bird populations and their habitats. The partners use this information to help guide the distribution of resources to the needs and issues of highest priority.

Landscape Conservation Cooperatives

The refuge is located in the North Atlantic LCC which combines BCRs 14 (Northern Atlantic Forest) and 30 (New England/Mid-Atlantic Coast), and contains 12 out of 13 northeast states as well as the District of Columbia (map 1-4). It includes a diverse array of ecosystems; from high elevation spruce-fir forests to coastal islands (map 1-4). Many conserved lands exist in southeastern Massachusetts near Massasoit NWR with which the refuge can partner. For more information on the North Atlantic LCC, go to: *http://www.northatlanticlcc.org/* (accessed October 2015).

Major Historical Influences Shaping Landscape Vegetation

Describing the historic natural vegetation types, understanding how they were distributed, and what ecological processes influenced them prior to major, human-induced disturbance can help us evaluate future management options and environmental impacts. However, many ecologists caution against selecting one point in time, and instead recommend evaluating the "historical range of variation" for each habitat type.

The following, briefly summarizes major historic influences on natural vegetation patterns variation across the landscape.

Glaciation

Massachusetts, like all of New England, was covered by the Laurentide ice sheet during the last glacial maximum, approximately 21,000 to 18,000 years before present (BP). The ice sheet lobes occupied large basins in the bedrock surface. The glacier reached its southernmost extent at the islands of Nantucket and Martha's Vineyard, marked by the deposition of terminal moraines on these islands (Motzkin and Foster 2002).

During the last glacial maximum, much of what is now the submerged continental shelf along the Massachusetts coast was exposed, with much of the world's water locked up in continental ice sheets. Estimated worldwide sea levels were 279 to 427 feet lower than today (Pielou 1991). By approximately 18,000 BP, the ice sheet began retreating with a warming climate, and by about 14,000 to 15,000 BP reached what is now the northern border of Massachusetts. As ice sheets retreated, sea levels gradually rose and the earth's crust slowly rebounded from the heavy weight of ice, but not as fast as sea levels were rising. This caused flooding along the northern New England coast as far south as present-day Boston (Jorgensen 1971). By about 12,000 BP the coastline between the Bay of Fundy and Cape Cod was much as it is today (Pielou 1991).

The advance and subsequent retreat of the glacier and changing climate had a profound impact on the local biota. With the glacial advance, many northern species were locally displaced and subsisted in southern areas of unaltered habitat. The period of glacial recession was one of highly fluctuating climatic factors (temperature, precipitation, humidity, and atmospheric carbon dioxide). The glacier directly altered the landscape as it retreated by depositing till, boulders, and creating kettle hole ponds. Kettle hole ponds formed when blocks of ice breaking off from a receding glacier became imbedded in or covered by outwash materials (till or sediments deposited from meltwater streams). Upon the melting of the ice, depressions remained that filled with freshwater as ground water levels rose. Typically, kettle ponds lack a surface water inlet or outlet and receive water from precipitation, groundwater from the aquifer below, or a combination of both. The pond levels generally fluctuate in response to the seasonal rise and fall of the water table (USGS 2013). Lakes were also forming as a result of the voluminous meltwater pouring off the retreating glacial front (Prentice et al. 1991, Jackson et al. 2000, Williams 2002). Combined, these factors made for ever-changing conditions as plant and wildlife species recolonized the area.

As the climate warmed and ice retreated northward, continual weathering and erosion of rock released nutrients and created new soils for plant recolonization. Tundra-like vegetation dominated the landscape just south of the glacier, though there may have been places where the ice abutted spruce forests (Pielou 1991, Jackson et al. 2000). The landscape was dominated by sedges and dwarf shrubs for several thousand years. As the climate warmed, these plants and associated animals followed the glacier as it continued to recede (Davis 1983, Marchand 1987).

Regional temperature and moisture levels primarily determined the variability in the post-glacial plant biogeography in southern New England. By 14,600 BP spruce predominated New England landscapes until 11,600 BP when white pine became dominant during a drier, warmer climatic period. By about 8,200 BP, hemlock, beech, and birch had replaced white pine, following a concurrent rise in moisture. Hemlock, a more mesic species, experienced a population crash around 5,400 BP originally attributed to the first-ever recorded occurrence of a pathogen. However, more recent evidence indicates that a drier microclimate may have also been a factor. Deciduous species such as hickory and chestnut were much slower to reach New England, about 6,000 BP and 3,000 BP respectively, likely due to regionally cooler temperatures and lower moisture levels than today (Shuman et al. 2004, Shuman et al. 2005).

The spruce parklands and grassy savanna habitats supported and were influenced by large mammals, including mastodons that disappeared quickly as the glacier receded and humans advanced across the region (Pielou 1991, Askins 2000).

Late Quaternary Water-level Variations and Vegetation History at Crooked Pond

Sediment cores collected along transects in Crooked Pond indicated water level changes between 15,000 BP and the present. The amount of fine-grained, detrital, organic accumulation in the basin suggests low water levels between 11,200 and 8,000 years BP and from 5,300 to 3,200 years BP. This history is consistent with records from the nearby Makepeace Cedar Swamp and other sites in New England and eastern Canada. The similarities in these records indicate that: (1) regional conditions were drier than currently when white pine grew abundantly between 11,200 and 9,500 BP; (2) higher moisture levels existed between 8,000 BP and 5,500 BP as the ice sheet retreated, and; (3) drier conditions possibly contributed to the decline of hemlock at 5,300 BP. Although sensitive to sea level rise, moist climate conditions were the primary reasons for water level rise during the Holocene Period (Shuman et al. 2001) (map 2-4, Figure 2-1; both reprinted from Shuman et al. 2001).

Fire

In contrast to its relatively minor role in the northern forests of Canada and northern New England, fire historically played a major role in shaping the ecosystems of coastal and southern New England, particularly the oak-dominated forests in the south, and the barrens and coastal marsh habitats. Several natural historians have concluded that fires set frequently by native peoples, along with naturally occurring fires, were important ecological factors in New England, especially in oak forests and pine plains (Bromley 1935, Day 1953, Motzkin et al. 1996). In reconstructing pre-European North American fire frequencies[1], Frost (1998) estimated that in PIF Region 9 (previously described in chapter 1) fires occurred approximately every 7 to 12 years in the more fire-prone habitats of the coastal plain, while on plains with hills or low mountains further inland, fire-prone areas burned approximately every 13 to 25 years. In pre-colonial and early colonial periods, the pine barren habitat in Plymouth County was

[1] Frost (1998) used a synthesis of physiographic factors (land surface form and topography), fire compartment size, vegetation records, fire-frequency indicator species, lightning ignition data, composite fire scar chronologies, remnant natural vegetation communities, and published fire history studies.

frequently burned. At that time the region was a mosaic of pitch pine-scrub oak barrens with frequent shrubby openings and grasslands. Pitch pine-scrub oak communities need fire to maintain the community structure and diversity (DeGraaf et al. 2005). The resinous, waxy cutins in the leaves of many of the plant species found in this community are highly flammable and ignite easily during dry periods. Fire-prone areas in New England usually coincide with soils derived from glacial outwash sands and gravels, with fractured or loose rock, or with shallow soils over bedrock (DeGraaf et al. 2005). Davis (1996) reports that fire was the major historic disturbance that shaped the vegetation of coastal Massachusetts, Connecticut, Rhode Island, and New York.

The region has a history of catastrophic wildfires during the 20th century. A 1937 wildfire in the Pine Hills area trapped and killed two firefighters. Humans were considered the cause for that fire as well as additional fires on Island Pond Road and Summer Street in Plymouth. In May of 1957, a wildfire started on the west side of MSSF at Cranberry Road in Carver and swept across what is now Massasoit NWR, jumped Route 3 in Plymouth and, driven by high winds, swept to the coastline at Manomet. This was one of the largest wildfires in the history of this area and burned 15,000 acres, destroyed 6 cottages and forced 150 residents to evacuate. In 1964, a wildfire that started in MSSF under high winds and dry conditions burned over 5,500 acres and destroyed 20 cottages in the area (MADCR 2011). In 1971, a 165-acre fire with 50-foot flames damaged two fire engines and injured seven firefighters. In 1991, a 1,200-acre fire along Route 3 destroyed two cottages and a trailer. And again in 1995, a 95-acre wildfire forced local residents to evacuate the Bourne Road area (Crosby 2001, updated 2007).

Recent improved wildfire protection has resulted in a taller and more closed-canopy pine forest. Pitch pine-scrub oak communities carry one of the highest fuel loads on the North Atlantic Coast (Patterson 1988). Pitch pines have fire resistant bark and serotinous cones, which release stored seeds when subjected to the heat of a surface fire. Taller white oaks and white pines are indications that an area is gradually succeeding towards a closed-canopy forest (NHESP 1990). Natural forest succession proceeded uninterrupted with fire suppression, and this can decrease species diversity. More frequent fires reduce the duff and litter layers and create a more open overstory allowing certain shrubs, grasses, herbs, and forbs with high wildlife value to flourish. Fire suppression can also negatively impact species abundance.

The Service and partners have recently implemented efforts to reduce hazardous fuels within the wildland-urban interface, roughly defined as the zone where natural areas and development meet. The wildland urban interface has gained increasing importance as more Americans build homes in rural settings adjacent to public lands. The Service works closely with neighboring communities to reduce future wildfire risks to homes near national wildlife refuges and other Service lands. Homeowner responsibility for maintaining property according to fire safety standards is essential to effectively protecting communities from catastrophic wildfire (*http://www.fws.gov/fire/living_with_fire/wildland_urban_interface.shtml*; accessed October 2015). Approximately 50 acres of the refuge have been treated with prescribed fires to reduce hazardous fuels (20 of those acres were burned twice since 2007) in the wildland-urban interface (map 2-5). Hazardous fuels were reduced on an additional 12 acres through mechanical treatments along the northern boundary of the Crooked Pond parcel shared with the residential subdivision. Table 2-1 summarizes refuge fuel reduction treatments applied since 2006.

Other Contemporary Influences on Vegetation Patterns

Natural disturbances vary across New England depending on geographic location, forest type, and local conditions. In pre-settlement times coastal regions experienced the highest rates of disturbance because of the prevalence of sandy pine-oak barren, high densities of human (Native American) inhabitants, higher

Map 2-4. Present Bathymetry of Crooked Pond with Transect and Core Sampling Locations

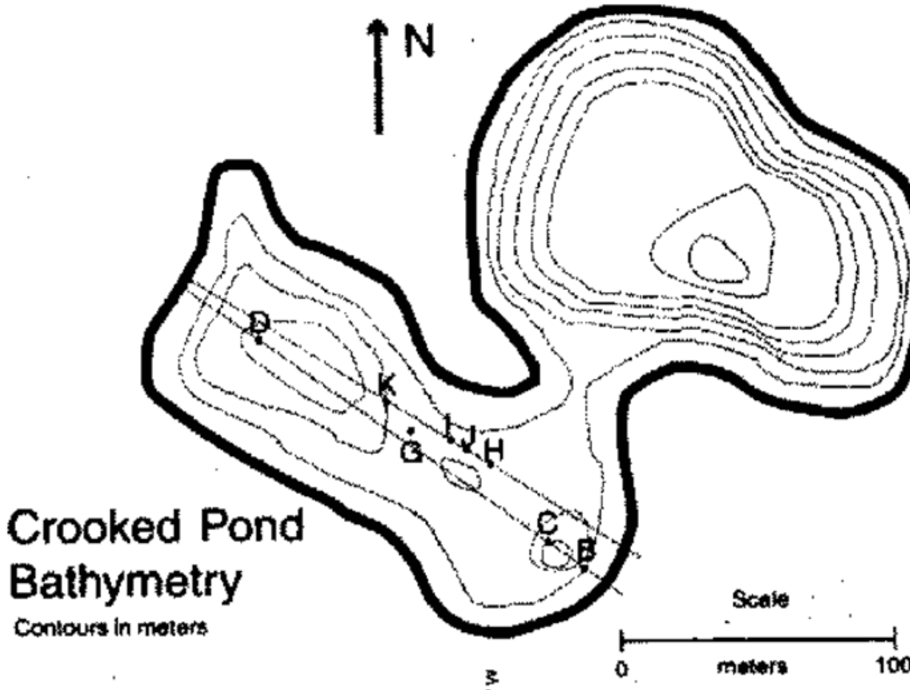
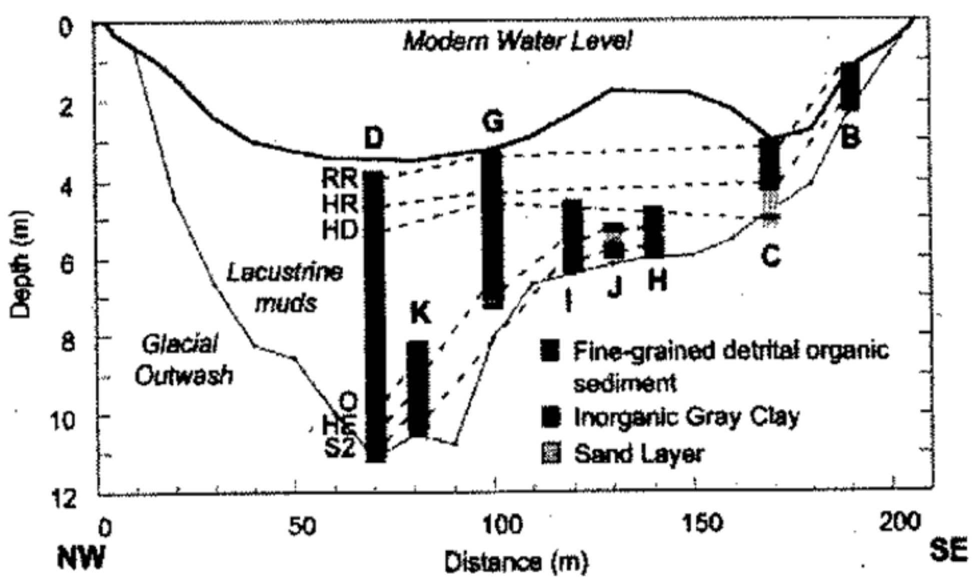


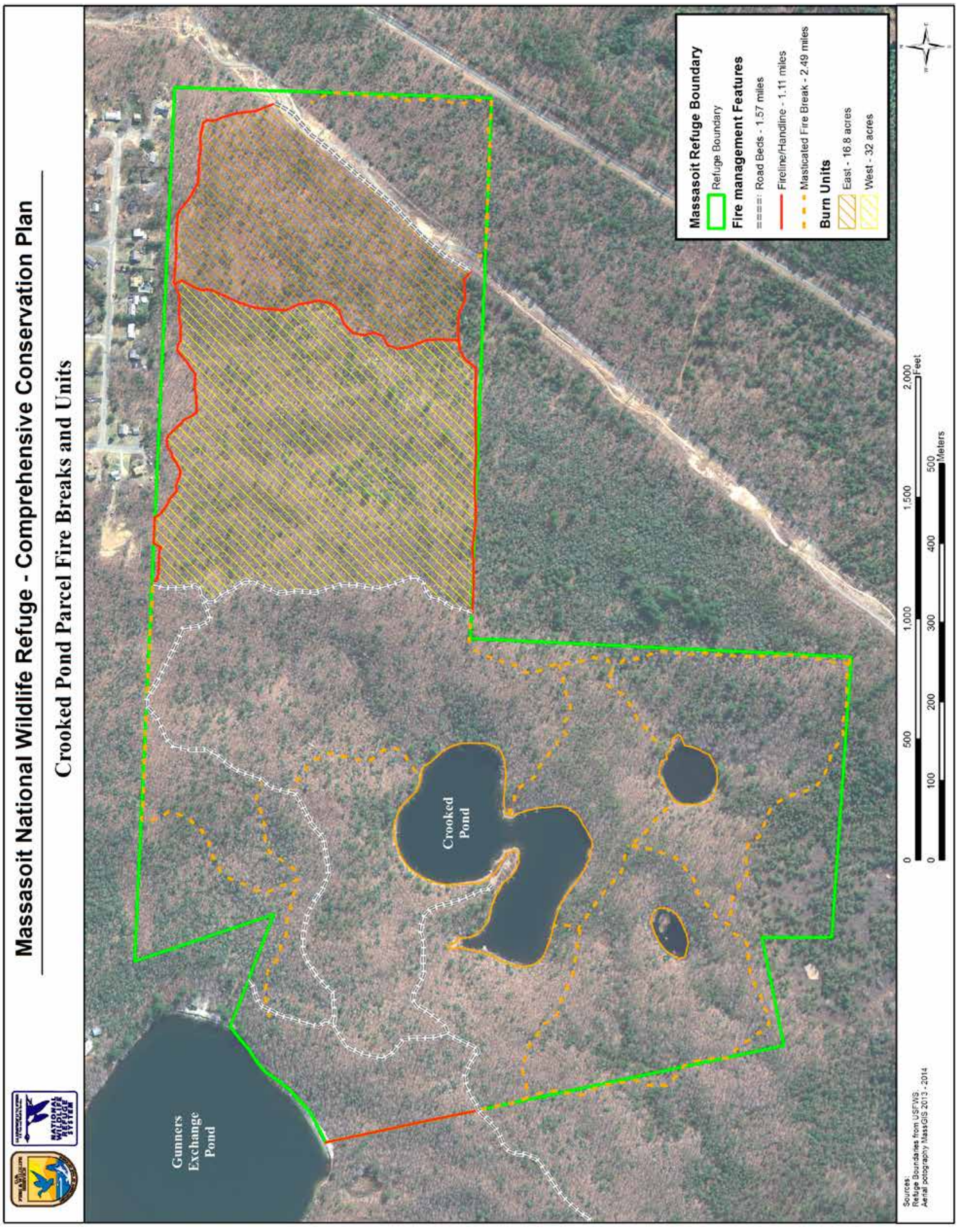
Figure 2-1. Crooked Pond Profile with Core Locations, Sediment Stratigraphy, and Pollen Stratigraphic Correlations.



The dashed lines connect the positions of the second peak in spruce pollen abundance (S2), the peak in heath pollen abundance (HE), the point at which oak pollen first rises above 30 percent (O), the hemlock decline (HD), the late-Holocene hemlock rise (HR), and the ragweed rise (RR). The core stratigraphies are generalized to show three types of sediment: detrital organic sediments, inorganic clay, and sands.

Source: reprinted from Shuman et al. 2001

Map 2-5. Crooked Pond Parcel Fire Breaks and Prescribed Burn Units



frequencies and severity of hurricane and coastal storm impacts, and longer snow-free periods. These disturbance regimes may have maintained about 1 to 3 percent of the inland northern hardwood forests, more than 10 percent of the coastal pine-oak barrens, and perhaps 7 percent of spruce swamps and spruce flats in early successional habitat (Lorimer and White 2003). Native insects and disease, ice storms, droughts, floods, landslides, and avalanches have caused minor and major disturbances across New England. Lorimer and White (2003) depict hurricane frequencies as varying from 85 years in southeastern New England, to 150 years throughout central Massachusetts and the southeast corner of New Hampshire, to 380 years or more in northern New England. Lorimer (1977) estimated catastrophic disturbances from fire and wind-throw at intervals of 800 and 1,150 years, respectively.

Land Use History

Pre-Contact Period-Early Native American Influences

Human occupation of the area around Massasoit NWR began with the arrival of Paleo-Indian hunter-gatherers around 11,000 years ago. Several Paleo-Indian sites are known in the local area, representing the three main periods within the Paleo-Indian era, although none have been found within the refuge boundaries. The well-drained sandy soils would have supported a diverse array of plant and animal food resources typically found along outwash plains and near lakes during the Pleistocene-Holocene transition.

Paleo-Indian people were settling into a developing environment with oak and spruce reemerging as dominant tree species. Oaks provided food for deer and other mast-eating species that could be hunted. During the Early Archaic (9,000 to 7,000 BP), Paleo-Indian people lived in small, widely distributed bands. Although no Early Archaic sites have been found on the refuge, the environment would have been conducive to human settlement during this period. Evidence indicates native people living near what is now Massasoit NWR constructed snail-shaped winter houses as shelter from the cold winter winds. Archeological data indicate that during the summer months, indigenous people exploited riverine environments to gather fish, deer, cattails, and Jerusalem artichokes.

Fishing implements began appearing during the Middle Archaic period when people were primarily settled along drainage systems and around lakes. Native inhabitants made extensive use of newly establishing marshy environments along lake edges and near the coast. Interior lands were used during the winters while the coastal areas were inhabited during the summers.

During the Late Archaic Period, which lasted until approximately 3,000 years ago, fish became very important in Native American diets. People were more settled, establishing seasonal camps from which gatherers and hunters dispersed to harvest nearby food resources (Plymouth Archeological Rediscovery Project (PARP) 2013). Although no recorded Late Archaic sites are located on the refuge, the area would have been conducive to human settlement during this period as well.

The Transitional Archaic overlaps with the Early Woodland (3,000 to 1,650 BP) period, and no diagnostic artifacts distinguish these two periods. Clay pottery began to appear, possibly coinciding with the beginnings of horticulture (PARP 2013). Population densities were low, and the refuge provided an ideal environment to support such populations during this time.

During the Middle Woodland Period (1,650 BP to 1,000 BP), populations increased and became more reliant on agriculture. Plants such as goosefoot, sunflowers, and squashes were domesticated, ceramic manufacture became more widespread, and material cultures emerged which distinguished one group from another. Political structures became more complex and people began to live in village-like communities (PARP 2013).

The Late Woodland began 1,000 years ago and ended with the arrival of Europeans. Maize was introduced from the south. Villages in some areas were fortified, and people lived in larger groups. Social organization was hierarchical with populations organized into sachemships or chiefdoms.

Contact Period-European Influences

Agriculture, logging, fire, wind-throw, exotic pests and diseases, and development have greatly altered the New England landscape since pre-historic times. Agriculture has had the greatest effect on New England's forests, causing major changes in cover types and soils over a wide area. Although most of the region's forests were cut at least once, most logging did not affect succession or impact soils. However, intense fires fueled by logging slash did have a lasting impact on forest vegetation patterns (DeGraaf and Yamasaki 2001).

Table 2-1. Prescribed Fire and Fuel Reduction Management on Massasoit NWR since 2006.

Parcel	Date	Activity	Acreage
Crooked Pond (north side)	Fall 2006	Mechanical methods to reduce fuels and create buffer adjacent to neighborhood. Cleared 100-foot buffer by removing tall white pines and snags, and brush mowed huckleberry understory	12
Crooked Pond (east burn unit)	April 2007	Prescribed burn	20
Crooked Pond (east and west burn unit)	Spring 2011	Prescribed burn	50
Crooked Pond, throughout	January to May 2015	Mechanical methods to reduce fuels through mastication and fire break creation	4

The Proto-Historic and Contact Periods began in 1500 AD and ended around 1650 AD. During this period diseases introduced by Europeans decimated native people groups living around Massasoit NWR. During the early contact period, Native Americans traded with European explorers, trading furs and tobacco for brass kettles, beads, and other European items that were then incorporated into their material culture. No estimates are available of the number of Portuguese, Breton, and Bristol fishermen, Basque whalers, French fur traders, or English codders who established a presence on the North Atlantic coast beginning early in the16th century (Cronon 1983). English traders and fishermen had daily contact with indigenous people but lived on ships or in segregated enclaves around salt-dried codfish stations (favored by the English) built along Massachusetts Bay. In 1620, the Pilgrims migrated to New England and famously settled in Plymouth Colony nearby what is now the refuge.

The Pilgrims were aware that coastal Tribes had been decimated by disease just three to four years before their arrival (1616-1619), when many Native Americans living on the southeastern coast of present-day Massachusetts died from a mysterious pandemic disease. The Patuxet (Plimouth) Native American village was severely depopulated. Classic explanations include yellow fever, smallpox, and plague, and more recently chickenpox, trichinosis, and leptospirosis complicated by Weil syndrome (Marr and Cathey 2010). In New England, Smith noted "three plagues in three years successively neere two hundred miles along the coast" of southern Massachusetts to Cape Cod and inland for 15 miles (Smith 1622). Bennett suggested a 50- to 60-mile interior extension, corresponding with the area of corn horticulture (Bennett 1955). Native American influence on the local landscape subsequently declined following this pandemic, and was replaced by European influence.

By 1616, several subtribes of the Wampanoag (Pokanoket) Nation were living between the present-day borders of eastern Rhode Island and southeastern Maine. The Patuxet village was localized to an area in and around Plymouth harbor. Salisbury (1982) estimated the size of the Patuxet Tribe before the epidemic at 2,000. Demographers and historians disagree about the total size of the Wampanoag Nation, but Salisbury (1982) considers an estimate of 21,000 to 24,000 as reasonable. Gookin (1972) also estimated 3,000 men living in Massachusetts before the epidemic which when extrapolated for family size is consistent with Salisbury's overall estimate.

The Pilgrims chose a settlement location near an abandoned indigenous village that provided plant and animal foods, and land with drainage patterns suitable for agriculture. Massasoit NWR is located very close to the Plymouth settlement area, and it is likely that these early English settlers used and impacted resources located on the refuge.

As time progressed, Plymouth changed and declined as the political or economic center of the colony, shifting north to Boston, the new regional center. The region around the refuge became important as a source of agricultural products for markets in Boston. The refuge area would have likely also provided valuable timber for ship building. During the Federal Period (1750 to 1830), maritime commerce increased, further depleting timber around the refuge. Also, a shift from an agricultural to an industrially based economy began with improvements in water power technology and the subsequent development of new mills. Villages housing millworkers began growing around rural mills, and road networks and turnpikes emerged linking rural villages to larger markets.

During the Early Industrial Period (1830 to 1870), the introduction of railroads revolutionized transportation. Agriculture declined as the frontier and settlement extended westward. The Civil War generated major expansions in textile, metal working, machinery manufacturing, and shoe and boot industries. Whaling declined with the advent of petroleum products, and this in turn lowered the demand for ship timbers.

Plymouth remained the largest agriculture and fishing community throughout the 19th century. Shipbuilding and shipping developed leading to its principal industry, rope-making. The Plymouth Cordage Company founded in 1824 produced rope and cords into the 20th century. During the Late Industrial Period (1870 to 1915), technological advances altered the development of rural areas. Electricity, gas lighting, and motorized vehicles allowed people to live farther from cities, and there was also an influx of immigrants.

In 1856, Plymouth County became the central cranberry production area in Massachusetts as many areas previously mined for bog iron were reused as cranberry bogs. East Head Pond in the MSSF was dammed in 1868 to provide a water source for cranberry production, a use still remaining today. By 1890, extensive wetlands located southwest of the refuge were developed for cranberry production (MADNR 1971).

Human Influences over the past 100 years

The Modern Period (1915 to present) witnessed the decline of the mill industries during the Great Depression, and agriculture became the most important economic base around the refuge. In the 1960s, the Plymouth Cordage Company failed and the factory was converted to retail and commercial use.

Cranberries

Highway development in the 1970s led to increased population growth in Plymouth as it became more accessible to Boston. Plymouth's population increased more than fourfold in the past 50 years. The inexpensive land costs and a low tax rate are cited as factors in this rise in population. The downtown area and North Plymouth have become commercial centers (Town of Plymouth 2009). In 2007, a large industrial center was completed with one of the largest retail malls along the South Shore. Throughout the region, rural areas continue to be altered by large-scale residential developments, most often in the form of large lot single-family homes. Additional large tracts of rural land, often outside of the established village centers, remain attractive and are constantly being evaluated for additional development (Town of Plymouth 2013). The continuing availability of large tracts of developable land, the region's rural character, the high quality community services, transportation improvements, and proximity to Boston will continue to promote a high growth rate.

Current Conditions

Climate

Influenced by its proximity to the Atlantic Ocean, the refuge climate is characterized by warmer temperatures in the winter and cooler temperatures in the summer compared to more interior locations. The frost-free growing season for Plymouth ranges from 146 to 174 days (U.S. Climate Data 2011). The average annual temperature for Plymouth is 51 degrees Fahrenheit (°F). The July average high temperature is 82°F and the average low temperature is 60.3 °F. The coldest month is January with an average high temperature of 36.8 °F and an average low temperature of 16.2 °F.

The refuge, like other coastal areas, is vulnerable to nor'easters as well as to Atlantic hurricanes and tropical storms. The average annual precipitation is approximately 49 inches spread evenly throughout the year. Annual snowfall averages approximately 20 inches. The wettest month is normally January and the driest months are June, July, and August. Variations in precipitation from year to year can cause drought or flooding with as much as a 5-foot variation in water table levels (Epsilon 2000).

Also see the Climate Change discussion later in this chapter.

Air Quality

Under the CAA, the USEPA regulates six criteria pollutants—ozone, carbon monoxide, nitrogen dioxide, particulate matter, sulfur dioxide, and lead, as well as hazardous and other toxic air pollutants, including mercury. A maximum concentration is established for each criteria pollutant, above which adverse effects on human health may occur. These threshold concentrations are called National Ambient Air Quality Standards (NAAQS). Areas of the country where air pollution levels persistently exceed the NAAQS may be designated "nonattainment." When an area does not meet the air quality standard for one of the criteria pollutants, it may be subject to the formal rule-making process to designate it as "nonattainment." The CAA further classifies nonattainment areas based on the magnitude of an area's problem. These nonattainment classifications may be used to specify what air pollution reduction measures an area must adopt, and when the area must reach attainment (40 CFR 81).

The Massachusetts Department of Environmental Protection (MADEP) monitors levels of ozone, particle pollution (also known as particulate matter; $PM_{2.5}$ or PM_{10}), carbon monoxide (CO), sulfur dioxide (SO_2), and nitrogen dioxide (NO_2). These pollutants are measured from several stations in Massachusetts for attainment or exceedance above the limit of the NAAQS set by the USEPA to protect public health. These standards are reviewed every 5 years by the USEPA and may be changed in response to new scientific information. Each state must ensure that these standards are met and maintained. In the case of an exceedance of these standards, pollution control strategies are implemented, and once the standards are attained a plan is developed to maintain compliance in a way that incorporates future economic and emissions growth. In 2010, Massachusetts was in attainment of the air quality standards for all pollutants except ozone. Ozone at ground level is a respiratory irritant that can reduce the overall function of the lungs, cause asthma attacks, and aggravate chronic lung diseases. It also inhibits vegetation growth, and is often found in higher concentrations far downwind from the origin of the precursors that react to form it (MADEP 2008).

In 1997, USEPA set a new 8-hour ozone standard designed to be more representative of exposure over time. Massachusetts is designated as nonattainment of this 8-hour standard. Ozone monitors currently show that the State is meeting the 1997 0.08 parts per million (ppm) standard (MADEP 2008). In January 2008, Massachusetts submitted a *State Implementation Plan* to the USEPA, describing strategies to attain the 8-hour ozone standard by 2010 (MADEP 2008). However, the 8-hour standard was revised in 2008 to 0.075 ppm. In March 2009, Massachusetts recommended to USEPA that the entire State be designated as nonattainment for the 2008 standard. In January 2010, USEPA proposed to further revise the primary 8-hour ozone standard to a level with a range of 0.06 to 0.07 ppm, but postponed the new ozone standards in September 2011.

There are a total of 29 air quality monitoring stations across Massachusetts, and one additional Tribal site on Martha's Vineyard. Fifteen of these sites are designated as part of the ozone monitoring network. Exceedances at a station, averaged over 3 years, can lead to a NAAQS violation. Based on data from these sites, there were a total of 36 exceedances (above the standard) of NAAQS Statewide for ozone on 14 days in 2010. One of the closest monitoring stations to the refuge in Brockton, Massachusetts (MADEP 2012) had no exceedances. Based on data from 2009 to 2012, the results from the Brockton station, air quality did not violate the primary 8-hour ozone standard (MADEP 2012).

Water Quality

Long-Term Trends and Status of Water Quality for Massasoit NWR
Municipal and private wells tap the groundwater throughout the town of Plymouth, primarily for residential and irrigation uses. This water is largely returned to the aquifer through ground discharge to the ground from septic systems or infiltration of irrigation waters. In areas served by public sewer, primarily North Plymouth and downtown Plymouth, wastewater is redirected to a new sewage treatment plant, and treated water is discharged into the Eel River headwaters. Groundwater recharge is important in Plymouth because

the numerous kettle ponds and freshwater wetlands depend on groundwater for their existence. However, intensive development can result in the nitrification of groundwater, a serious public health concern (Town of Plymouth 2009).

State-reported Impaired Waters

The goals of the State's water quality assessment program are to determine whether water quality standards are met and to design and implement a plan to restore waters with impaired quality.

In 2012, the DEP released the 305(b)/303(d) *Integrated List of Waters* (MADEP 2012a). It combines both the 305(b) Water Quality Assessment and the 303(d) Report on Impaired Waters for each river basin. The DEP compiled those reports and submitted them to the EPA and Congress, satisfying reporting requirements under section 305(b) of the Clean Water Act.

Water quality standards designate six uses for surface waters:

(1) Aquatic life
(2) Fish consumption
(3) Drinking water
(4) Shell-fishing
(5) Primary and secondary contact recreation
(6) Aesthetics

The standards define the water quality needed to support each of these designated uses, and if a water body is more contaminated than allowed under existing water quality standards and so will not support one or more of its designated uses, it has "impaired" water quality. In most cases, a cleanup plan [called a "Total Maximum Daily Load" (TMDL)] must be developed and implemented to restore impaired waters.

The report on impaired waters in the State describes segments of streams, lakes, and estuaries that exhibit violations of water quality standards. It also

Crooked Pond at Massasoit National Wildlife Refuge

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identifies the pollutant responsible for the violation(s) and the cause and source of the pollutant, if known. In this report there was no mention of the level of contamination for the ponds within the refuge boundaries. The Eel River showed impairment due to nonnative vegetation (MADEP 2012a).

Refuge Natural Resources

Terrain and Soil

Refuge topography is primarily flat glacial till plains and elevated moraines. Evidence of the Wisconsin glaciation is readily observed in the deposits of sediments and other materials that shaped the local landscape. The ponds located on the refuge are kettle ponds created by glaciation. Crooked Pond is a typical coastal plain pond occupying a depression connected hydrologically to an underground aquifer; hence, the water level of the pond fluctuates with the water table. The water level is usually high in winter and spring and generally much lower by late summer when the shoreline is exposed. Three other ponds, Island, Gunner's Exchange, and Hoyt, are within 0.62 miles of Crooked Pond. The southeastern corner of Gunner's Exchange Pond and parcels with frontage on Hoyt Pond and Island Pond are part of the refuge. Surficial geology at Massasoit NWR is mostly composed of excessively drained soils from the Merrimac, Plymouth, and Plymouth-Carver series (table 2-2, map 2-6, Natural Resources Conservation Service (NRCS) Soil Survey Geographic (SSURGO) Database *http://websoilsurvey.nrcs.usda.gov/app/HomePage.htm*; accessed October 2015).

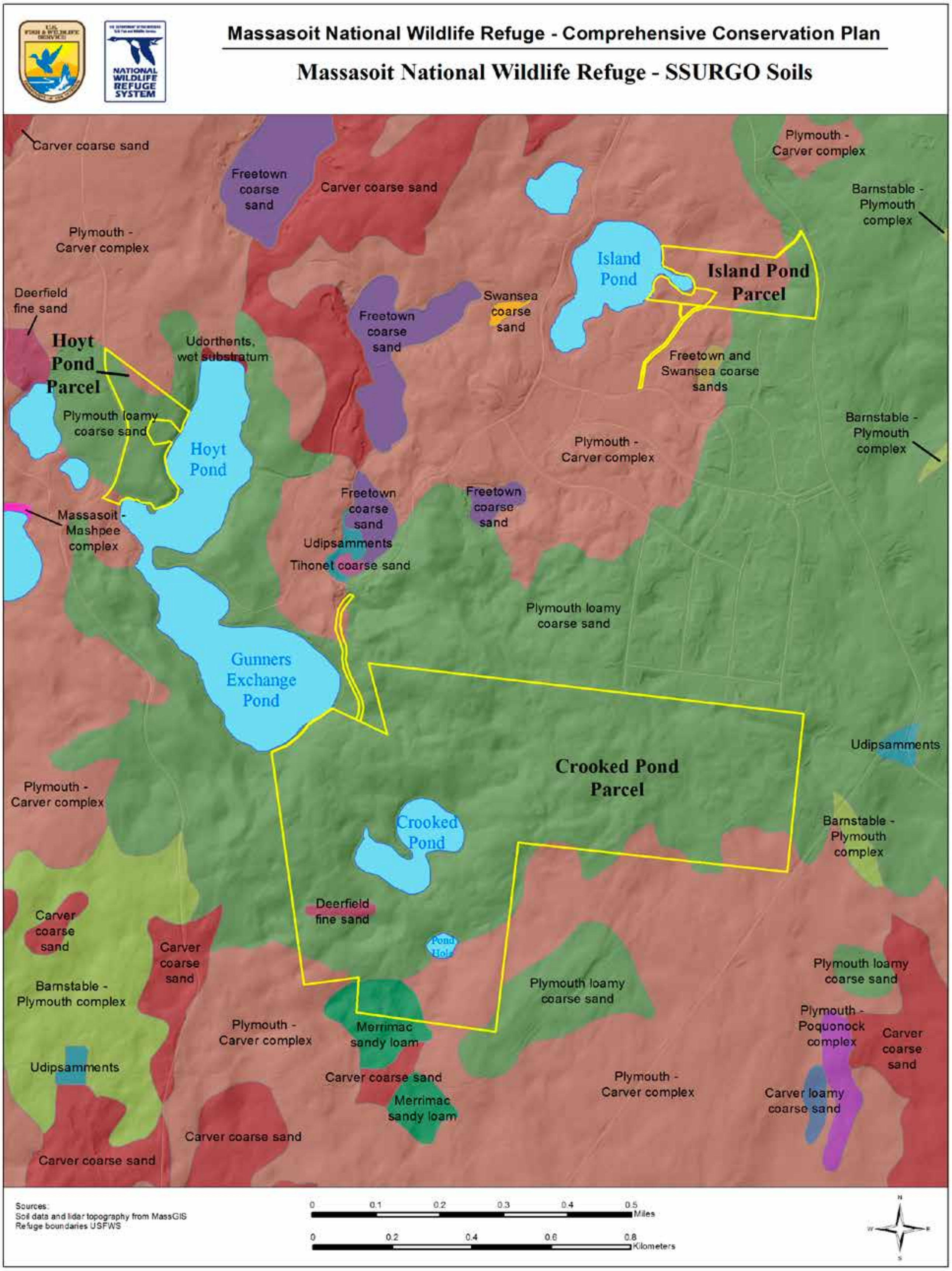
Refuge Habitats

Natural Community Types and Vegetation

In 2010, AECOM® was contracted to conduct vegetation cover type mapping on the refuge. Infrared aerial imagery was acquired in July and used to classify vegetation on the entire refuge using a minimum mapping unit of 1 acre. The vegetation cover types are based upon the National Vegetation Classification System (NVCS) developed by USGS and NPS. However, because the NVCS classifications for Massachusetts are incomplete, other sources were also used to classify habitat types (AECOM 2010; refer to the report for more details). Nine community types were identified for Massasoit NWR. Table 2-3 below lists the NVCS Associations as determined by AECOM (2010), the comparable Massachusetts Community Types identified by AECOM (2010), the description of those Community Types from Swain and Kearsley (2001) in the Classification of Natural Communities in Massachusetts, and the acreage for each. Map 2-7 shows habitat type locations.

In addition to the vegetation cover type mapping effort, a comprehensive survey of plant species was conducted on the refuge by volunteer botanists in 2012, and 183 plant species were documented (Zinovjev and Kadis, 2012 unpublished report). The species list is included in appendix A. Among the species documented are two Massachusetts State-listed as Special Concern species and five Watch List species (see table 2-4; Zinovjev and Kadis, 2012 unpublished report). On adjacent MSSF lands, 15 plant species have been documented (Myles Standish State Forest 2011) that are listed as Endangered, Threatened, or Special Concern in Massachusetts (Dow Cullina et al. 2011), including the two Special Concern species found on the refuge. It is possible that other rare species found on the State forest also occur on the refuge. The volunteer botanists also documented 21 nonnative species, 10 of which are classified as invasive in Massachusetts, or for which invasive status is pending. Two additional non-native species (spotted knapweed and rabbit-foot clover) were recorded during vegetation cover type mapping work (AECOM 2010), and all 23 nonnative species are listed in table 2-5. Additional botanical work will likely result in more species being added to the refuge species list.

Map 2-6. Massasoit National Wildlife Refuge - SSURGO Soils



Map 2-7. Massasoit National Wildlife Refuge Habitat Types

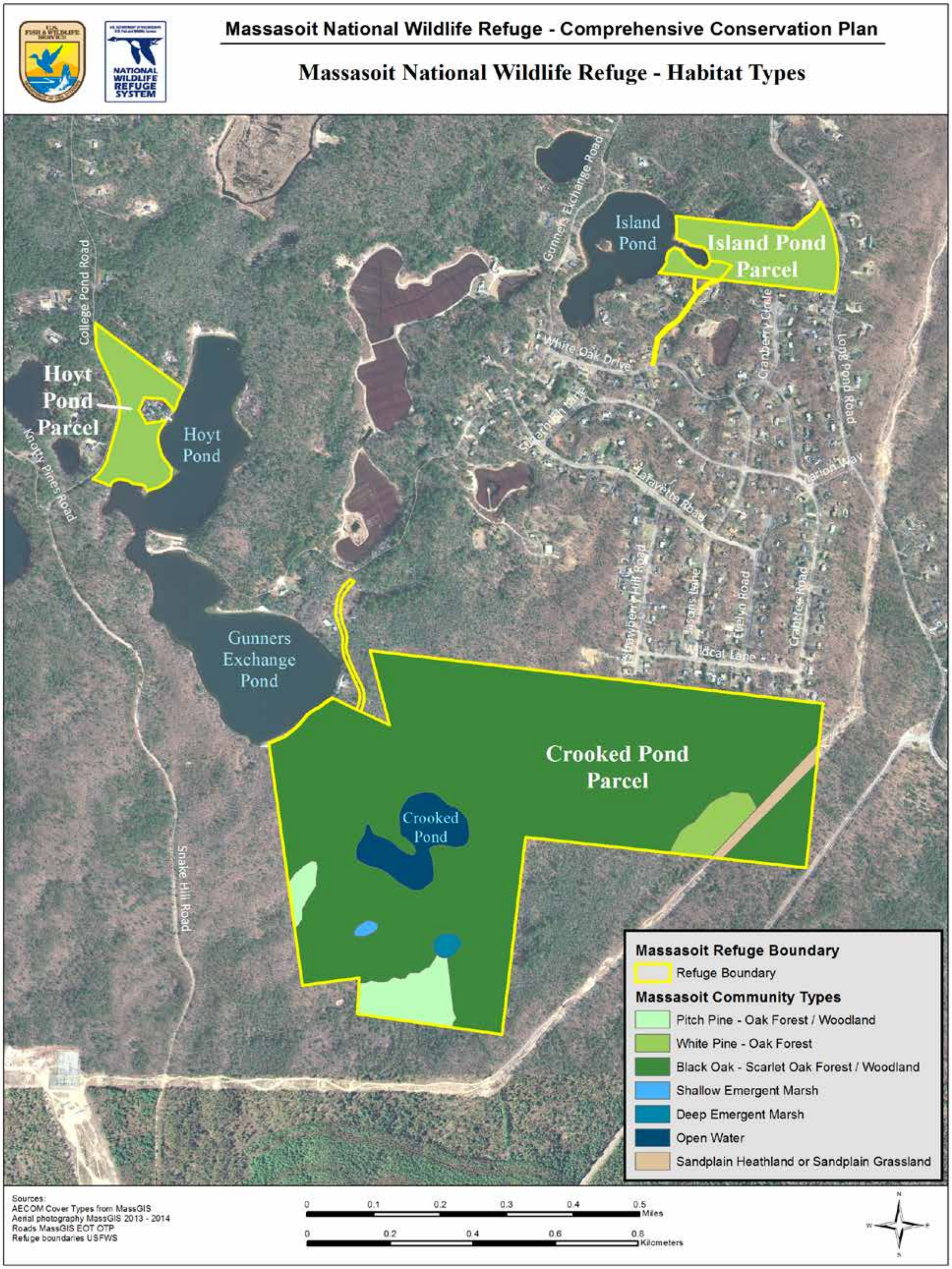


Table 2-2. Massasoit NWR Soils.

Soil Type	Percent Slope	Drainage Class	Parent Material	Landform
254C Merrimac sandy loam	8 to 15 percent	Somewhat excessively drained	Coarse loamy Aeolian deposits over sandy and gravelly glaciofluvial deposits	Outwash plains, terraces, kames
437B Plymouth loamy coarse sand bouldery	3 to 8 percent	Excessively drained	Sandy and gravelly supraglacial meltout till over sandy and gravelly glaciofluvial deposits	Outwash plains, moraines
437C Plymouth loamy coarse sand bouldery	8 to 15 percent	Excessively drained	Sandy and gravelly supraglacial meltout till over sandy and gravelly glaciofluvial deposits	Outwash plains, moraines
437E Plymouth loamy coarse sand bouldery	15 to 35 percent	Excessively drained	Sandy and gravelly supraglacial meltout till over sandy and gravelly glaciofluvial deposits	Outwash plains, moraines
438B Plymouth loamy coarse sand extremely bouldery	3 to 8 percent	Excessively drained	Sandy and gravelly supraglacial meltout till over sandy and gravelly glaciofluvial deposits	Outwash plains, moraines
438E Plymouth loamy coarse sand extremely bouldery	8 to 15 percent	Excessively drained	Sandy and gravelly supraglacial meltout till over sandy and gravelly glaciofluvial deposits	Outwash plains, moraines
480E Plymouth-Carver complex	15 to 35 percent	Excessively drained	Sandy and gravelly supraglacial meltout till over sandy and gravelly glaciofluvial deposits	Outwash plains, moraines
481B Plymouth-Carver complex bouldery	3 to 8 percent	Excessively drained	Sandy and gravelly supraglacial meltout till over sandy and gravelly glaciofluvial deposits	Outwash plains, moraines

Source: USDA-NRCS Soil Survey Online

Table 2-3. Vegetation Types at Massasoit NWR.

NVCS Association as identified by AECOM (2010)[1]	Comparable Massachusetts Community Types as identified by AECOM (2010)	Acres: Crooked Pond	Acres: Island Pond	Acres: Hoyt Pond	Acres: Total	Vegetation Description for Massachusetts Community Types (from Swain and Kearsley 2001)
Pitch Pine–Oak (scarlet, black, white) Forest	Pitch Pine–Oak Forest / Woodland	8.0	0	0	8.0	Pitch pine–oak forests have a canopy of pitch pine and tree oaks (black, scarlet, chestnut, and white), with blueberries (lowbush and blue ridge), black huckleberry and other ericaceous shrubs forming an often continuous low shrub layer. Scattered patches of scrub oak and bear oak can be dense. Catbriar and other briars (*Smilax* **spp.**) often make dense barriers around low, damp openings. The herb layer is generally sparse, with bracken fern, wild sarsaparilla, wintergreen, Pennsylvania sedge, and, less commonly, pink lady's slipper. Occasional white pine and red maple contribute to the canopy.
White Pine–Oak (scarlet, black, white) Forest	White Pine–Oak Forest	4.3	15.0	10.0	29.3	White pine and oak species (northern red, black, white, scarlet, or chestnut) dominate the canopy layer in a variety of proportions. Pitch pine, red maple, white birch, and black birch, occur regularly but in low numbers. Southern areas also have pignut hickory and sassafras. American chestnut is frequently present as a shrubby tree. Usually has a prominent heath shrub layer, with blueberries (lowbush and blue ridge), black huckleberry, mountain laurel, and sheep laurel. Other shrubs include maple-leaf viburnum. Characteristic species of the sparse herb layer include bracken fern, wild sarsaparilla, Canada mayflower, wintergreen, partridge-berry, pink lady's slipper, cow-wheat, and whorled loosestrife.
Oak (scarlet, black, white)–Pine (pitch, white) Forest	Black Oak–Scarlet Oak Forest/ Woodland	159.0	0	0	159	Black and scarlet oaks are the dominant canopy species. White oak and red maple are common associates. A sparse subcanopy may have species of recent disturbance such as grey birch, black cherry, and sassafras, as well as species less tolerant of fire such as flowering dogwood or shadbush. Blueberries (lowbush and blue ridge), black huckleberry, and scrub oak form a fairly dense, but clumped low shrub layer, with scattered maple-leaf viburnum and American hazelnut. Sedges (such as Pennsylvania sedge), bracken fern, and pink lady's slipper are often scattered in the open herbaceous layer.
Swamp Loosestrife Semipermanently Flooded Shrubland White Water Lily–Cow-lily Permanently Flooded Temperate Herbaceous Highbush Blueberry Saturated Shrubland	Shallow Emergent Marsh or Deep Emergent Marsh	1.2	0	0	1.2	Vegetation composition is similar to deep emergent marshes except that shorter grasses, sedges, and rushes dominate. Cattails, *Phragmites*, and wool-grass, the dominants of deep emergent marshes, can occur but are never dominant. Tussock forming species, like tussock sedge and Canada bluejoint, often cover broad areas and form a hummock hollow topography. Reed canary grass can also occur. It is common to see tussock sedge-dominated marshes in old beaver flowages mixed with scattered shrubs like alder and *Spiraea*. The shallow water typically has a mixture of bur-reeds, sedges, and rice cut-grass. Floating leaved plants, like American white water lily and cow lily, and submergents, like pondweeds, occur in open areas, and duckweed is abundant in still water. Tall graminoids, like broad-leaved cattail and *Phragmites*, often form extensive dense stands. Narrow-leaved cattail occurs in more alkaline sites or in saline areas along roads. Other characteristic graminoids include woolgrass, common threesquare, Canada bluejoint, rice cut-grass, and tussock-sedge. Herbaceous associates include arrow-leaf, tearthumb, bulblet, water-hemlock, swamp-candles, beggar-ticks, bedstraw, common arrowhead, slender-leaved goldenrod, and marsh-fern.

NVCS Association as identified by AECOM (2010)[1]	Comparable Massachusetts Community Types as identified by AECOM (2010)	Acres				Vegetation Description for Massachusetts Community Types (from Swain and Kearsley 2001)
		Crooked Pond	Island Pond	Hoyt Pond	Total	
Open Water (non-vegetated lacustrine unconsolidated bottom)	NA	8.2	0	0	8.2	NA
Pitch Pine–Scrub Oak Shrubland						
Little Bluestem Herbaceous	Sandplain Heathland or Sandplain Grassland[2]	2.3	0	0	2.3	Many of the dominant species in heathlands are woody: scrub oak, black huckleberry, bearberry, and lowbush blueberry. Other characteristic species include hairgrass, Pennsylvania sedge, little blue stem, stiff aster, bayberry, golden heather, chokeberry, dwarf chinquapin oak, sweetfern. Heathlands are less species rich than grasslands and appear taller. The tall shrublands association particularly includes non-ericaceous tall shrubs such as beaked hazelnut, beach plum, and dewberry. The species overlap with grasslands is great: it is the proportion of the species and the resultant structure that separates the communities. The communities are not distinct at some sites. Grasslands are dominated by graminoids, usually little blue stem grass, Pennsylvania sedge, and poverty grass, with bearberry, scrub oak, stiff aster, bayberry, lowbush blueberry, and black huckleberry. Shrub clones often form patches. There is great species overlap with sandplain heathlands, but sandplain grasslands are much richer in vascular species. As a group, Goat's rue, yellow wild indigo, butterfly weed, and bird's foot violet are good indicators of the community.

[1] *AECOM (2010) referenced a Draft NVCS report from 1994 which was used to determine the appropriate NVCS Association. Up-to-date NVCS information can be found at http://usnvc.org/explore-*classification/ *(last accessed October 2015). Slight changes in the NVCS Associations identified by AECOM may be evident in the NVCS Website.*

[2] *This is actually habitat along a power line right-of-way, and the habitat classification may not be accurate.*

Source: AECOM 2010

Table 2-4. State-Listed Species Documented on Massasoit NWR during Botanical Surveys in 2012.

Species	Status in Massachusetts*	General Locations**
Pink Tickseed	Watch List	Crooked Pond; Island Pond; Gunner's Exchange Pond
Plymouth Gentian	Special Concern	Island Pond
Sessile Water-horehound	Watch List	Island Pond
Pondshore or Terete Arrowhead	Special Concern	Crooked Pond; Island Pond;, Gunner's Exchange Pond; Hoyt Pond
Black-fruited Spike-rush	Watch List	Island Pond, Crooked Pond, Hoyt Pond
Annual Umbrella Sedge	Watch List	Island Pond
Black Oatgrass	Watch List	Crooked Pond Parcel

Source: Zinovjev and Kadis, unpublished report

** Dow Cullina et al. 2011.*

***Locations were tied to a parcel (Crooked Pond Parcel, Island Pond Parcel, and Hoyt Pond Parcel). Each of the four ponds was also recognized as a separate location (Crooked Pond, Island Pond, Hoyt Pond, and Gunner's Exchange Pond).*

No comprehensive surveys of aquatic plants have been conducted on the refuge, but Eurasian water-milfoil (also a nonnative invasive species) and arrowhead have been documented in Crooked Pond (USFWS 1985). Both fanwort and hydrilla are increasingly detected in Massachusetts coastal plain ponds; control of these species is very difficult. The control of nuisance aquatic plants, particularly submerged aquatic vegetation, often requires the use of herbicides at concentrations that can harm local populations of rare native plants and animals if present, or labor intensive hand or mechanical removal. An exotic invasive species that has recently invaded a number of Massachusetts coastal plain ponds is gray willow.

Coastal Plain Pondshore Community

The kettle ponds on the refuge, having no inlet or outlet, are recharged from groundwater so water levels within these ponds are influenced by seasonal and year-to-year groundwater table fluctuations in the. The ease with which water moves through the sandy glacial till substrates causes the water levels of the ponds to fluctuate directly with the water table, partially or completely exposing the pond shorelines during late summer and early fall. Fluctuating pond water levels are key to a globally rare plant and animal community known as the Coastal Plain Pondshore (Swain and Kearsely, 2001). Plants and animals of this community type are adapted to the nutrient-poor, changing pond water levels, and many occur almost exclusively on coastal plain ponds. The Massachusetts SWAP (MassWildlife 2015) identifies buffer areas around aquatic (including coastal pond) Core Habitats as Critical Natural Landscapes to help ensure their long-term (biological) integrity. The periodic inundations of the shore help deter shrubs and upland plants, and the periodic drying deters the obligate aquatic plants. Dominant plants on the exposed shore as the water levels drop are herbaceous and graminoid species. During leaf-out in the spring, trees increase transpiration, evaporation increases from leaves and pond surfaces, and pond water levels fall. McHorney and Neill (2007) demonstrated a distinct connection between some coastal plain ponds and groundwater. Groundwater connections provide cool, normally low-nutrient water to coastal ponds. In areas with polluted groundwater however, ponds can acquire the pollutants. In the winter, when there is little evaporation and much precipitation, the groundwater and pond levels rise, and are recharged.

Sudden alterations to natural hydrologic regimes pose the greatest threats to these systems. Many coastal plain ponds are in a fragile balance. ORV use on and around pond shorelines destroys herbaceous vegetation, dragonfly and damselfly habitat, and turtle nesting habitat (NHESP 2007). Nutrient input into naturally low-nutrient Coastal Plain Ponds allows more weedy plant species to grow, changing the habitat for plants and animals alike. Increased nutrient input can come from improperly maintained septic systems, large numbers of swimmers, over-wintering populations of Canada geese, fertilizer use in the watershed, and soil erosion. Heavy recreational use of pond shorelines removes plants and deters animals from using the habitat. Concentrating recreation at particular ponds effectively protects the other ponds (NHESP 2007). Although Island, Gunner's Exchange, and Hoyt Pond have shoreline residential development which affect the habitat through septic use and recreational activities, these threats do not occur at Crooked Pond where the Service owns and controls access to the entire pond and shoreline.


Alexey Zinovjev_and Irina Kadis

Slender arrowhead (Sagittaria teres)

Several Massachusetts plant species occur only in coastal plain ponds, including the globally rare species Plymouth gentian, rose coreopsis, terete arrowhead, and creeping St. John's wort (MassWildlife 2015). Many of the rare plant species associated with coastal plain ponds are regionally rare species as well, as indicated by Brumback and Gerke (2013). The plants of the community appear to form zones dependent on the magnitude, duration, frequency, and timing of flooding and exposure events between the water and the shrubs around the pond. Of the Massachusetts SGCN plants, New England boneset, Maryland meadow-beauty, and pondshore and swamp smartweeds occur in the driest zone, inundated only during high-water periods. An intermediate area of beach provides habitat for most of the species of the coastal plain pondshore community; the globally restricted but locally abundant Plymouth gentian and rose coreopsis grow in this zone. In the submerged or water-saturated areas, terete arrowhead, subulate bladderwort, and the horned- and bald-sedges may occur.

Coastal plain pond shorelines are important habitat for dragonflies and damselflies (over 45 odonate species are known to occur on coastal plain ponds and several of those species are rare). Further, coastal plain ponds have been listed by others as the most vulnerable odonate habitats in the northeastern United States (White et al. 2014). Near-shore emergent plants are important sites for dragonflies and damselflies. Many live amongst the submerged vegetation as larvae and climb onto the emergent vegetation to undergo metamorphosis to adults. Eggs and larvae may survive for a time either in the stalks of vegetation (where many species lay their eggs) or in the mud of drying ponds.

Larger ponds are used by migrating and wintering waterfowl. Some of these ponds support warm-water fish and freshwater mussels, and others can function as vernal pools when fish populations are absent. Freshwater mussel species likely to occur include the MESA-listed eastern pondmussel and tidewater mucket, and the unlisted eastern lampmussel and triangle floater.

An exotic invasive species that has recently invaded a number of Massachusetts coastal plain ponds is gray willow, actually a species complex that includes *Salix cinerea*, *S. atrocinerea*, and probable hybrids (MassWildlife 2015). This species complex is not as averse to seasonally high water as native shrubs are, and seems to thrive along these pond shores, particularly where soil disturbance has occurred. Both fanwort and hydrilla are increasingly detected in Massachusetts coastal plain ponds and control of these species is very difficult.

Recent research indicates that the last two decades have been the wettest years in the Northeast in 500 years (Pederson et al. 2013, Newby et al. 2014, Weider and Boutt 2010). Pond shorelines not under the influence of water withdrawals did not experience pondshore exposure for 10 years, which has led to the loss of several native plant populations from several ponds. The Sustainable Water Management Initiative, administered by the MADEP, with input from multiple state agencies, is supporting research by the USGS into the degree of hydrological alterations imposed by water supply withdrawals and climate change (MassWildlife 2015).

The coastal plain pondshore community consists largely of plant species adapted to the special shoreline environment, able to thrive in the nutrient-poor, acidic conditions and out-compete more common plant species. Some species' seeds germinate early in the growing season when the shore is still covered with water, and other seeds germinate as water levels drop and the shores dry.

Table 2-5. Nonnative species documented on Massasoit NWR during vegetation cover type mapping and during 2012 botanical surveys.

Species	Status in Massachusetts*	General Locations**
Bull Thistle	Nonnative	Crooked Pond Parcel
Smooth Hawkweed	Nonnative	Crooked Pond Parcel; Crooked Pond
King Devil	Nonnative, Invasive Status Outside MA	Gunner's Exchange Pond
Spotted Cat's Ear	Nonnative, Invasive Status Outside MA	Island Pond Parcel; Gunner's Exchange Pond
Spotted Knapweed	Nonnative, Likely Invasive	Right of Way
Butterfly-bush	Nonnative, Invasive Status Outside MA	Crooked Pond Parcel
Morrow Honeysuckle	Nonnative, Invasive	Crooked Pond Parcel
Mouse-ear Chickweed	Nonnative	Crooked Pond Parcel
Oriental Bittersweet	Nonnative, Invasive	Island Pond
Black Locust	Nonnative, Invasive	Island Pond Parcel
Rabbit-foot Clover	Nonnative	Right of Way
Palmate Hop-clover	Nonnative	Crooked Pond Parcel
Carpetweed	Nonnative	Crooked Pond; Island Pond
White Mulberry	Nonnative	Island Pond
Lady's Thumb	Nonnative	Crooked Pond; Island Pond
Bitter Dock	Nonnative	Island Pond
Glossy Alder-buckthorn	Nonnative, Invasive	Crooked Pond Parcel; Crooked Pond; Island Pond Parcel

Species	Status in Massachusetts*	General Locations**
Gray Willow	Nonnative, Invasive	Crooked Pond Parcel; Island Pond Parcel; Island Pond; Gunner's Exchange Pond; Hoyt Pond
Common Mullein	Nonnative, Invasive Status Outside MA	Crooked Pond Parcel
Barnyard-grass	Nonnative	Island Pond
Sheep Fescue	Nonnative	Crooked Pond Parcel; Crooked Pond; Island Pond Parcel
Common Reed	Nonnative, Invasive	Island Pond
Norway Spruce	Nonnative, Invasive Status Outside MA	Crooked Pond Parcel

Sources: AECOM 2010; Zinovjev and Kadis, unpublished report

** Dow Cullina et al. 2011.*

***Locations were tied to a parcel (Crooked Pond Parcel, Island Pond Parcel, and Hoyt Pond Parcel). Each of the four ponds were also recognized as separate locations (Crooked Pond, Island Pond, Hoyt Pond, and Gunner's Exchange Pond).*

Plant Pests and Insects

Plymouth County has seen a greatly increased number of winter moth adults, a member of the Geometridae family, that typically emerge around Thanksgiving and continue throughout December. The following spring, the caterpillars emerge in large numbers, defoliating maples, oaks, and other deciduous trees (*https://ag.umass.edu/fact-sheets/winter-moth-overview* accessed March 2016). Initially introduced in Nova Scotia from Europe in the 1950s, this species became a problem causing tree foliage damage. Deciduous plants on the refuge susceptible to winter moth damage include oaks, blueberries, and maples. In Plymouth County, oaks primarily are showing signs of decline after consecutive years of winter moth defoliation.

Oaks in Plymouth County have also been impacted by outbreaks of gypsy moths. Leaf defoliation from gypsy moths frequently occurs in forests with greater than 50 percent oak presence (Schweitzer 2004). Pitch pine and scrub oak are more resistant and are at a lower risk level to defoliation than other trees, whereas white pine is defoliated much more often than other pines (U.S. Forest Service 2007). In June 1981, heavy defoliation occurred in oak and mixed oak forests from southern Maine to coastal Connecticut. Defoliation maps published by the Forest Service show no major defoliation in the Plymouth area in recent years.

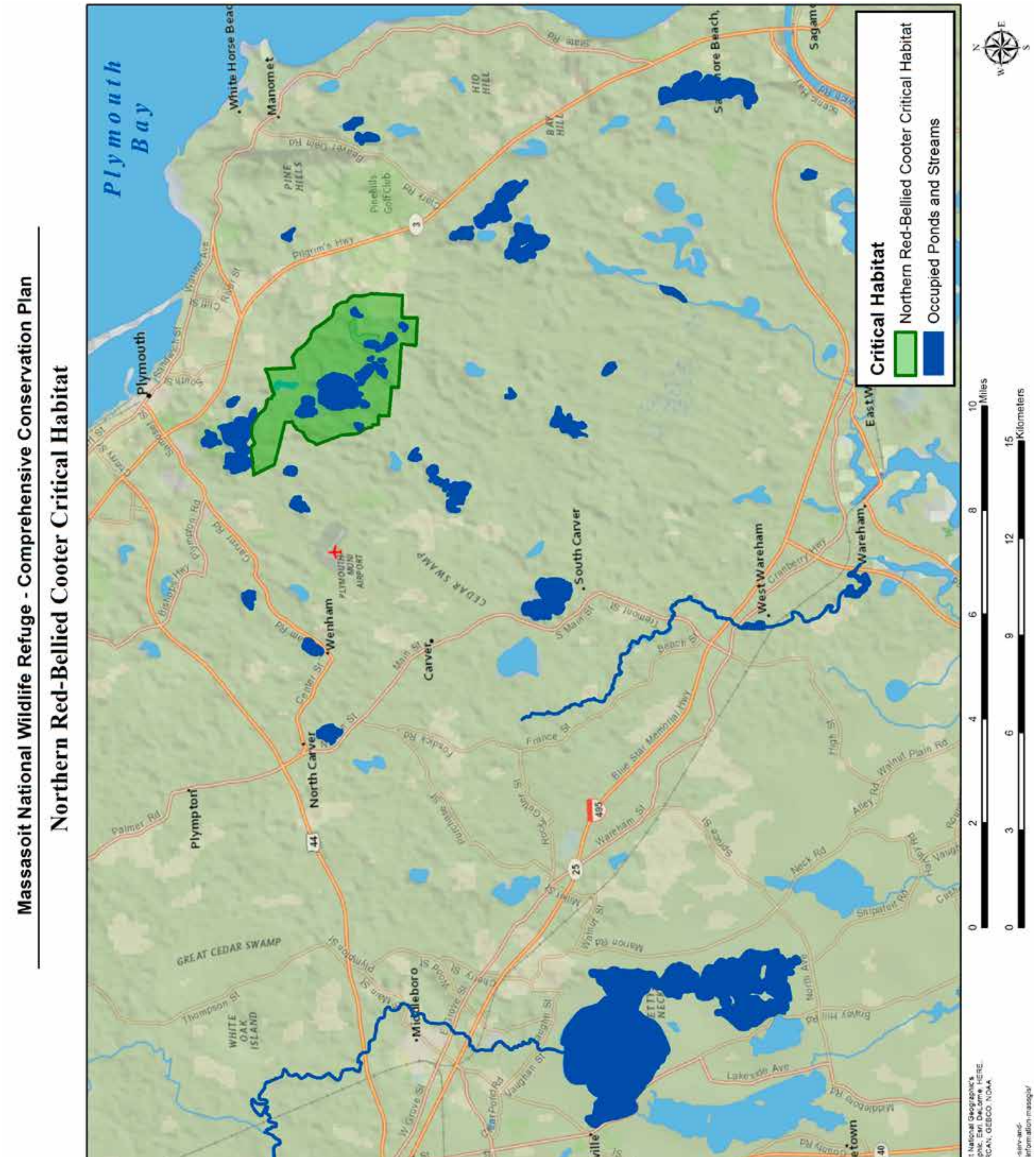
There is limited information about specific pest outbreaks in or near the refuge. Neighboring MSSF has had several pest outbreaks in past years including the outbreak of the pine looper that killed many pitch pines in the 1970s and 1980s. The black turpentine beetle has also impacted trees there. Outbreaks of gypsy moths have defoliated scrub oaks in past summers, but have since recovered (MADCR 2011).

Federally Listed Northern Red-bellied Cooter

Ecology and Rangewide Status

The northern red-bellied cooter is a large, freshwater basking turtle with a carapace (shell) length of 10 to 12 inches when mature. They subsist primarily on submergent vegetation, and require good water quality and suitable basking, nesting, and overwintering sites free from disturbance. Northern red-bellied cooters spend most of their lives in freshwater coastal ponds in Plymouth and Carver counties, coming on land to bask and breed in sandy soils. Typically, they reach sexual maturity at 14 to 15 years of age. In 1979, the total number of breeding-age individuals was estimated to be approximately 300, and on April 2, 1980, the species was listed as federally endangered and 3,269 acres were designated as critical habitat (map 2-8; USFWS 1994). Massasoit NWR was

Map 2-8. Northern Red-bellied Cooter Critical Habitat



established for the protection of northern red-bellied cooters and lies entirely within the critical habitat designation.

In 1981 the first recovery plan was written for the northern red-bellied cooter (USFWS 1981), and in 1994 the recovery plan was updated (USFWS 1994). At that time, this population was considered a subspecies (*P. r. bangsii*) of the more broadly distributed red-bellied cooter; however, taxonomic revision removed the subspecific status. The Service has determined that the population qualifies as a distinct population segment, and formally revised the listing. The northern red-bellied cooter is found only in southeastern Massachusetts, disjunct from the remainder of the species distribution, with the next closest population being located in New Jersey. Northern red-bellied cooters in Massachusetts were known from just 12 ponds in Plymouth County, with an estimated population of approximately 200 individuals when first listed. The 1994 Recovery Plan states that downlisting to "Threatened" status will be considered when the populations collectively include 600 breeding-age northern red-bellied cooters, among at least 15 self-sustaining populations. In addition, the species will be considered for delisting when the populations collectively include at least 1,000 breeding-age individuals among 20 self-sustaining populations, along with certain requirements for habitat protection and increased life history information to protect and manage the species and its habitat (USFWS 2007).


Bill Byrne MDFW

A young northern red-bellied cooter

Many factors have contributed to the current endangered status. The northern red-bellied cooter's small population size and restricted range are foremost among factors limiting its long-term viability. As a small, isolated population, the northern red-bellied cooter may be subject to inbreeding and genetic drift, which can reduce genetic variability and potentially decrease survivorship. Limiting factors include: adverse modification of water quality due to siltation from land clearing adjacent to ponds; pollution and excess nutrients in ponds; and pollution of groundwater or reduction in the water levels of ponds from groundwater withdrawals (pumping). These disturbances can adversely affect aquatic invertebrates and vegetation which provide food and shelter. Other factors include draining or filling of wetlands adjacent to occupied ponds and shoreline modifications such as filling, dredging for beaches, dikes, real estate development, or similar activities. The northern red-bellied cooter has also been subject to environmental pressures in more recent times. The Plymouth County area, particularly along pond shores, has undergone rapid residential and commercial development. Long-term changes to land use practices (such as those associated with development and recreation) may cause loss of needed undisturbed nesting and basking sites. Closure of the forest canopy also plays an important role in diminishing habitat suitability. In pre-colonial and early colonial periods, the pine barren habitat was burned often. Today, the area has been largely protected from fire, and most remaining undeveloped areas are closed-canopy pine forest. The closed-canopy forest surrounds most ponds; hence, suitable nesting habitat that receives adequate solar heating (sunlight) for nest incubation is scarce (USFWS 1994).

Habitat alteration as a result of agricultural development and practices may affect the status of the northern red-bellied cooter population. It is unknown to what extent northern red-bellied cooters have been affected by the growth of the cranberry industry in the region. Cranberry bog acreage increased greatly during the last century, and the industry owns and manages more than 14,000 acres in Massachusetts (Cranberry Growers Association 2014). The immediate and long-term effects of chemicals used by cranberry growers have not been studied. While the bogs themselves are a monoculture of cranberry plants, and considered low value northern red-bellied cooter habitat, many of the reservoirs and upland watershed areas managed by the industry provide high quality habitat. Some of these areas have become increasingly important to the species conservation as surrounding habitat is lost to residential development or becomes over-shaded through forest succession. Due to the changing markets and socioeconomic pressures, the potential decrease in acreage owned and managed by these growers could pose new threats of development and disturbance to northern red-bellied cooters.

Limiting factors for hatchling and juvenile northern red-bellied cooters include predation, low nesting success, and high juvenile mortality. Less than one percent of newly hatched turtles survive their first winter (USFWS 2007), although protecting nests and releasing head-started turtles may be effective short-term measures to improve first winter survival rates. Available data indicate that non-headstart hatchlings released directly into ponds may experience nearly 100 percent mortality. Predation by bullfrogs, herons, and snapping turtles is suspected but poorly documented. Predation of unprotected nests by raccoons and striped skunks, whose populations tend to increase with residential development and habitat fragmentation, has been documented to be relatively high (Graham Annual reports 1984-1999, USFWS 1994). The widespread introduction and translocation of several predatory sport fish including smallmouth bass, largemouth bass, chain pickerel, brown bullhead, and white perch, may also play a key role in the low hatchling turtles survivorship, although no studies have been undertaken to address this possibility (USFWS 1985, USFWS 2007).

To increase survival and recruitment by reducing predation rates, in 1985 MassWildlife, in partnership with the Service, began a headstart program that continues today. Headstarting involves raising northern red-bellied cooter hatchlings in captivity for nine months (through their first fall and winter) and then releasing them back to the wild in the following spring/summer. Since 1985, over 3,500 wild-born individuals have been headstarted and released at 28 sites, including two large river systems and 13 new ponds. This is the longest and most intensive freshwater turtle headstart program in existence. Anecdotal observations and some preliminary field work suggest that the headstart program has provided an important contribution to species recovery, but the population increase and landscape occupancy remains uncertain. It is estimated that the population increased from 400 to 600 breeding-age individuals, in more than 20 ponds (USFWS 2007).This breeding-age population estimate is likely conservative because it is based on a demographic model that incorporates known survival rates of headstarted individuals, but not reproduction by the headstarted or wild cooters (both of which are now documented). Additionally, very little field work has been conducted to validate other model assumptions (i.e., no increased annual survival with age, most likely an untrue assumption), or determine the current distribution of northern red-bellied cooters across the landscape.

From the late 1960s through 2001, researchers working with the Service and MassWildlife studied northern red-bellied cooters throughout their range. Some of this work occured at the refuge (USFWS unpublished reports). Research focused primarily on determining the species biology and identifying factors adversely affecting population size, and secondarily assessing taxonomic status. Data for determining age- and sex-distribution, population size, and growth and survival rates were collected at several ponds. However, information needs remain (Haskel 1993). Although focused, on-the-ground research ceased in the early 2000's, Massachusetts Division of Fisheries and Wildlife has continued monitoring at priority nesting sites. In 2013, the Division re-initiated field research, focusing on refining methods for (1) capture and processing of adult and juvenile cooters, (2) documentation of nesting, and (3) visual surveys. This preliminary field work also provided evidence of the improved population status of this species. Through this effort over 100 adult and subadult individuals (released as headstarts from 1987 to 2006) were captured and implanted with passive integrated transponder tags at two primary study sites where northern red-bellied cooter populations were established through the release of individually marked, headstarted turtles in the late 1980's and early 1990's. Over 40 nesting attempts by adult headstarts and evidence of juvenile recruitment were documented (MassWildlife unpublished data).

Northern Red-bellied Cooters at Crooked Pond

Headstarted northern red-bellied cooters (81 total) were released annually into Crooked Pond from 1985 to 1991 (USFWS 1994), and mark-recapture surveys were conducted. Population size of these head-started turtles is estimated at 40, and annual survival rates are high, averaging over 85 percent (Haskell 1993). Surveys conducted from 1985 to 2001 show the Crooked Pond northern red-bellied cooter population was almost entirely headstarted individuals, with a disproportionate sex ratio favoring males. Limited movement, primarily of male cooters, was documented (T. Graham, personal communication, undated).

Refuge staff conducted habitat management work on the Crooked Pond shore to improve and create additional cooter nesting habitat since 2001. Management actions include girdling trees to decrease canopy cover and increase sunlight, rototilling and loosening of soil, and thinning low shrubby vegetation. Management was conducted at three sites: (1) on the western peninsula; (2) on the southwestern cove, and; (3) on the eastern peninsula. Monitoring of nesting habitat has been inconsistent in some years because of the travel distance to the refuge from our Sudbury headquarters, and varying levels of funding and staff. Beginning in 2013, refuge staff used trail cameras to monitor nesting areas at Crooked Pond and monitoring efforts have been thorough and consistent. Management actions and known nesting activity are summarized below in table 2-6.

Migratory Birds

Breeding landbird surveys were conducted on the refuge twice each year from 2001 through 2010. Over 60 species were detected during the surveys, and 2,401 individual birds were recorded. The most commonly recorded species was ovenbird (16 percent of all landbirds recorded), followed by eastern towhee (9 percent of all landbirds recorded). The 9 most commonly recorded species comprised more than 60 percent of all landbirds recorded (See table 2-7). These species also tended to be widespread and were generally detected at all (or most) of the 11 survey points during the 10 years of surveys. For a complete list of birds documented during breeding bird surveys, and recorded opportunistically on the refuge, see appendix A. Breeding landbird surveys were recently re-initiated, but data have not been yet analyzed.

Mammals

Few mammal surveys have been conducted on the refuge. Acoustic monitoring was conducted in 2012 at the Crooked Pond parcel to determine presence of bat species, and in 2013 the survey effort was expanded to include the Island Pond parcel. Preliminary analysis of 2012 acoustic survey data indicates the presence of big brown, Eastern red, silver-haired, tri-colored, and Eastern small footed bats, but data verification from 2012, as well as preliminary analysis and data verification from 2014, are still ongoing. No bats calls were recorded in 2013 (USFWS unpublished data).

Limited live trapping was also done at the refuge in January 2012 to survey for New England cottontail, but the only mammal caught was a fisher. Mammals observed opportunistically on the refuge include red squirrel, white-tailed deer, raccoon, striped skunk, red fox, grey fox, and coyote (USFWS unpublished data).

It is uncertain as to whether white-tailed deer on the refuge are overabundant due to the large scale at which regional deer population studies are conducted. A study of deer survivorship in the MSSF indicated the deer density was 15 to 20 deer per square mile (Epsilon 2001 as referenced in MADCR 2011). This suggests deer abundance in the vicinity of the refuge is currently well above the MassWildlife 2014 "target" of 6 to 8 deer per square mile average density for Wildlife Management Zone 11(MassWildlife 2015; *http://www.mass.gov/eea/agencies/dfg/dfw/publications/masswildlife-annual-reports.html*; accessed November 2015).

Appendix A lists mammal species present on the refuge.

Reptiles and Amphibians (other than Northern Red-bellied Cooters)

Standardized anuran surveys were conducted on the Crooked Pond parcel of the refuge in 2001 and 2002 and several species of frogs and toads were recorded: bullfrog, green frog, northern spring peeper, American toad, and gray treefrog (USFWS unpublished data). Several other reptile and amphibian species have been recorded by Service staff and volunteers while conducting other work including Fowler's toad, northern leopard frog, wood frog, red-spotted newt, red-backed salamander, milk snake, eastern ribbon snake, and eastern hognose snake. Turtles recorded by staff while conducting cooter surveys included musk (stinkpot) turtle, snapping turtle, and painted turtle (USFWS unpublished data). Appendix A lists reptile and amphibian species present on the refuge.

One amphibian and two reptiles identified as SGCN in the Massachusetts SWAP (MassWildlife 2015) inhabit lake and pond environments. Northern leopard frog can be found in damp, heavily vegetated areas of lake margins or swampy areas, as well as adjacent terrestrial habitats, which provide foraging, refuge, and breeding habitats.

Fish

No formal fish surveys have been conducted by the Service on refuge property; however, largemouth and smallmouth bass, chain pickerel, yellow perch, white perch, black crappie, and pumpkinseed have all been documented in Crooked Pond (Graham Annual Reports, 1987-2000). Additionally, redbreast sunfish are frequently seen in Crooked Pond (USFWS unpublished data). Appendix A lists fish species present on the refuge.

Brian Bastarache

Redbreast sunfish and their nests in Crooked Pond at Massasoit National Wildlife Refuge

Invertebrates, Including Pollinators

No formal surveys of invertebrates have been conducted on the refuge, but several species have been documented by Service staff and volunteers while conducting other work. Those species are listed in appendix A.

Coastal plain ponds and pine barren supports several rare invertebrates, including moths and other native pollinators. Rare species have been documented on neighboring MSSF (2011) and are listed in appendix A.

Seven dragonfly and damselfly species (odonates) identified in the 2015 Massachusetts SWAP are also found within and around lake and pond environments. Further, coastal plain ponds have been listed by others as the most vulnerable odonate habitats in the northeastern U.S. (White et al. 2014). Odonates display three distinct life stages: aquatic egg and larval stages, and an adult flying stage. Near-shore emergent plants are important dragonfly and damselfly sites. Many larval odonates live amongst the submerged vegetation and climb onto the emergent vegetation to undergo metamorphosis to adults within littoral lake habitats. Upon emergence, dragonfly and damselfly adults move briefly to upland habitats to feed and mature before returning to vegetated lake and pond margins to mate. Eggs and larvae may survive short-duration water level drawdowns for a time either in the stalks of vegetation or in the mud of drying ponds. The scarlet bluet, attenuated bluet, and Pine Barrens bluet are known from only a limited number of locations primarily in coastal plain ponds of southeastern Massachusetts and the Cape.

The water-willow stem borer, a Noctuid moth, another Massachusetts SGNC (MassWildlife 2015), inhabits shallow portions of coastal plain ponds, swamps, and abandoned cranberry bogs. Larvae of this moth species bore into and feed internally upon water-willow, requiring management and conservation strategies are undertaken on a broader, landscape, ecosystem-based scale.

Table 2-6. Summary of Management Activities for the Northern Red-bellied Cooter at Crooked Pond.

Year	Summary of Habitat Management	Northern red-bellied cooter Nesting Activity
2001	• Cleared vegetation from eastern peninsula in March and April.	• None.
2002	• Cleared vegetation and loosened soil in western cove. • Cleared vegetation from eastern peninsula in March.	• None.
2003	• None.	• None found by staff, but volunteer found one nest on eastern peninsula that was depredated by a canid.
2004	• Rototilled soil and removed vegetation in western cove. • Removed trees, raked vegetation, and rototilled soil on western peninsula. • Turned soil manually and removed shrubs on eastern peninsula in June.	• None found in 2004, however, evidence of nesting in 2004 was confirmed when one nest was discovered on May 17, 2005, during habitat work on eastern peninsula. Volunteer found four eggshells and one shell with a cooter still inside.
2005	• Turned soil manually on eastern peninsula. • Rototilled soil on western cove and western peninsula. • Removed high bush blueberry along edges and around 15 trees on western peninsula in May.	• None.
2006	• Removed old cabin on western peninsula in spring and filled foundation with sand in fall.	• None.
2007	• Cut vegetation and girdled trees on western peninsula in March and April. • Rototilled soil on western peninsula and western cove in May.	• Two nests (around 14 eggs each) successfully hatched from western peninsula near old cabin site. Evidence of nest hatches were found on October 4 and had likely hatched within a week prior.
2008	• Rototilled soil on western peninsula and western cove; trimmed vegetation on western peninsula edges in May.	• None.

Year	Summary of Habitat Management	Northern red-bellied cooter Nesting Activity
2009	• Rototilled soil on western peninsula and western cove. Trimmed vegetation on western peninsula edges and in some swaths to pond edge in May.	• One nest (at least 10 eggs) was found on July 6 in western cove and protected with a predator exclosure.
2010	• Rototilled soil and removed vegetation on western peninsula and western cove in May.	• None.
2011	• None.	• None.
2012	• None.	• No nests found, but three females trapped in Crooked Pond are known to have nested (caught while gravid, and again post-laying) and likely nested on the Crooked Pond shoreline.
2013	• None.	• One nest (10 eggs) was found and protected with a predator exclosure. • Ten hatchlings collected from 1 nest.
2014	• Removed shrubs and small trees crowding the nesting areas with power and hand tools. • Turned over soil and removed small grasses with rakes and hoes.	• Five nests were found; 3 were predated and 2 were protected with a predator exclosure (11 eggs and 14 eggs). • Twenty-four hatchlings total collected from 2 nests.
2015	• None.	• Eight nests were found; 7 were predated and 1 protected with a predator exclosure. (15 eggs). • Thirteen hatchlings total collected from one nest.

Table 2-7. Bird Species Detected at Most Survey Points during 10 Years of Breeding Surveys.

Species	Total Individuals Recorded	Percentage of Total Recorded	Percentage of Points Detected
Ovenbird	384	16	100
Eastern Towhee	201	9	91
Baltimore Oriole	163	7	100
Pine Warbler	140	6	100
Hermit Thrush	126	5	100
Tufted Titmouse	123	5	100
Black-capped Chickadee	109	5	100
Eastern Wood-Pewee	100	4	100
Scarlet Tanager	92	4	91

Climate Change

Climate warming is unequivocal, as evidenced by observations of increased global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level. In its 2007 assessment report on climate change, the International Panel on Climate Change (IPCC) stated that it had "very high confidence that the global average net effect of human activities since 1750 has been one of warming" (IPCC 2007). The U.S. Climate Change Science Program (CCSP) published findings in agreement with the IPCC report, stating that "studies to detect climate change and attribute its causes using patterns of observed temperature change in space and time show clear evidence of human influences on the climate system (due to changes in greenhouse gases, aerosols, and stratospheric ozone)" (CCSP 2008).

Climate change is a serious concern to the Service and our conservation community partners. Scientists are predicting dramatic changes in temperature, precipitation, soil moisture, sea level, and frequency and magnitude of storm-surge flooding and coastal erosion—all of which could adversely affect the function of ecological systems and modify vegetation and wildlife distributions (CCSP 2008). Species' ranges are expected to continue shifting northward or to higher elevations as temperatures rise; however, responses will likely be species-specific and vary according to local changes in precipitation and temperature. Under rapidly changing conditions, migration not evolution, would determine which species are able to survive (Inkley et al. 2013, NABCI 2010, IPCC 2007). Species that cannot migrate or otherwise disperse at a sufficient rate to keep pace with shifting climate zones, such as many plants and a variety of less motile wildlife, will suffer the most. For example, plants, mussels, and amphibians are more vulnerable to shifts in temperature that may affect their ability to survive, grow, and reproduce. Climate change impacts in coastal regions also include a higher frequency of intense hurricanes and storms, more severe impacts of lesser intensity storms (including nor'easters), warming ocean waters, and rising sea levels (Frumhoff et al. 2007).

Climate Change as it Relates to Massachusetts

Predictions

Massachusetts' climate is already changing and will continue to do so over the course of this century. Ambient temperature has increased by approximately 1.8 °F since 1970, and sea surface temperature has increased, on average, by 2.3 °F between 1970 and 2002. These warming trends have been associated with other observed changes, including a rise in sea level of 0.72 feet between 1921 and 2006, more frequent days with temperatures above 90 °F, reduced snowpack, and earlier snow melt and spring peak flows (Frumhoff et al. 2006, 2007; Hayhoe et al. 2006). By the end of the century, under the IPCC high emissions scenario, Massachusetts is predicted to experience a 5 to 10 °F average ambient temperature increase, with several more days of extreme heat during the summer months. The annual number of days with temperatures greater than 90 °F is predicted to increase from 5 to 20 days currently to 30 to 60 days annually. At the same time, the number of days with temperatures above 100 °F is expected to rise from 2 days currently to as many as 28 days annually (Frumhoff et al. 2006, 2007). Sea surface temperatures are also predicted to increase by 8 °F (Dutil and Brander 2003, Frumhoff et al. 2007, Nixon et al. 2004), while winter precipitation—mostly as rain—is expected to increase by 12 to 30 percent. The number of snow events is predicted to decrease from five each month to one to three each month (Hayhoe et al. 2006).

Ecological changes in response to climatic change have been observed in the northeastern United States as plants leaf out and bloom earlier (Wolfe et al. 2005), amphibian breeding seasons start earlier (Gibbs and Breisch 2001), and Atlantic salmon spring migrations begin sooner (Juanes et al. 2004). In addition to these direct impacts, species and ecosystems face a broad range of indirect climate-related threats. For example, rising temperatures cause decoupling of bird migration and food source timing and provide a competitive advantage to nonnative insects and plants.

It is also important to recognize that the observed ecological changes in North America and elsewhere have occurred under a relatively modest average global temperature increase of only 1.3 °F; the additional increase of 5 to 10 °F predicted for the Northeast is likely to have considerably greater impacts on ecosystems.

Coastal Plain Ponds (Kettle ponds)
Changes in climate and local weather patterns will likely affect aquatic systems by exacerbating or accelerating habitat degradation due to other identified threats (MassWildlife 2015). Warmer temperatures will warm coastal plain pond waters faster. Additionally, increases in severe rain and snowfall events will increase runoff of pollutants from agricultural and urban areas into waterbodies that combined with increased surface water temperatures will allow longer growing seasons for nuisance aquatic plants and harmful algal blooms (MassWildlife 2015). Increases in rain will also increase atmospheric deposition of pollutants, including nitrogen deposition. Extended periods of drought could result in lowered water levels and the loss of littoral habitat.

Recent research indicates that the last two decades have been the wettest years in the Northeast in 500 years (Pederson et al. 2013, Newby et al. 2014, Weider and Boutt 2010). The Sustainable Water Management Initiative, administered by the MADEP, with input from multiple state agencies, is supporting research by the USGS into the degree of hydrological alterations imposed by water supply withdrawals and climate change (MassWildlife 2015).


USFWS

Forest habitat on Massasoit National Wildlife Refuge

Upland Forests
Upland forests provide important functions including support for a variety of habitats and wide-ranging biological diversity, purification of air and water, moderation of subsurface and overland water flow, and the sequestration of carbon in both the above-ground vegetation and in the organic components of forest soils. In addition, forests provide scenic, recreational, and tourism benefits and a rural quality of life desired by many citizens.

Upland forests provide important filters along wetlands, rivers, and streams and stabilize soils and sediments in high-gradient streams, thus minimizing erosion. They also help to moderate temperature by shading small streams. They provide important habitat for wildlife species that occupy vernal pools and offer both direct or indirect habitat benefits to forest-dependent wildlife species. In conjunction with other stressors, climate change will alter forest structure and function and change species composition and the ability of forests to provide wildlife habitat. Climate change could also reduce the ability of forests to provide ecological services such as air and water cleansing (Executive Office of Energy and Environmental Affairs (EOEEA) 2011).

Under the most commonly accepted climate change scenarios, Massachusetts could experience a greater intensity and frequency of forest-disturbing weather events, including ice storms, localized or regional wind events such as microbursts or hurricanes, and more frequent and longer droughts and associated wildfire. Any of these conditions or events has the potential to kill or alter the vigor of native trees, thereby opening the forest to new species. The same climate change phenomena that affect trees could also impact forest-dependent species such as song birds, forest floor plants, and invertebrates, as well as disrupt predator-prey relationships and alter phenological patterns and other complex ecological processes. Some changes may be slow while others may proceed quickly once critical thresholds are met (e.g., forest pests). Changes in species composition are predicted as the result of increased ambient temperatures that will extend the northern limits of species with limited cold tolerance. Corresponding changes in habitat suitability are also likely. Range shifts in tree distribution (historically, forest types have shifted at the rate of 12 to 15 miles every 100 years) will change the relative proportions of forest tree species. However, the migration of tree species in response to habitat changes is likely to be much slower than the predicted changes in habitat due to climate change. It is also important to note that differing movement is likely to occur at the individual species level and not by groups of species. These changes could happen quickly or take place over decades (EOEEA 2011).

Changing climate factors and forest types will also likely alter the composition and role of myriad other forest species including vertebrates, invertebrates, shrubs, herbs, non-vascular plants, fungi, and bacteria. Invasive insects and diseases will also respond to climate change. For example the hemlock woolly adelgid is likely to expand northward while the response of other species, such as the emerald ash borer, the Asian longhorned beetle (currently attacking hardwoods in Worcester), or the widespread beech bark disease, is uncertain. Overall, the negative impacts of invasive species may increase as native forests are increasingly stressed and become more vulnerable to changes in mean and maximum air temperatures and subsequent changes in the water cycle (EOEEA 2011).

The 2015 Massachusetts SWAP states that Massachusetts forestlands are being impacted by elements of human-accelerated climate change (Rustad et al. 2012) such as increasing growing season length, more extreme summer temperatures, and increased periods of summer drought, as well as by more frequent freeze-thaw cycles in winter (*http://nsrcforest.org/sites/default/files/uploads/templer09full.pdf*, accessed November 2015). Climate change appears at least partially responsible for the recent and rapid spread of native insect pests such as the Southern pine beetle into more northern climes (Gan 2004). Southern pine beetle very recently caused extensive mortality of pitch pine on Long Island, and could soon cause similar mortality in southeastern Massachusetts' pitch pine forests.

The *Climate Change and Massachusetts Fisheries and Wildlife* report was written to address the climate change stressors to habitats and wildlife mentioned in the Massachusetts SWAP (MassWildlife 2006). The overall objective of this three volume report is to advance the adaptation planning to climate change (Manomet and MassWildlife 2010). Volume 2 addressed the vulnerabilities to habitats and wildlife and specifically addressed twenty habitats most likely to be impacted by climate change. Vulnerability scores were assigned to each habitat based on both low and high emissions scenarios and are delineated from "critically vulnerable" to "greatly benefit" from climate change. This report indicates a *medium* vulnerability score (four) for pitch-pine-scrub oak habitats, suggesting these forests are *less vulnerable* to climate change and unlikely to change in their extent, or to experience only moderate losses under both the lower and higher emissions scenarios. The confidence score assigned to this habitat is *Medium* because of the potentially confounding effects of drought. While it is likely that an increased frequency and severity of drought could adversely affect these habitats in Massachusetts, given the uncertainty of modeling precipitation change the scientists were unable to project future changes with more confidence (Manomet and MassWildlife 2010). Other forest types represented on the refuge were not listed in the vulnerability assessment. Because pitch pine is prevalent on the refuge, it is less vulnerable to climate change due in part to its ability to tolerate wildfire (Manomet and MassWildlife 2010) with the removal of excess hazardous fuel through prescribed burning.

Climate change may cause a shift in species composition in young forest and shrubland habitats in Massachusetts, but these habitats will be able to be maintained on the landscape with active management (MassWildlife 2015). Some rare plant species, such as chestnut-colored sedge, currently near their southern extent in Massachusetts, may disappear from our landscape as a result of climate change.

This report may be viewed online at: *http://www.mass.gov/eea/agencies/dfg/dfw/wildlife-habitat-conservation/climate-change-and-massachusetts-fish-and-wildlife.html* accessed October 2015.

Precipitation, Drought, and Streamflow

The Northeast is forecasted to experience a greater frequency of high precipitation events. Scientists predict an 8 percent increase in extreme precipitation events in the northeastern U.S. by mid-century, and up to a 13 percent rise by 2100. In the case of coastal storms, the frequency and timing of winter storms or "nor'easters" could change. Under the low-emissions scenario, little change is predicted in the number of "nor'easters" striking the Northeast, but it could experience approximately 5 to 15 percent more late-winter storms under the high-emissions scenario (Frumhoff et al. 2007).

Changes in temperature, as well as in the amount, timing, and type of precipitation, affect streamflows and drought characteristics. With more winter precipitation as rain and less as snow, there is likely to be more runoff during the winter and less during the spring. This phenomenon along with the increased temperatures would cause streamflow to peak earlier in the year and to be lower in the spring, which is typically when flows are highest. Changes in precipitation and runoff can have a substantial impact on fisheries, agriculture, and other natural systems. Drought is related to soil moisture, which in turn is related to evapotranspiration, rainfall, temperature, drainage, and climatic changes. By the end of the century, under the high emissions scenario, the occurrence of droughts lasting 1 to 3 months could rise by as much as 75 percent over historic conditions (Hayhoe et al. 2006). Streamflows would be lower in the summer months, especially under the high emissions scenario, as a result of higher evapotranspiration.

Aquatic Resources

Aquatic ecosystems are also vulnerable to climate change. Predicted changes in timing, frequency, and duration of precipitation events, more intense storms, a shift from winter snow to rain, more frequent and longer summer droughts, and increases in temperature trends as well as extreme high temperatures will affect both lotic (flowing water) and lentic (still water) habitats (EOEEA 2011).

Predicted increases in temperature, drought, and the number of extreme heat days, combined with a decrease in summer precipitation, are expected to adversely impact water quality and quantity. Higher temperatures along with changes in stream flow will degrade water quality. Warmer, drier conditions will lead to deeper and stronger thermal stratification in lakes which will decrease the volume of the deeper, cooler, well oxygenated water that is critical summer habitat to a number of species. This habitat may be eliminated altogether from many shallower lakes and ponds. Under warmer conditions, nonnative species will likely become a bigger problem in lake and stream ecosystems (Ramsar 2002). In general, climate change can influence the establishment and spread of invasive species and reduce resilience of native habitats to these species (USEPA 2008). Increased mobilization of non-point source nutrients and suspended solids from more intense winter rain storms, followed by higher summer temperatures, will result in more frequent algal blooms (e.g., blue-green algae) and the vigorous growth of aquatic vegetation leading to nutrient rich and dissolved oxygen depleted lakes and impounded rivers (EOEEA 2011).

A projected increase in average winter temperatures will decrease the amount of snowpack and ice and negatively impact aquatic ecosystems. Reduced ice cover on lakes and ponds will result in more winter sunlight penetrating below the surface and more abundant aquatic vegetation, while less melting snowpack will reduce spring groundwater recharge. A shift from snow to rain during the winter will potentially lead to more runoff, more flooding, and greater storm damage, and scour and erosion during a time when there is reduced vegetative cover and low evapotranspiration (the combination of evaporation from the ground and transpiration from plants). In waterways and water bodies, increased temperatures are likely to cause loss of thermal refuges for coldwater species, decreases in dissolved oxygen, changes to hydrologic mixing regimes, and changes in biogeochemical cycling (Ramsar 2002).

The *Climate Change and Massachusetts Fisheries and Wildlife* report indicates that kettle ponds have a *medium vulnerability* rate (score of five) for impacts from climate change under both the low and high emissions scenarios. This score means that these ponds are *vulnerable* to climate change and at risk of being reduced or greatly reduced in extent under either emissions scenario. The factor most influencing this score is the vulnerability to aquatic invasive species (Manomet and MassWildlife 2010). These ponds are also potentially vulnerable to drought which is projected to increase in intensity and frequency under both scenarios (Manomet and MassWildlife 2010).


Andrew MacLachlan

Female eastern towhee

The 2015 Massachusetts SWAP states that changes in climate and local weather patterns will likely affect aquatic systems by exacerbating or accelerating habitat degradation due to other identified threats. Extended periods of drought could result in lowered water levels and loss of littoral habitat. Littoral areas are used for foraging, rearing, reproduction, and refuge by a myriad of species including mussel, odonate, fish, and invertebrate species. Thus extended periods of drought and the loss of these areas has the potential to reduce the abundance of these species. Additionally, increases in severe rain and snowfall events will increase runoff of pollutants from agricultural and urban areas into waterbodies. Increases in rain will also increase atmospheric deposition of pollutants, including nitrogen deposition. In addition to increased nutrient pollution from runoff and atmospheric deposition, increased surface water temperatures will allow longer growing seasons for nuisance aquatic plants and harmful algal blooms.

Climate change and severe weather may threaten coastal plain pond and pond shore habitats (MassWildlife 2015). While much uncertainty remains as to exactly how climate change impacts will manifest themselves, it is reasonable to expect that warmer temperatures will warm water in coastal plain ponds faster than normal, and may make some ponds inhospitable to their suite of current species. Warming of surface and groundwater in coastal plain ponds may create conditions that favor invasive species, and increase growing seasons for harmful algal blooms. Additionally, increases in severe rain and snowfall events will increase runoff of pollutants from agricultural and urban areas into waterbodies. Increases in rain will also increase atmospheric deposition of pollutants, including nitrogen deposition. In addition to increased nutrient pollution from runoff and atmospheric deposition, increased surface water temperatures will allow longer growing seasons for nuisance aquatic plants and harmful algal blooms.

Although total precipitation is expected to increase for southeastern Massachusetts, other common predictions include warmer temperatures, longer and more severe summer droughts, shorter but more intense winter/spring floods, and reduced extent and duration of winter snow cover. Taken together, such changes could alter the hydrological regimes of many coastal pondshore habitats in the region. Expected outcomes include seasonal drying of wetland soils, which could facilitate changes in dominant vegetation.

Lake Depth
In 2009, researchers collected surface and deep core sediment samples from Crooked Pond as part of a study to establish a relationship between chironomids and lake depth, with the goal of using chironomid remains as an indicator of moisture levels, and thus climate change (map 2-4). Although precipitation is a major climatic variable, there are almost no proxies available to quantitatively reconstruct lake depth, which is a major problem for establishing natural variations in precipitation, but also for validating climate models used to predict future climate changes. This project aims to develop a new tool for reconstructing past changes in precipitation using fossil chironomid remains as indicators (Cwynar 2009). The deep sediment core was used to reconstruct changes in depth over the last 8,000 years, and results can be found in Engels et al. (2012).

Specific Climate Change Impacts on the Northern red-bellied cooter
The northern red-bellied cooter population is geographically separate and distinct from the more southern species and an increasingly warmer climate could have several effects on this northern population. Warmer weather in spring and summer may provide more favorable conditions for basking, feeding, and nesting. Hatching success (absent predation) may increase, and a more equal sex ratio of hatchlings could result. However, shifts in other species' ranges could affect this population as well, introducing new competitors, pathogens, and invasive species (USFWS 2007). Drought conditions could reduce groundwater levels and subsequently lower water levels within the kettle ponds, streams, rivers, and other important wetlands. Warmer winters could result in ponds not icing over and therefore change the winter hibernation pattern of the cooter. More research is needed to determine the impact of climate change on the northern red-bellied cooter and other species of conservation concern.

Potential Contributions of Refuges to Climate Change Mitigation and Adaptation
Table 2-8 below demonstrates potential impacts from climate change and offers specific examples of how those impacts can be addressed at Massasoit NWR:

Table 2-8. Potential Contributions of Refuges to Climate Change Mitigation and Adaptation.

Problems Associated with Climate Change	Refuge Mitigation Potential
Rising ambient air temperature caused by increasing greenhouse gases. Increased water temperatures.	Sequester carbon in vegetative biomass that also serves as "sinks" for greenhouse gasses.
Modified fire frequency and intensity.	Use controlled burn programs to reduce fuel loads and forest canopy shading on refuge and train fire professionals for other areas in need.
Loss of species and their required habitat.	Protect lands with a diversity of habitats for declining species and spearhead efforts to protect species of concern. Protect genetic diversity and serve as a source for repopulation efforts.
Geographical shifts in biomes and species' ranges.	Serve as ecological hub in a greater network of conservation lands, allowing for species migration.
Altered species phenologies and interaction (competition, predation, parasitism, and disease).	Provide natural, minimally altered (i.e., minimal building structures) settings for the evolutionary process and wildlife interaction.
Advancement of exotic invasive species, pest species, pathogens, and contaminants.	Manage to control and eradicate invasive species on refuge lands. Focus efforts to reduce species susceptibility to disease, pathogens, pests, and contaminants.
Limited scientific understanding of long-term climate change implications.	Develop inventory and monitoring sites for ecological and climate variables. Conduct direct research to address climate change topics. Continue to build scientific capacities and expertise in the agency. Foster collaboration among conservation science community.

Source: Excerpt from table in Crane Meadows Refuge CCP (USFWS 2010)

Refuge Access and Public Uses

Priority Wildlife-Dependent Recreational Uses

The refuge is currently closed to all public uses including the six priority, wildlife-dependent recreational uses: hunting, fishing, wildlife observation and photography, environmental education and interpretation. The refuge has not been open to the public since its establishment due to both staffing limitations and the presence of a federally endangered species that is disturbance sensitive. Exceptions have been made for occasional interpretive and environmental education programs under a special use permit (SUP) or special staff-led programs.

Activities Not Allowed

Unauthorized activities that occur on the refuge include: horseback riding; ORV use, including all-terrain vehicles (ATVs) and motorized dirt bike use; mountain biking; fishing in Crooked Pond; dog walking; swimming; boating; and hiking.

Law Enforcement Concerns

Law enforcement on the refuge is conducted:

- To enhance the management and protection of fish and wildlife resources on refuges.
- To ensure legal and equitable utilization of fish and wildlife resources on refuges, as prescribed by law.
- To obtain compliance with laws and regulations necessary for proper administration, management, and protection of the Refuge System.
- To protect refuge visitors and their possessions from disturbance or harm by other visitors or themselves.
- To assist visitors in understanding refuge laws and regulations and the reasons for them.

Massasoit NWR is patrolled by Federal wildlife officers from the Refuge Complex, along with officers from the Massachusetts Environmental Police. In addition to general public safety, these officers focus on the prevention of, and investigation into resource violations such as disturbance of the northern red-bellied cooter and its habitat, and trespass of horses, dogs, and ORVs.

Special Use Permits, Including Research

SUPs are issued to individuals, organizations, and agencies that request the use of refuge facilities or resources beyond those generally available to the public. To ensure that wildlife disturbance is minimized, special conditions and restrictions are identified for each request. We generally support research activities on the refuge that are compatible with the refuge purposes and help us gain knowledge and understanding to benefit our management goals and objectives. Further details on SUPs are available from the Refuge Complex.

Refuge Archeological, Historical, or Cultural Resources

No specific archeological surveys have been conducted on the refuge. The Massachusetts Historical Commission (MHC) and Service files indicate no known sites within the current refuge boundaries. The refuge has the potential to yield important information that could contribute to our knowledge about the original inhabitants of this area, and efforts must be made to protect the resources there. The area around the refuge has been significant for humans for the past 11,000 years. It is the ancestral homeland of the Wampanoag Nation, comprised of 69 Tribes from Provincetown to Narrangassett Bay. The Paktuksut Wampanoags were instrumental to the survival of the English colonists who landed in the Plymouth area in 1620 *http://www.mashpeewampanoagtribe.com/historyculture* (accessed August 2016). Today, many members of the Mashpee Wampanoag Tribe and the Gay Wampanoag Tribe of Gay Head (Aquinnah), both federally recognized Tribes, live in or maintain ties to the area. Refuge staff actively coordinate with Tribal members in the management of Mashpee and Nomans Land Island refuges. Systematic archaeological testing could help identify more pre-historic sites in this area, as well as further evidence of historical settlement.

Regional Socioeconomic Setting

Population Demographics

Massasoit NWR lies in Plymouth County, which consists of 660.85 square miles of land and in 2010 had a population density of 748.9 people per square mile (State density of 835.2 people per square mile). The population of Plymouth County, at the time of the 2010 Census, was 494,919, or about 7 ½ percent of Massachusetts' population (6,547,629). Between 2000 and 2010, Plymouth County's population grew by 4.7 percent, compared to a Statewide 3.1 percent growth rate *http://quickfacts.census.gov/qfd/states/25/25001.html* (last accessed October 2015). Table 2-9 below illustrates the population changes over the last 100 years.

Table 2-9. Population Change in Plymouth County.

Year	1910	1920	1930	1940	1950	1960	1970	1980	1990	2000	2010
Population	144,337	156,968	162,311	168,824	189,468	248,449	333,314	405,437	435,276	472,822	494,919
Percent Change		+8.8	+3.4	+4.0	+12.2	+31.1	+25.5	+21.6	+7.4	+8.6	+4.7

Source: http://www.census.gov/population/cencounts/ma190090.txt (accessed October 2015)

As of 2010, there were 174,288 households in Plymouth County with an average of 2.73 persons per household. There were a total of 194,237 (2009) housing units within the county at an average density of 294 per square mile. The population distribution included 24.2 percent children under age 18 and 13.4 percent adults age 65 years or older. Fifty-one percent of the population was female (2009). The racial makeup of the county is depicted in table 2-11. While periodic updates do occur between the decennial censuses, we include only the official decennial census data here for simplicity's sake. Please visit: *http://www.census.gov/quickfacts/table/PST045216/25023,00* for more recent Plymouth County population and demographic estimates.

The town of Plymouth is a coastal community in southeastern Massachusetts, approximately 5 miles north of the Cape Cod Canal. It is the seat of Plymouth County, and has the largest land area of any town in the Commonwealth. For most of its existence, Plymouth was an isolated seacoast community, where economic fortunes were linked to the sea and shipping. The site of the original 1620 settlement is now a portion of today's Downtown-Harbor District.

The South Shore's accessibility to the Boston metropolitan area has greatly influenced the growth rates of its communities. Desirability in terms of land prices, tax rates, and residential amenities further influenced community growth, and Plymouth's population mushroomed from 18,606 in 1970 to 45,608 in 1990, a 145 percent increase in just 20 years. Also of significance during this period was the development of a healthy industrial and commercial base. In 2000, Plymouth's population was 51,701; in 2010, it had grown to 56,468. The rate of growth declined from 13.3 percent in 1990 to 2000 to 9.2 percent in 2000 to 2010 and much of this new growth has occurred in the rural residential areas of South Plymouth. The town and surrounding areas continue to out-pace state averages for development (Town of Plymouth 2009). Plymouth has an overall population density of 501 people per square mile. The town of Plymouth is committed to controlling its residential growth while welcoming industrial and commercial expansion.

One of the largest threats to the federally endangered northern red-bellied cooter is the increase in both residential and business development. Privately owned, unprotected open space is being converted into residential homes and the number of residential housing developments found near the refuge is increasing. The possible sale and development of thousands of acres, currently owned and managed as cranberry bogs, has the potential to greatly increase demand for housing development, increase pressure on open areas for recreation, decrease high quality wildlife habitat and wildlife corridors, and increase human-wildlife conflicts.

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Signs of trespass on the refuge

The median household income for Plymouth County in 2010 was $70,447, and this income level was among the highest compared to neighboring counties. Nantucket County had a median household income of $68,746; Barnstable County's and Bristol County's median household incomes were $64,057 and $54,048, respectively. The 2007 county business patterns for Plymouth County are listed below (table 2-10).

Plymouth's primary economic base is tourism and the different types of businesses that support that activity including hotel, restaurant, and retail industries. The major industry is tourism, with healthcare, technical and scientific research, real estate, and telecommunications also being primary industries. The largest employer in the town is Jordan Hospital (Town of Plymouth 2013).

Cranberry bogs have long been an important part of Massachusetts' culture, economy, and history. Plymouth County is one of the two biggest producers (Cape Cod being the other), with the nearby town of Carver hosting the Ocean Spray Corporation. The town of Plymouth has a small agricultural base (Town of Plymouth 2013) and hosts a current cranberry bog belonging to A.D. Makepeace Company, one of the largest cranberry companies in the world.

Environmental Justice

EO 12898, "Federal Actions to Address Environmental Justice in Minority and Low Income Populations," requires Federal agencies to identify and address potential disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations (EO 12898, February 11, 1994; *http://www.archives.gov/federal-register/executive-orders/pdf/12898.pdf*, accessed October 2015). The Presidential Memorandum accompanying this EO further directs Federal agencies to improve opportunities for community input and the accessibility of meetings, documents, and notices (Presidential Memorandum, February 11, 1994; *http://govinfo.library.unt.edu/npr/library/direct/memos/21a6.html*, accessed October 2015).

In creating table 2-11 below, we used the definitions provided by the United States Census Bureau for race, ethnicity, income, and poverty.

Table 2-10. Industry in Plymouth County.

Industry	Number of Employees	Annual Payroll ($1,000)
Forestry, Fishing, Hunting, Agriculture	67	3,772
Mining	145	11,174
Utilities	1,440	148,741
Construction	13,599	657,152
Manufacturing	11,869	567,468

Industry	Number of Employees	Annual Payroll ($1,000)
Wholesale Trade	6,893	414,032
Retail Trade	28,889	742,089
Transportation and Warehousing	5,026	189,209
Information	2,409	147,689
Finance and Insurance	7,120	379,100
Real Estate and Rental Leasing	1,834	70,984
Professional, Scientific, and Technical Services	7,370	418,185
Management of Companies and Enterprises	3,836	391,004
Admin, Support, Waste Management, Remediation Services	11,721	449,792
Educational Services	2,958	84,849
Health Care and Social Assistance	27,111	1,061,526
Arts, Entertainment, and Recreation	3,553	77,396
Accommodation and Food Services	16,873	252,674
Other Services (Except Public Administration)	7,940	251,941

Source: U.S. Census Bureau, 2008 Economic Census

Table 2-11. Regional Environmental Justice Detailed Characteristics.

	Plymouth County, Massachusetts (percent)	State of Massachusetts
Race and Ethnicity (from year 2010)		
White persons	85.5	80.4
Black Persons	7.2	6.6
American Indian and Alaska Native persons	0.2	0.3
Asian persons	1.2	5.3
Native Hawaiian and Other Pacific Islander	0.0	0.0
Persons reporting two or more races	2.6	2.6
Persons of Hispanic and Latino origin	3.2	9.6
White persons not Hispanic	83.9	76.1
Income and Poverty (from years 2005 to 2009)		
Median household income	$ 70,447	$ 64,057
Per capita income	$32,686	$33,460
Percent Persons below poverty level (from year 2009)	7.6	10.3

Source: United States Census Bureau, 2010

Refuge Administration

Refuge Funding

Successful implementation of the CCPs for each refuge in the Refuge Complex relies on our ability to secure funding, personnel, infrastructure, and other resources to accomplish the actions identified. The funding for Massasoit NWR is embedded in the larger Refuge Complex budget. Operational funding includes salaries, supplies, travel, and all other operational activities (wildlife and habitat surveys and management) that are not funded by special projects. Annual funding fluctuates according to the number and size of the projects funded that year (e.g. vehicle or equipment replacement, visitor service enhancements, and facility improvements). Table 2-12 summarizes the funding levels of levels for the larger Refuge Complex, including Massasoit NWR, for fiscal years 2008 through 2015.

Refuge Revenue Sharing Payments

The Refuge Revenue Sharing Act of 1935, as amended, provides annual payments to taxing authorities, based on acreage and value of refuge lands. We have contributed refuge revenue sharing payments to the town of Plymouth since 2001 (table 2-13). 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 actual refuge revenue sharing payment varies from year to year because Congress may or may not appropriate sufficient funds to make full payment. Payments are based on one of several different formulas, whichever results in the highest payment to the local taxing authority. In Massachusetts, the payments are based on ¾ of 1 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 their properties every 5 years.

Table 2-12. Fiscal Year Funding for the Eastern Massachusetts Refuge Complex from 2008 to 2015.

	2008	2009	2010	2011	2012	2013	2014	2015
Operations	$2,181,898	$1,919,276	$1,949,686	$2,109,679	$2,077,697	$1,545,974	$2,068,493	$2,317,269
Project, Construction, Temporary, and Other Funds	$497,465	$4,560,000*	$2,022,800*	$227,302	$470,289	$895,927	$1,013,199	$574,438
Total Fiscal Year Budget	$2,679,363	$6,479,276*	$3,972,486*	$2,336,981	$2,547,986	$2,441,901	$3,081,692	$2,891,707

**Includes American Recovery and Reinvestment Act funded projects, road work and construction of a new visitor center at Assabet River NWR.*

Table 2-13. Refuge Revenue Sharing Payments to Town of Plymouth in Dollars ($) for Massasoit NWR from 2001 to 2015.

Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Payment	4,927	5,299	5,093	4,505	5,088	1,735	1,678	1,302	1,223	862	923	4,380	5,140	4,811	5,058

Refuge Facilities and Maintenance

There are no buildings on the refuge. Two old cabins present on the refuge were demolished due to degradation and vandalism. There is no public parking at the refuge and no place to construct a parking lot.

Staff and equipment that provide support for operations and management on Massasoit NWR come primarily from the Refuge Complex headquarters located on Great Meadows NWR in Sudbury, Massachusetts.

Rights-of-Way and Access

Refuge staff generally access the Crooked Pond parcel through the MSSF on a dirt road located off of Snake Hill Road. A formal ROW off of Gunner's Exchange Road is rarely used by Service staff and is closed to public use. Access to the Island Pond parcel is from a legal ROW off Cannon Road. While all the refuge parcels have some road frontage, it is extremely limited. Construction of parking areas on these parcels is not feasible for safety reasons, lack of suitable location, or the negative impact a parking area would have on refuge neighbors. Because the refuge has been closed to public use since its establishment, the lack of suitable parking and access has not been a problem.

Partnerships and Community Outreach

The NHESP works collaboratively with the refuge in the protection and enhancement of the northern red-bellied cooter population. Prior to 1993, the refuge was managed by a partnering agency, the Massachusetts Division of Fisheries and Wildlife. Massasoit NWR was originally associated with the Parker River NWR Complex. When the Service reorganized, refuge oversight shifted to the Refuge Complex. At that time, the Memorandum of Agreement with MassWildlife was not renewed and the Service assumed management (T. French, 2012 personal communication).

Due to staffing limitations and given the refuge is closed to public use, very little community outreach has occurred by refuge staff. Past outreach included the collaborative efforts of the northern red-bellied cooter headstart program and this CCP process, including using volunteers for inventorying and monitoring, outreach to landowners surrounding the refuge primarily regarding wildland-urban interface and fire management, and conservation opportunities with organizations such as TNC (who recently closed their Plymouth Office), the Wildland Trust, MassWildlife, University of Massachusetts Cooperative Research Unit, Bristol County Agricultural High School, and others.

The MSSF abuts the refuge to the south and west. This forest is managed by the MADCR and falls within the designated critical habitat area for the northern red-bellied cooter. MSSF consists of more than 12,000 acres of both wildlife habitat and recreational areas. The staff and Friends of MSSF have contributed to the refuge by offering species data, volunteer botanists for plant inventory, and some shared environmental education opportunities. The Service has also agreed to collaborate in prescribed burning efforts for the benefit of wildlife habitat and for fuel reduction

Volunteer Programs

Although the refuge volunteer program at Massasoit NWR is currently small, volunteers have made important contributions towards habitat management and inventory and monitoring program by conducting vegetation surveys (including rare and nonnative species), assisting with efforts to improve northern red-bellied cooter nesting habitat, and monitoring nesting activity and hatchling emergence.

Northern red-bellied cooter (on right) and painted turtle

Bill Byrne

Chapter 3

Red shouldered hawk at Crooked Pond

Alternatives Considered, Including the Service-preferred Alternative

- **Introduction**
- **Formulating Alternatives**
- **Actions Common to Both Alternatives**
- **Alternatives or Actions Considered but Eliminated from Further Study**
- **Alternative A. Current Management**
- **Alternative B. Expanded Management**
- **Summary of Alternatives**

Introduction

This chapter describes our process for formulating alternatives, the actions that are common to the alternatives, and description of the two alternatives we analyzed in detail. At the end of this chapter, table 3-1 compares how each of the alternatives addresses key issues, supports major programs, and achieves refuge goals.

Formulating Alternatives

Relating Goals, Objectives, and Strategies

Refuge goals and objectives define each of the management alternatives identified below. Refuge goals are intentionally broad, descriptive statements of the desired future condition of refuge resources. By design, they define the targets of our management actions in prescriptive rather than quantitative terms. They also articulate the principal elements of the refuge purposes and vision statement, and provide a foundation for developing specific management objectives and strategies. All alternatives share the same goals.

Objectives are essentially incremental steps toward achieving a goal and further define management targets in measurable terms. They vary among the alternatives and provide the basis for developing detailed strategies that are the means by which we achieve our objectives. We also identify monitoring elements that help us evaluate progress toward meeting our objectives. “Writing Refuge Management Goals and Objectives: A Handbook” (USFWS 2004) recommends writing “SMART” objectives characterized by five attributes: *S*pecific, *M*easurable, *A*chievable, *R*esults-oriented, and *T*ime-fixed.

Where possible, we incorporated the principles of SHC in the development of our objectives and strategies. According to “Strategic Habitat Conservation: Final Report of the National Ecological Assessment Team” (USFWS 2006a): “This approach focuses on the ability of the landscape to sustain species as expressed in measurable objectives. Developing a strategy to attain a biological outcome, such as a population objective, requires documented and testable assumptions to determine whether the objective is met.” Not only will this approach ensure refuges are contributing to the Refuge System and Service mission and goals in a strategic, standardized, and transparent way, but it also ensures that refuges contribute to local and regional conservation priorities and goals (USFWS 2008b).

Next we identified strategies, or the actions, tools, and techniques we may use to achieve each objective. The list of strategies in each objective represents the potential suite of actions we may implement. We will evaluate most of them further as to how, when, and where we should implement them when we write refuge stepdown plans. We will measure success by how well our strategies achieve our objectives and goals.

A rationale accompanies each objective to explain its context and importance. We will use the objectives in the alternative selected for the final CCP to write refuge stepdown plans, described later in this chapter.

Developing Alternatives, including the “No Action” or “Current Management” Alternative

A wide range of possible management objectives and strategies that could achieve our goals were identified by the planning team, the public, and our partners. The planning team evaluated that input further and began the next step of designing management alternatives. Alternatives are essentially packages of complementary objectives and strategies, designed to meet refuge purposes and the Refuge System mission and goals, while responding to the issues and opportunities arising during the planning process. After evaluating how objectives might interact, their compatibility with refuge purposes, and the reality of accomplishing them within a reasonable period, objectives were further

Dead trees (snag) benefit many wildlife

refined and placed into either the "Current Management" or the "Expanded Management" alternative.

In this chapter, we fully describe two alternatives for managing the refuge over the next 15 years. As required by NEPA, we believe they represent a reasonable range of alternative proposals for achieving the refuge purpose, vision, and goals, and addressing the issues described in chapter 1. Unless otherwise noted, refuge staff would implement all actions.

Alternative A satisfies the NEPA requirement of a "no action" alternative, which we define as continuing the status quo, or current management. Alternative A describes our existing management priorities and activities, and serves as a baseline for comparing and contrasting alternative B (Expanded Management). Current management efforts consist of limited biological and enforcement activities as staff and funding allow (see chapter 2, "Affected Environment," for detailed descriptions of current refuge resources and programs), primarily focused on the northern red-bellied cooter.

The objectives in alternative A do not strictly follow the objective-setting guidance in the Service goals and objectives handbook, but rather describe ongoing management actions established prior to that guidance. Consequently, objectives in alternative A are more subjective than those in alternative B. Descriptions of alternative A management actions devolve from a variety of pre-existing formal and informal management decisions and planning documents. However, informal applications of adaptive management are still an important component of wildlife and habitat management in alternative A.

Alternative B, the Service-preferred alternative, more formally emphasizes adaptive management to reduce uncertainty in stewardship decision-making and outcomes. Alternative B also places greater emphasis on understanding how the refuge fits into the context of the larger landscape. Priority resources of concern were re-evaluated in light of new Federal trust resources, recent landscape-level plans and priorities (including but not limited to BCR 30, LCC Regional Prioritization, and 2015 Massachusetts SWAP), and additional biological information gathered on the refuge and surrounding lands. In addition, this alternative enhances public access and our present visitor services with opportunities to reach more visitors.

Actions Common to Both Alternatives

Both alternatives share the following common actions or elements that occur at varying degrees or levels as described in each alternative, and summarized in table 3-1. Some of the actions are required by law or policy, or represent management decisions that have previously undergone NEPA analysis including public review, agency review, and approval. Others may be administrative actions that do not require public review, but that we want to highlight in this public document.

All of the following actions are current practices or policies that would continue under both alternatives:

- Implementing adaptive management.
- Monitoring and abating wildlife and plant diseases.
- Conducting biological and ecological research and investigations.
- Conducting non-lethal predator management.
- Reducing hazardous fuels.
- Providing some environmental education or interpretation opportunities through refuge partners.
- Fostering volunteers and partnerships.
- Providing refuge staffing and administration.
- Protecting resources and ensuring visitor safety.
- Managing access or rights-of-way.
- Prohibiting fishing.
- Distributing refuge revenue sharing payments.
- Completing stepdown management plans.
- Protecting cultural resources.
- Conducting additional NEPA analysis.

Implementing Adaptive Management

All alternatives employ an adaptive management approach for improving resource management based on what is learned from management outcomes. In 2007, the Secretary of the Interior issued Secretarial Order No. 3270 to provide guidance on policy and procedures for implementing adaptive management in departmental agencies. In response to that order, an intradepartmental working group developed a technical guidebook to assist managers and practitioners: “Adaptive Management: The U.S. Department of Interior, Technical Guide.” It defines adaptive management, the conditions under which we should consider it, the process for implementing it in a structured framework, and evaluating its effectiveness (Williams et al. 2009). The guidebook may be viewed at: *http://www.doi.gov/ppa/upload/TechGuide.pdf* (accessed December 2016).

The guidebook provides the following operational definition for adaptive management:

"Adaptive management [is a decision process that] promotes flexible decision making that can be adjusted in the face of uncertainties as outcomes from management actions and other events become better understood. Careful monitoring of these outcomes both advances scientific understanding and helps adjust policies or operations as part of an iterative learning process. Adaptive management also recognizes the importance of natural variability in contributing to ecological resilience and productivity. It is not a 'trial and error' process, but rather emphasizes learning while doing. Adaptive management does not represent an end in itself, but rather a means to more effective decisions and enhanced benefits. Its true measure is in how well it helps meet environmental, social and economic goals, increase scientific knowledge, and reduces tensions among stakeholders."

This definition gives special emphasis to the uncertainty about management impacts, iterative learning to reduce uncertainty over time, and improved management as a result of learning. At the refuge level, monitoring management actions and outcomes, and key resources, is essential to implementing an adaptive management process. Our management of threatened and endangered species, migratory birds, and other wildlife habitats, are examples of refuge programs or activities in which an adaptive management approach may already be implemented or will be in the near future.

The final CCP covers a 15-year period, and periodic review of the CCP is required to ensure established goals and objectives are being met and that the CCP is being implemented as scheduled, provided adequate resources are available to do so. 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, including the rates of coastal landscape change that determine the type, amount, and arrangement of wildlife habitats and populations.

Collecting baseline data on wildlife populations and habitats will be implemented where necessary. These data would update the limited existing records of wildlife species using the refuge, their habitat requirements, and seasonal use patterns. This data will also be used to evaluate the effects of habitat management 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. Monitoring will assist in determining if management activities are meeting refuge goals and objectives. Information resulting from monitoring will allow staff to set more specific and better management objectives, more rigorously evaluate management objectives, and ultimately make better future management decisions. This process of evaluation, implementation, and re-evaluation is known as adaptive resource management.

The refuge manager is responsible for changing management actions and strategies that do not produce the desired conditions. Substantive changes from what is presented in our final CCP may warrant additional NEPA analysis and public comment.

Monitoring and Abating Wildlife and Plant Diseases

CDC

Photograph of a black-legged tick, also known as a deer tick (Ixodes scapularis)

As the Service has not published its manual chapter on disease prevention and control, we derive guidance on this topic from the Refuge Manual and specific directives from the Director of the Service or the Secretary of the Interior. The Refuge Manual (7 RM 17.3) lists three objectives for the prevention and control of disease:

- Manage wildlife populations and habitats to minimize the likelihood of the contraction and contagion of disease.
- Provide for the early detection and identification of disease mortality when it occurs.
- Minimize the losses of wildlife from outbreaks of disease.

The Service published these objectives in 1982. Since then, in addition to diseases that cause serious mortality among wildlife, diseases transmitted through wildlife to humans, such as Lyme disease, eastern equine encephalitis (EEE) or West Nile virus (WNV), have received considerable attention.

In addition to diseases affecting wildlife, we will be attentive to the diseases and pests that affect the health of the ecosystems that the refuge supports. However, the occurrence of any wildlife or habitat disease will be responded to only if it poses an immediate or serious threat to indigenous wildlife and habitat, at a level commensurate with Service staffing and funding.

These are the general strategies for preventing or controlling disease:

- Continue to conduct disease surveillance in conjunction with other field work.
- Cooperate with partners by providing access for sampling and following protocols in the event of an outbreak.
- Inform volunteers and others who work in the field about the dangers of diseases transmitted through wildlife and measures to avoid contracting them.
- Monitor habitats for indicators of the increased occurrence of pests or disease. For example, note changes in flowering or fruiting phenology that do not appear to be linked to global climate change, such as physical damage, decay, weakening, or sudden death, particularly of major host species; also note changes in wildlife use of habitats, such as the absence of breeding birds that used to appear regularly.
- Follow the protocols in national, state, and refuge disease prevention and control plans.

Conducting Biological and Ecological Research and Investigations

The Refuge Manual and the Service Manual both contain guidance on conducting and facilitating biological and ecological research, and investigations on refuges. In 1982, the Service published three objectives in the Refuge Manual for supporting research on units of the national wildlife refuge system (4 RM 6.2):

- To promote new information and improve the basis for, and quality of, refuge and other Service management decisions.
- To expand the body of scientific knowledge about fish and wildlife, their habitats, the use of these resources, appropriate resource management and the environment in general.

- To provide the opportunity for students and others to learn the principles of field research.

In 2006, the Service Manual replaced the Refuge Manual and provided guidance on the appropriateness of research on refuges: "We actively encourage cooperative natural and cultural resource research activities that address our management needs. We also encourage research related to the management of priority general public uses. Such research activities are generally appropriate. However, we must review all research activities to decide if they are appropriate or not as defined in section 1.11. Research that directly benefits refuge management has priority over other research" (603 FW 1.10D (4)).

All research conducted on the refuge must be determined (in writing) to be both appropriate and compatible, unless we determine it to be an administrative activity. Research projects also must contribute to a need identified by the refuge or the Service. Opportunities to conduct research on the refuge may arise under either of the alternatives we propose in this draft CCP/EA. In determining the appropriateness and compatibility of future research proposals, we will follow the guidance in the manuals, and will employ the following general strategies:

- Seek qualified researchers and funding to help answer refuge-specific management questions.

- Participate in appropriate multi-refuge studies conducted in partnership with others.

- Coordinate with partners to initiate or conduct research on priority issues identified at local and regional scales.

All researchers will be required to submit detailed research proposals following the guidelines established by Service policy and refuge staff (see appendix B, Research by Non-Service Personnel). SUPs will also identify the schedules for progress reports, the criteria for determining when a project should cease, and the requirements for publication or other interim and final reports. All publications will acknowledge the Service and the role of Service staff as key partners in funding and/or operations.

Conducting Non-lethal Predator Management


Kourtnie Bouley/USFWS

Protecting a northern red-bellied cooter nest

Under both alternatives, refuge staff, volunteers, and partners would use non-lethal predator management techniques to minimize loss of northern red-bellied cooter nests (eggs and hatchlings) on Massasoit NWR. The only technique used to date has been enclosing northern red-bellied cooter nests (and excluding predators) with wire mesh cages in situ as soon as they are located to prevent depredation. Nest enclosures (predator exclosures) are left on the nests until the hatchlings hatch and emerge, or until late incubation when staff collect the nests to finish incubation in captivity. Nest enclosures work very well if the nests are found soon after the eggs are laid, but many nests are depredated before staff or volunteers have a chance to protect them. For this reason, additional non-lethal predator management techniques are proposed and discussed in alternative B. It is not believed that lethal predator control measures are necessary for management purposes at this time.

Reducing Hazardous Fuels

Under both alternatives, refuge staff with assistance from partners would use prescribed fire in combination with mechanical mowing, cutting, and/or mastication (chipping/mulching), to maintain fuel loads below hazardous levels in accordance with the approved Fire Management Plan and Annual Burn Plans, and secondarily to open forest and shrub canopies to increase sunlight reaching the forest floor. Fire suppression in the past has resulted in an increase in fuel loads that put the neighboring community and refuge resources at risk for wildland fires. The area managed with prescribed fire and mechanical means varies by alternative.

The same partners assisting the Service with refuge fuels projects need the Service to reciprocate by providing refuge firefighting and other resource assistance to them to complete similar hazardous fuel reduction treatments in their respective jurisdictions (off-refuge), across the larger at risk community. This assistance would continue identically under both alternatives.

Providing Limited Environmental Education or Interpretation

Under both alternatives, SUPs would continue to be issued to refuge partners who wish to provide environmental education or interpretative opportunities that are consistent with refuge purposes and management goals and objectives, and coordinated with refuge staff. A compatibility determination is included in appendix B.

Fostering Volunteers and Partnerships

Strong support in the community and the region contributes to the refuge's 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 goals and objectives, the Service and Refuge System missions, and community needs be achieved.

Although the refuge volunteer program is currently small, volunteers have made important contributions toward habitat management and inventory and monitoring programs by conducting vegetation surveys (including rare and non-native invasive species), assisting with efforts to improve northern red-bellied cooter nesting habitat, and monitoring northern red-bellied cooter nesting and hatchling emergence. The refuge volunteer program would continue under both alternatives.


Stephanie Koch/USFWS

Volunteers participating on a bird survey

In addition to volunteer contributions, our conservation partners play a crucial role in the success of refuge resource management and public outreach programs. Both alternatives would maintain the existing partnerships identified in chapter 2, and later in this chapter under goal 3, while also seeking new ones. These relationships are vital to our achievements in all aspects of refuge management—conserving land, managing habitats and protecting species or cultural resources, conducting outreach and education, and providing wildlife-dependent recreation. Our relationships include MassWildlife, particularly when we can manage our refuges in a manner that benefit species that are listed by the state as endangered or threatened. We would pursue new partnerships in areas of mutual interest that benefit refuge goals and objectives and also provide additional opportunities for visitors.

Providing Refuge Staffing and Administration

Our proposals in this document do not constitute a commitment for staffing increases or funding for operations or maintenance. Congress determines our annual budgets, which our Washington headquarters and regional offices distribute to field stations. Chapter 2 presents our current staffing levels, operating, and maintenance funds for the Refuge Complex. The activities shared among the alternatives described below pertain to staffing, administration, and operations, and collectively support achieving all three refuge goals.

In both alternatives, we strive to sustain levels of annual funding and staffing that allow us to achieve refuge purposes, by achieving the goals, objectives, and strategies in this draft CCP/EA. As a rule, the Service's Northeast Region works toward maintaining a ratio of 75 percent of funding for refuge staff and salaries and the remaining 25 percent for on the ground management. Often, many highly visible projects are conducted through special project funds that typically have a 1- to 2-year duration. Although vitally important, their flexibility is limited because we cannot use those funds for any other priority project that may arise. Additionally, we rarely know when or if we will receive these funds in advance of when work must begin.

Under both alternatives, the Service will continue to investigate additional sources of funding to complement and extend or "leverage" existing budget allocations. Additional opportunities may emerge and will be pursued as a result of expanding outreach and partnerships with key conservation partners.

Protecting Resources and Ensuring Visitor Safety

Currently, no law enforcement officer position is assigned specifically to the refuge or stationed onsite. Law enforcement staff assigned to the Refuge Complex headquarters in Sudbury provides resource and visitor protection for all eight refuges, including but not limited to Massasoit NWR. When necessary, supplemental policing may be conducted by other Service law enforcement officers on detail, Massachusetts Environmental Police, and police officers commissioned by the town of Plymouth.

Managing Refuge Access or Rights-of-Way (340 FW 3)

The refuge will use and maintain its existing rights-of-way on Gunners Exchange Road and Cannon Road and access a dirt road off Snake Hill Road to access its properties for refuge resource management and law enforcement.

Prohibiting Fishing

Although fishing is identified as a priority public use of the Refuge System and is therefore an appropriate use, this activity is not compatible with the purpose for which Massasoit NWR was established. Along shorelines where northern red-bellied cooters nest and bask, increased human presence (especially during the late spring, summer, and early fall) would also cause direct disturbance to northern red-bellied cooters, could impact nesting success, and could result in an increased predator presence at these locations. Allowing angler access to any of the refuge-owned shorelines could also degrade habitat.

Distributing Refuge Revenue Sharing Payments

Under both alternatives, refuge revenue sharing payments (see chapter 2, Socioeconomic Environment section) will continue in accordance with the law, commensurate with changes in the appraised market value of refuge lands, the extent of the property, and appropriation levels provided by Congress.

Completing Stepdown Management Plans

Service planning policy identifies 25 stepdown plans that may be applicable on any given refuge. As previously discussed in chapter 1, six have been completed for the Refuge Complex as a whole, which includes Massasoit NWR. We have identified the additional plans that are the most relevant to this planning process and have prioritized their completion. Several are ongoing as part of Refuge Complex-wide planning, but others will be completed depending upon the alternative chosen and available funding and staffing.

The following refuge stepdown management plans would be completed after a final Massasoit NWR CCP is complete:

Northern red-bellied cooter nesting habitat at Crooked Pond

USFWS

- Habitat Management Plan, within 2 years following CCP approval (see discussion below).
- Annual Habitat Work Plan, annually beginning within 3 years of CCP approval (see discussion below).
- Inventory and Monitoring Plan, within 2 years following CCP approval (see discussion below).
- Avian Disease Contingency Plan, within 5 years of CCP approval.
- Integrated Pest Management Plan, within 5 years of CCP approval (see discussion below).
- Cultural Resources Management Plan, within 5 years of CCP approval.

Habitat Management Plan (HMP)

An HMP is a dynamic working document that provides refuge managers with a decision-making process, guidance for the management of refuge habitat, and consistency for habitat management on refuge lands. Each plan incorporates the role of refuge habitat in international, national, regional, Tribal, state, ecosystem, and refuge goals and objectives. The plan guides analysis of specific habitat management strategies to achieve habitat goals and objectives, and utilizes key data, scientific literature, expert opinion, and staff expertise. Specifically, the HMP defines management areas and treatment units, identifies the type or method of treatment, establishes the timing for management actions, and defines how we will measure success over the next 15 years. The HMP for the refuge is the first step toward achieving goal 1 objectives, regardless of the alternative selected for implementation. The goals, objectives, and list of strategies in each objective identify how we intend to manage habitats on the refuge, based on current resource information, published research, and our own field experiences. In the HMP, we will update our methods, timing, and techniques as new, credible information becomes available. To facilitate our management, we will regularly maintain our geographic information system (GIS) database, documenting any major changes to the refuge wildlife habitats. As appropriate, we will incorporate the actions common to all alternatives into the HMP.

Annual Habitat Work Plan (AHWP)

The AHWP is an essential component of an adaptive management approach. It details incremental (or annual) tasks in support of goals and objectives, and identifies habitat management strategies outlined in the CCP and HMP to be completed within the plan year. Typically, the AHWP evaluates progress toward achieving the habitat objective(s) from present management strategies and prescriptions by evaluating the response of the resources of concern as well as non-target resources to the habitat management strategies and prescriptions. The refuge uses this information to help select the management strategies with the most positive effect on refuge resources as a whole.

Inventory and Monitoring Plan (IMP)

The refuge IMP is a priority for completion upon CCP approval. Regardless of the alternative chosen, an IMP is vital for measuring our success in meeting objectives, though inventory and monitoring methods and intensity will vary according to the alternative chosen. The IMP will outline the methodology to assess whether our original assumptions and proposed management actions support our habitat and species objectives. The IMP may also be used to monitor the potential effects of global climate change on refuge habitats and wildlife populations. We will prioritize our inventory and monitoring needs for the selected CCP alternative in the IMP. The inventory and monitoring results will provide us with more status information on our natural resources.

Integrated Pest Management (IPM) Plan

In controlling non-native or native pests, we use an integrated approach. The Refuge Manual (7 RM 14.4C) defines IPM as "A dynamic approach to pest management which utilizes a full knowledge of pest problems through an understanding of the ecology of the pest and ecologically related organisms and through continuous monitoring of their populations. Once an acceptable level of pest damage is determined, control programs are carefully designed using a combination of compatible techniques to limit damage to that level."

The IPM Plan is a stepdown plan from the CCP and supplements both the CCP and HMP, with documentation on how to manage specific invasive or pest species. It will be written and kept on file at the Refuge Complex headquarters when complete. Along with a more detailed discussion of IPM techniques, this plan describes the selective use of pesticides for pest management on the refuge, where necessary.

Pesticide use, with appropriate and practical best management practices for habitat management, would be approved for use on the refuge when there likely would be only minor, temporary, and localized effects on species and environmental quality, by not exceeding threshold values in the chemical profiles. We adhere to all administrative requirements for completing pesticide use plans. Our control program would address the most critical problems first and can be adjusted to reflect regional Service priorities, new information, or a new resource.

Protecting Cultural Resources

As a Federal land management agency, we are responsible for locating and protecting all historic resources; specifically, archeological sites and historic structures eligible for listing or listed on the National Register of Historic Places. This applies not only to refuge land, but also to land affected by refuge activities. The Service files indicate two cultural resources within the refuge boundaries (two abandoned cabins) that have subsequently been demolished due to vandalism and disrepair. The MHC and Service files indicate no other known sites within the current refuge boundaries. However, archaeological sites might be exposed at any time through erosion.

Under both alternatives, we will evaluate the potential for impact on archeological and historical resources as required. We will consult with the Massachusetts SHPO and the Tribal Historic Preservation Officers (THPOs) for the Mashpee Wampanoag Tribe, the nearest federally recognized Tribe. These activities ensure our compliance with Section 106 of the NHPA, regardless of the alternative. Compliance may require a State Historic Preservation Records survey, literature survey, or field survey.

Conducting Additional NEPA Analysis

For all major Federal actions, NEPA requires site-specific analysis and disclosure of expected impacts, either by categorical exclusion, or in an EA, or environmental impact statement. NEPA provides for categorically excluding other routine activities from that requirement. Generally, those include the administrative actions listed in chapter 4. Many of the actions proposed in the alternatives, and fully analyzed in this draft CCP/EA, are described in enough detail to comply with NEPA and will not require additional environmental analysis prior to implementation. Although this list is not all-inclusive, the following projects fall into that category:

- Research and refuge inventory and monitoring activities.
- Habitat management activities.
- Implementation of predator or pest management programs.

Additional NEPA analysis would be required if we were to implement a significant public action (e.g., hunt program) or construction project not considered in detail in this document.

Alternatives or Actions Considered but Eliminated from Further Study

Based on public scoping and internal agency discussions the following alternative management actions were considered, but eliminated from further study. All other actions identified are incorporated into at least one of the two proposed CCP alternatives presented.

Trail Proposal

The town of Plymouth requested that the Service consider allowing a trail across the refuge and adjoining tracts owned by TNC that links parts of a larger system of trails within the Plymouth region. The Town-proposed trail would connect a tax title parcel owned by the town of Plymouth that abuts the northern corner of the Crooked Pond parcel to MSSF trails. The town of Plymouth's proposal would use existing informal footpaths that were created by fire breaks and by unauthorized use on the refuge.

The town of Plymouth parcel is connected to a large parcel owned by TNC that is part of a larger Eel River Restoration Project conducted in collaboration with the Service. TNC expressed concerns over possible adverse off-refuge resource impacts with the current trail proposal. As originally proposed by the Town, the new connecting trail segment on Massasoit NWR also would traverse a steep grade requiring switchbacks. Portions of the proposed trail route would have passed close to known northern red-bellied cooter habitat. Therefore the proposed trail routing suggested by the town of Plymouth was eliminated from further study.

Habitat Management

The Service considered an alternative to not conduct any habitat management other than for enhancing cooter nesting along pond shorelines. The refuge currently manages up to 50 acres of upland habitat primarily to reduce hazardous wildland fuel loads, and proposes to manage additional upland acres to achieve additional hazard fuel reduction and improve habitat for several species of migratory birds, rare Lepidoptera, and the New England cottontail. If the refuge were to discontinue all upland habitat management, we would no longer be meeting regional or national hazard fuel management goals and objectives. The risk from wildfire would continue to increase for the surrounding communities. Upland habitats would also be at risk of being negatively altered by catastrophic wildfires. Without frequent lower intensity fire events, upland habitats will continue converting to a white pine dominated forest which is not typical and less biologically diverse than the native habitat type.

Refuge Expansion

The Service considered a strategic expansion of the refuge to protect additional tracts of land in order to better support the recovery of the cooter as well as protect and manage additional lands to benefit early successional or shrubland dependent species in focal areas identified by the Service and conservation partners. This action was considered to be well beyond the geographic scope of the Massasoit NWR CCP process and, therefore, eliminated from further study. However, a separate ongoing effort by the Service to protect shrubland habitats on a larger landscape level is underway that will address such landscape scale concerns, and if approved, can be incorporated during future Massasoit NWR CCP updates.

Mosquito Control

The Service considered the potential need for surveillance monitoring or control of mosquito species known as potential vectors of human or wildlife diseases, such as WNV or EEE which is historically documented in the Plymouth-Carver area. Past mosquito control operations in the area focused on cedar swamps, which do not occur within Massasoit NWR. Any future operations can be adequately addressed by applying the Service's existing IPM (569 FW-1) and biological integrity, diversity, and environmental health (601 FW 3) policies to the specific circumstances. Treatment options will be chosen based on these policies, and will emphasize human safety and environmental integrity, effectiveness, and cost factors. We will use human, wildlife, or domestic animal mosquito-associated health threat determinations, combined with refuge mosquito population estimates, to determine the appropriate refuge mosquito management response. We will use current monitoring data for larval, pupal, and adult mosquitoes to determine the need for larvicides, pupacides, and adulticides, respectively. We will allow the use of adulticides only when there are no practical, effective alternatives to reduce a health threat during a declared public health emergency.

Alternative A. Current Management

Alternative A reflects current management, including activities previously undertaken or already planned or approved. In addition to the actions common to both alternatives, under the "Current Management" alternative, there would be little or no change in our current management programs at the refuge. The refuge would continue operations and maintenance activities within current staffing and funding levels. Alternative A (current management) is summarized in table 3-1, which compares the two management alternatives considered.

Notching a northern red-bellied cooter for tracking purposes

USFWS

Habitat and Population Management

Currently, refuge habitat management consists of improving approximately a 1/4-acre of northern red-bellied cooter nesting habitat along the Crooked Pond shoreline using mechanical means every few years. Non-lethal predator management (enclosing nests with wire mesh) is also implemented to reduce northern red-bellied cooter nest depredation. These actions would continue under alternative A.

Inventory and Monitoring

Under alternative A, refuge staff would continue updating baseline information, including species presence, as funding and volunteer time permits. Staff would also continue monitoring northern red-bellied cooter nest attempts and success along the Crooked Pond shoreline. Inventory and monitoring activities are a major component of evaluating the success of refuge management.

Hazardous Fuel Reduction

Under alternative A, with support from New England Zone fire management resources, refuge staff would continue to manage 50 acres of oak-pine forest and woodland to reduce hazardous fuel loading. Prescribed fire and mechanical means would be used within the wildland urban interface. Existing fire breaks would be managed to reduce wildfire risk to refuge neighbors as well as provide defensible space for wildland firefighters.

Visitor Services

Under alternative A, the refuge would remain closed to general public use. Wildlife interpretation and environmental education would be allowed under a SUP on a case-by-case basis, when refuge staff are involved with programming or are working with partners to conduct it. There would also be small scale outreach and virtual interpretation via the refuge Website and distribution of materials such as the Refuge Complex brochure in the area.

Refuge Administration

In alternative A, refuge staffing would remain at current levels, with all support staff stationed at the Refuge Complex headquarters in Sudbury, Massachusetts. There would be no dedicated staff for Massasoit NWR under alternative A.

In the discussion that follows, we describe in detail the goals, objectives, and strategies that we would implement under alternative A.

GOAL 1:

Perpetuate the biological integrity, diversity, and environmental health of the pitch pine-oak forest habitat type and associated coastal plain ponds and wetlands on Massasoit NWR to sustain native wildlife, especially species of conservation concern such as the federally listed northern red-bellied cooter.

Objective A1.1.

On the Crooked Pond parcel, contribute to rangewide northern red-bellied cooter population recovery by: (1) continue protecting 10 acres of existing pond habitat and associated shoreline from human disturbance, (2) creating and maintaining ¼-acre of high quality nesting habitat for the northern red-bellied cooter, and (3) increasing nest success and hatchling survival.

Rationale

The northern red-bellied cooter is a federally listed and a State-listed endangered species. Massasoit NWR was specifically established to conserve the northern red-bellied cooter and is entirely located within a 3,269-acre area formally designated as critical habitat (USFWS 1985). Chapter 2 includes more details about northern red-bellied cooter ecology and range-wide status. Continued threats to northern red-bellied cooters include (but are not limited to): a restricted geographic range; collection and disturbance by people; habitat alterations including closed canopies at nesting sites, and; high mortality of eggs, hatchlings, and juvenile turtles due to nest failure, nest predation, and predation on hatchlings following emergence (USFWS 1994 and 2007).

The Massachusetts SWAP (MassWildlife 2015) notes that Statewide, only 27 percent to 35 percent of non-open-water habitat required by freshwater turtles

Crooked Pond at Massasoit National Wildlife Refuge.

Kourtnie Bouley/USFWS

(northern red-bellied cooter, bog turtle, Blanding's turtle, and wood turtle) is currently protected.

At Massasoit NWR, headstarted northern red-bellied cooters (see chapter 2 for details on the rangewide project) were released annually into Crooked Pond from 1985 to 1991 (81 headstarted hatchlings total; USFWS 1994), and mark-recapture surveys were conducted to monitor their survival. Research showed high annual survival rates averaging over 85 percent, and that the estimated population was about 40 (Haskell 1993). From surveys conducted from 1985 to 2001, the Crooked Pond northern red-bellied cooter population composition was almost entirely headstarted, with a male-biased sex ratio (USFWS 2007). The current refuge northern red-bellied cooter population was recently estimated to still be very small. However, 2011 and 2012 research by refuge staff in confirmed breeding-age females present in Crooked Pond, with three gravid females confirmed in 2012. Re-initiating habitat improvements in 2014 and increased monitoring in 2014 and 2015 resulted in five and eight confirmed nests, respectively. Therefore, although this resident population may be small compared to other sites throughout the range, the efforts at Massasoit NWR are important and are contributing to population recovery.

Our objective of contributing to recovery through habitat protection and management, and our supporting strategies, specifically addresses Recovery Plan Task #3 (USFWS 1994):

Task 3.1: Protect occupied and potential habitat.

Task 3.2: Improve habitat at ponds with known populations by clearing nesting sites and providing basking sites where necessary.

Task 3.3: Annually locate and protect nests at ponds with major populations.

Task 3.4: Enforce all laws protecting the cooter and its habitat.

By protecting the 10-acre Crooked Pond and maintaining approximately 1/4-acre of nesting habitat along the shoreline, we would benefit this resident population. High quality northern red-bellied cooter nesting habitat is characterized by open, sandy substrate, with little canopy cover and a southern aspect. Historically, the land surrounding Crooked Pond consisted of pine barren habitat that occasionally burned from lightning strikes and fires set by Native Americans. Closure of the forest canopy around the pond edges may be detrimental as research suggests that both hatchling success and early hatchling survival may benefit from management which provides nesting habitat with ample sunlight (USFWS 1994). Although we were unable to monitor the shoreline daily for nesting activity until our recent deployment of trail cameras, northern red-bellied cooter nests have been confirmed in all three shoreline areas where habitat was improved on Crooked Pond (see chapter 2).

In addition to monitoring northern red-bellied cooters' response to habitat improvements, we would continue to protect nests from predators using non-lethal means whenever possible. Predation of northern red-bellied cooter nests and hatchlings following emergence is likely limiting population growth. Predators may include predatory fish, bullfrogs, herons, snapping turtles, raccoons, striped skunks, and other mammals. Wire nest enclosures (predator exclosures) placed around nests as soon as they are found have been used for decades at other sites to protect nests and hatchlings from predators (USFWS 1994). Hatchlings are trapped inside the enclosures as well and can be collected by researchers for either release directly back into ponds, or for headstarting which substantially increases their first year survival (see chapter 2). Hatchlings collected at the refuge since 2013 have been contributing to the headstarting program, and some of these hatchlings are released the following spring at non-refuge sites contributing to range-wide recovery.

The northern red-bellied cooter is protected by the ESA (16 USC 1531) and associated regulations (50 CFR 17), and by the MESA (MGL, Chapter 131A) and associated regulations (321 CMR 10.00). The Federal and State designations prohibit taking or possessing northern red-bellied cooters without a permit. Although the entire refuge is closed to the public, trespass issues persist and establishing a physical closure at nesting sites may prevent trespassers from entering sensitive nesting areas. Law enforcement staff enforces the closure of the refuge to prevent degradation of habitat and minimize disturbance to northern red-bellied cooters, especially at Crooked Pond. It can take a female cooter several hours once she emerges from the water to find a nesting spot, dig the nest chamber, lay her eggs, and cover the nest (USFWS unpublished data). Any human presence during the day, even for a short amount of time, could disrupt this behavior. Year-round closure of the refuge to public use would continue and limit access to northern red-bellied cooters and their habitat to minimize human disturbance.

Strategies

Continue to:

- Use mechanical and hand tools (such as rototiller, rakes, shovels, axes, and chainsaws) to reduce encroaching shrubby vegetation, remove herbaceous vegetation, girdle large canopy trees, and loosen soil at two sites on the Crooked Pond shoreline by late May at least every third year.

- Protect northern red-bellied cooter nests with predator exclosures (nest enclosures) to protect eggs and emerging hatchlings at Crooked Pond.

- Coordinate with conservation partners and participate in the State headstarting program when northern red-bellied cooters successfully nest on the refuge.

- Support and facilitate collaborative research on northern red-bellied cooters on refuge lands to determine the population and factors limiting survival and reproduction, and establish short-term population objectives.

- Use temporary signs to establish a physical closure at northern red-bellied cooter nesting sites along the Crooked Pond shoreline annually from mid-May through mid-September, and address trespass issues as they occur.

- Make appropriate changes in management for northern red-bellied cooters within 6 months of completion of any 5-year reviews or recovery plan updates to accommodate updated recovery criteria, research needs, or any additional needs identified.

Refer also to objective A3.1 for landscape scale, off-refuge strategies.

Inventory and Monitoring Elements
Continue to:
- Collaborate with conservation partners to search nesting habitat along the Crooked Pond shoreline for nesting northern red-bellied cooter activity from late May through August by walking through nesting areas at least once per week, and more often as time allows.

- Coordinate with conservation partners to install trail cameras at nesting sites to document nesting activity and trespass as time allows.

- Record location and monitor nest success (total eggs laid and hatched) if nests are found.

Objective A1.2. **Manage 50 acres of mixed pine-oak forest and other upland habitats on the refuge to reduce hazardous fuel loading through mechanical and prescribed fire.**

Rationale
The wildland urban interface has gained increasing importance as more Americans build homes in rural settings adjacent to public lands. Since the development and implementation of the National Fire Plan, there has been a marked increase in reduction of hazardous fuels in the wildlife urban interface on the edge of Federal lands. (*http://www.fws.gov/fire/living_with_fire/wildland_urban_interface.shtml*, last accessed 11/06/2015).

Plymouth was named a Federal "Community at Risk" in 2001 because of the high risk to the community from wildfire on Federal lands. A community is considered at risk from wildland fire if it lies within the urban/wildland interface, defined as: "where humans and their development meet or intermix with wildland fuel" (*Federal Register* Vol. 66, No. 3, Pages 751-754, January 4, 2001). To reduce risk of wildland fires to homes nearest to the refuge, the Service began using mechanical means and prescribed burns as management tools to reduce hazardous fuels. Firefighters from the Service, TNC, the Commonwealth of Massachusetts, and Plymouth Fire Department, performed controlled burns on 20 acres of the refuge in (spring) 2007. These same 20 acres and an additional adjacent 30 acres were burned in the spring of 2011. Controlled burns reduce the build-up of leaf litter, dead wood, and other plant material that could otherwise fuel a wildland fire, and also help prepare sites for seedling establishment, promote oak re-sprouting, and foster plant nutrient recycling.

The primary aims of prescribed burning under alternative A (see map 2-5) are to reduce hazardous fuel accumulations, establish fuel breaks between the refuge and neighboring residential communities, and reestablish the natural role of fire within the pine-oak community. Moreover, these management actions can secondarily benefit native habitat and wildlife by restoring more structural habitat and species diversity across the landscape.


USFWS

White pine habitat on Massasoit National Wildlife Refuge

The pitch pine-oak community is a fire-dependent habitat type. Pitch pines often have shoots that can grow directly from the trunk, enabling trees to re-sprout after fire has killed the crown, and thick bark protects the trunk from damage unless the fire is very severe. When fires occur in this community type on a frequent basis, they are generally of low severity, which helps maintain the plant community structure. If fires are not sufficiently frequent, the flammable material (fuel load) accumulates. Fires can burn much hotter and with greater severity. In such situations, a hot (high severity) fire may kill trees and, under certain wind conditions, potentially expand into surrounding communities at the wildland urban interface. The refuge is surrounded by several densely populated communities at risk of wildfire due to their close proximity to the hazardous fuels and lack of defensible space.

Strategies
Continue to:
- Evaluate the entire refuge in the context of wildland urban interface risks and along with Service partners, facilitate planning of additional hazardous fuel reductions to protect neighboring communities.

- Utilize prescribed fire and mechanical clearing including mowing, cutting, and masticating in accordance with the approved FMP and Annual Burn Plans every 3 to 5 years initially to maintain approximately 75- to 100-foot-wide shaded fuel breaks between the refuge and residential areas, and 10 to 25-foot fire breaks between burn units. Transition to a 5- to 10-year interval on the northeastern portion of the Crooked Pond parcel over time. The target shaded fuel break effective width is 100 feet, and the target fire break effective width between burn units is 12 feet.

Inventory and Monitoring Elements
Continue to:
- Document all management actions using GIS.

- Fulfill monitoring elements as outlined in annual burn plans to evaluate how well burn objectives are met.

GOAL 2: **Promote awareness and support for the protection of sensitive resources on Massasoit NWR through community outreach and opportunities for connecting the public to the refuge's natural resources.**

Objective A2.1. **Provide environmental education and interpretation programming via permit or special staff-led events, and conduct community outreach working through partnerships, to inform the public about the refuge and its resources.**

Rationale
Based on duty locations, budgetary and staffing constraints, regular onsite environmental education or interpretative programming is not offered. The Service has provided a limited amount of interpretation regarding the refuge

and its resources through its partners and Website. For example, the Service currently posts information on the management and natural history of the northern red-bellied cooter on the Massasoit NWR Website. The Refuge Complex brochure also provides information to the public about the refuge.

Informational signage on the refuge is currently minimal. Signs indicate closures to promote wildlife and habitat conservation. There are currently no interpretive resource signs on the refuge.

Continuation of current management under alternative A would retain the closure to all public uses, see map 3-1), providing environmental education and interpretation exclusively by SUP or when led by refuge staff. Environmental education and interpretation are proposed as compatible uses for Massasoit NWR when guided by a Service partner or refuge staff (see appendix B).The amount of future outreach would also remain minimal under this alternative with only the basic amount of community outreach conducted. It is standard practice for the Service to inform the public of any large scale management practices, including prescribed burns. We would continue to issue press releases for large-scale management activities taking place on the refuge to keep the Plymouth community informed.

It is important to cultivate an awareness and appreciation in local communities of the refuge's unique contribution to the Refuge System mission. Both environmental education and interpretation are among the six priority public uses for the Refuge System. In addition, the President has directed all Federal agencies, as part of his Transparency and Open Government memorandum and directive, to provide information to the public. Agencies "should harness new technologies to put information about their operations and decisions online and readily available to the public" (The White House 2009).

Strategies:
Continue to:
- Allow occasional guided interpretative field trips on the refuge hosted by partners under SUP.

- Use the refuge Website to provide information about the northern red-bellied cooter and explain refuge management.

- Disseminate the Refuge Complex brochure to provide information on refuge and wildlife management.

- Notify the public of large scale management activities (e.g., prescribed burns), their purposes, and possible impacts through press releases and the refuge Website.

- Manage the refuge volunteer program.

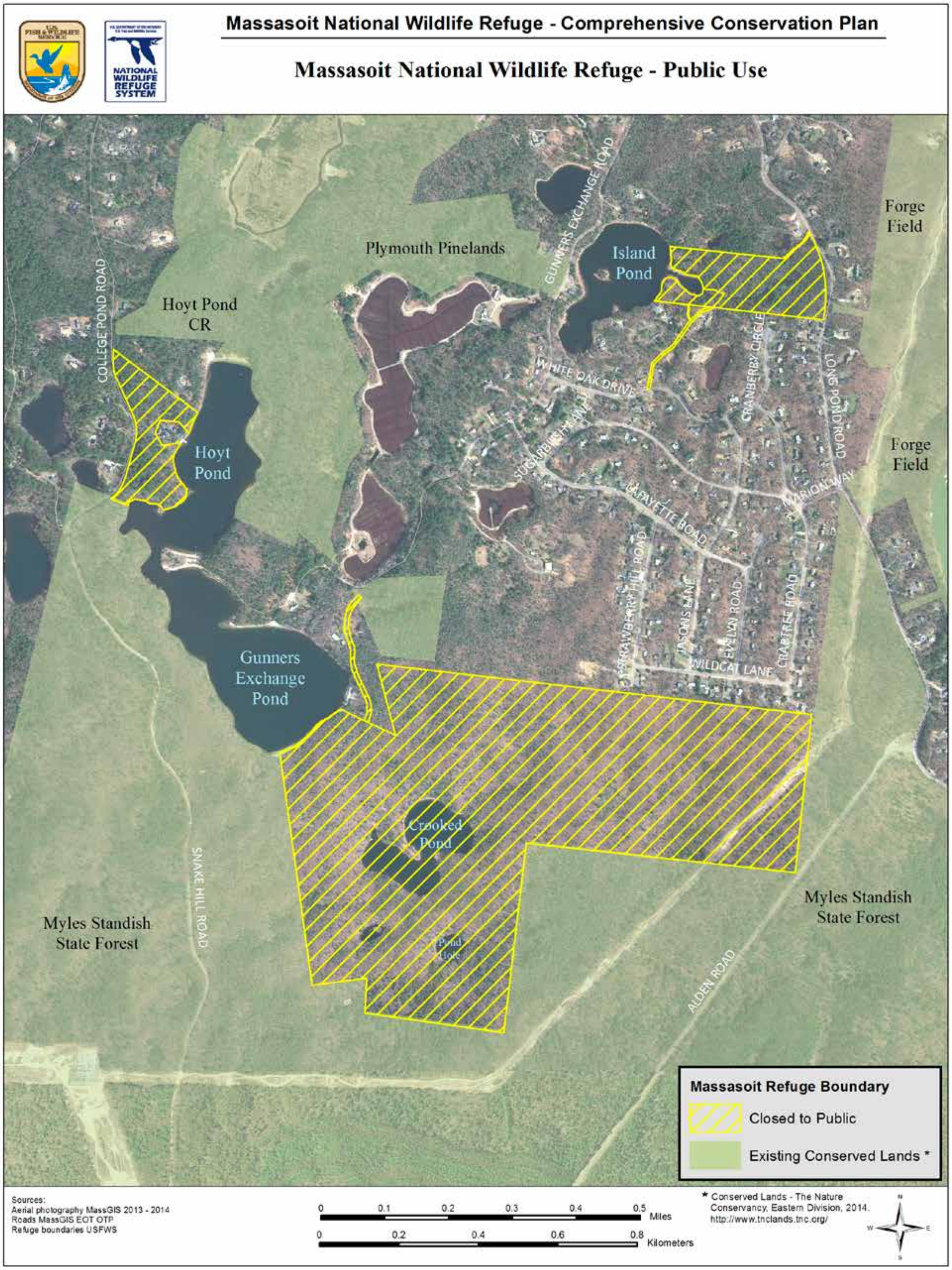
- Coordinate with local organizations to promote awareness about the refuge and its resources.

Monitoring Elements:
Continue to:
- Record number of interpretive programs and number of attendees.

- Record volunteer hours.

- Record number of press releases.

Map 3-1. Alternative A Public Use (Closures).



GOAL 3: **Enhance collaborations with Federal and State agencies, conservation organizations, and local communities to promote species and habitat conservation across the pitch pine-oak landscape in southeastern Massachusetts, and to support Massasoit NWR's purpose and the Refuge System and Service missions.**

Objective A3.1. **Work with the northern red-bellied cooter recovery team and species experts to refine our understanding of species habitat requirements, methods for assessing the quality of habitat range-wide, and the factors limiting survival and reproduction. Also, work with these experts to determine high priority areas for habitat management across its range and determine suitable management actions.**

Rationale

Although the refuge lies entirely within the formally designated critical habitat for northern red-bellied cooters (USFWS 1984), the refuge is comparatively small and supports only a small percentage of the total population. Actions taken on refuge lands will benefit northern red-bellied cooters, but the Service has an additional responsibility and opportunity to support rangewide recovery through research efforts and increased partnering. This objective specifically addresses Recovery Plan Tasks #2 (research) and #4 (population management informed by research):

Task 2.1: Expand studies to determine and mitigate limiting factors.

Task 2.2: Continue natural history studies.

Task 4.1: Continue to conduct and improve the hatchling headstart program.

Task 4.2: Evaluate the status of each pond/river population and supplement turtle numbers if and where warranted.

Research needs outlined in the recovery plans (USFWS 1981, 1994) and the 5-year update (USFWS 2007) will be best met with a collaborative approach involving many conservation partners. Funding for research is often difficult to secure. Currently, the Service has been working with the MassWildlife and the Massachusetts Cooperative Fish and Wildlife Research Unit, and has secured

Northern red-bellied cooter hatchling

Megan Cook

funding and entered into a cooperative agreement for 2015 and 2016. The overall aims of that cooperative agreement are to evaluate indicators of progress toward recovery, determine if down-listing or delisting criteria are met, and to make recommendations for listing reconsiderations. Specific research project objectives are: (1) document the current geographic distribution and abundance of cooters in southeastern Massachusetts; (2) document demographic parameters, such as growth rates and sex ratios, and evidence of reproduction and recruitment to model the ability of subpopulations to persist as self-sustaining subunits over time; (3) temporarily increase the headstart program and evaluate the efficacy of the 25-year headstart program as a cost-effective strategy to augment cooter populations, further expand geographic distribution, and reduce the risk of local extinction; (4) assess site specific habitat conditions and evaluate effectiveness of management at sites; and, (5) prioritize land protection. Protocols for assessing habitat and for conducting rapid assessment surveys to determine presence of northern red-bellied cooters are also being developed as part of this project. The Service will continue to provide staff and equipment support whenever possible and administer funds for this research.

Strategies
Continue to:

- Work with MassWildlife, Massachusetts Cooperative Fish and Wildlife Research Unit, and other partners to fulfill priority research objectives.

- Support efforts and research toward rangewide recovery of the northern red-bellied cooter.

Inventory and Monitoring Elements
Continue to:

- Record the number of research projects funded and research objectives met annually.

Objective A3.2. **Work with local and regional wildland and structural fire management professionals to continue to protect communities at risk in southeastern Massachusetts from wildfire.**

Rationale
Plymouth was named a Federal “Community at Risk” in 2001 because of the high risk to the community from wildfire on Federal lands, as described in objective A1.2. A community is considered at risk from wildland fire if it lies within the urban wildland interface, defined as: “where humans and their development meet or intermix with wildland fuel” (Federal Register Vol. 66, No. 3, Pages 751-754, January 4, 2001). To reduce risk of wildland fires to homes nearest to the refuge, the Service began using mechanical means and prescribed burns as management tools to reduce hazardous fuels. Firefighters from The Nature Conservancy, the State of Massachusetts, and the Plymouth Fire Department, assisted the Service with controlled burns on the refuge in (spring) 2007 and again in 2011 and provided the Service with technical and logistical support for planning and implementing other hazardous fuel reduction projects.

These same Service partners need the Service reciprocate by providing refuge firefighting and other resource assistance to them to complete similar hazardous fuel reduction treatments in their respective jurisdictions (off-refuge), across the larger at risk community. As all governmental budgets continue to decrease, collaborating and sharing resources across agency and ownership boundaries is becoming the norm throughout the wildland fire community.

Strategies:
Continue to:
- Coordinate with abutters, private landowners, and conservation partners to ensure protection of communities at risk as well as natural resources.

- Work with the MADCR to implement 'Fire Wise' (*http://www.firewise.org*) educational programs in neighboring communities.

- Support other land management agencies with their fuel reduction projects by providing assistance through training, equipment, staff time, and technical expertise.

Inventory and Monitoring Elements
- Annually record the number of partnership hazardous fuel reduction projects the Service participates in.

- Annually record the number of Fire Wise programs implemented and number of attendees.

- Annually record the number of acres treated.

Alternative B. Expanded Management

In addition to actions common to all alternatives, alternative B represents an extension and progression of all areas of refuge management. Alternative B reflects expanded management through additional biological work, as well as increased visitor services opportunities. Under alternative B, northern red-bellied cooter habitat management and monitoring would be conducted on additional refuge-owned parcels, and prescribed burning would be expanded and targeted toward increasing structural habitat and species diversity to benefit species of conservation concern. In addition, we would consider opening most of the Crooked Pond parcel to hunting, and would undertake a separate process for developing a hunt plan. We propose to open for the white-tailed deer and wild turkey hunt seasons, and perhaps others. All hunt seasons would be evaluated as part of this process. Wildlife observation and photography, interpretation and environmental education would be allowed on special occasions when led by refuge staff or partners working under an SUP. These activities would allow visitors to gain a better understanding of the unique natural resources the refuge protects and ideally to become better stewards and advocates for resource conservation. Under alternative B, refuge staffing and funding levels would support new wildlife population, habitat, and invasive/overabundant species management activities, and new compatible, wildlife-dependent recreational opportunities. Public use evaluations, along with wildlife and habitat monitoring programs, would assist us in assessing the intensity of public use and adapting our management strategies and practices. Alternative B goals, objectives, and strategies are summarized in table 3-1.

Habitat and Population Management

Alternative B expands current habitat and population management over the next 15 years. Alternative B expands efforts to improve northern red-bellied cooter nesting habitat enhancement work from Crooked Pond to additional refuge pond shorelines. We would also improve biological integrity, diversity, and environmental health refuge-wide by removing non-native invasive species, and expand the purpose of prescribed fire and mechanical treatments to improve habitat for breeding migratory songbirds such as ovenbirds, eastern towhees, eastern wood pewees, and prairie warblers.

Inventory and Monitoring

Inventory and monitoring efforts would expand to include more consistent and frequent monitoring of nesting northern red-bellied cooters. We would also initiate additional baseline inventories to expand our knowledge of plants, invertebrates, and other species of conservation concern on the refuge and adjoining landscape. The increase in management, such as prescribed burning, to benefit trust resources (including migratory birds) would result in an increased monitoring effort to carefully document how well management actions are achieving biological objectives, for example, by monitoring vegetation and bird response to habitat treatments and/or human disturbance.

Visitor Services

Under alternative B, the Service would provide opportunities for guided wildlife observation and photography, environmental education and interpretation. Hunting could occur in the future after completion of a separate assessment and public review process.

The following criteria are provided to ensure quality wildlife-dependent recreation on national wildlife refuges by the General Guidelines for Wildlife-Dependent Recreation, Fish and Wildlife, in the Service Manual, 605 FW 1:


USFWS
Turkey tracks

- Promotes safety of participants, other visitors, and facilities.
- Promotes compliance with applicable laws and regulations and responsible behavior.
- Minimizes or eliminates conflict with fish and wildlife populations or habitat goals or objectives in an approved plan.
- Minimizes or eliminates conflicts with other compatible wildlife-dependent recreation.
- Minimizes conflicts with neighboring landowners.
- Promotes accessibility and availability to a broad spectrum of the American people.
- Promotes resource stewardship and conservation.
- Promotes public understanding and increases public appreciation of America's natural resources and our role in managing and conserving these resources. Provides reliable and reasonable opportunities to experience wildlife.
- Uses facilities that are accessible to people and blend into the natural setting.
- Uses visitor satisfaction to help to define and evaluate programs.

Refuge Administration

Expanding northern red-bellied cooter conservation and management as proposed under alternative B would require additional staff resources to fully implement. A 2008 national staffing model for the Refuge System indicated that the Refuge Complex should have one additional law enforcement officer with shared responsibilities on several refuges and an additional biologist for the refuge. Alternative B proposes a staffing level consistent with the minimum requirements for a Refuge Complex of this size and importance by adding one additional law enforcement officer on the Refuge Complex and one (term/permanent) biologist dedicated to Massasoit NWR. Any staffing increases must be based on permanent sources of funding, and in consideration of all regional and Refuge Complex priorities. We would prioritize hiring a shared Federal wildlife officer for the Refuge first. Hiring a full-time biologist is a lower priority within the Refuge Complex.

The following describes in detail the goals, objectives, and strategies that we would implement in alternative B.

GOAL 1: **Perpetuate the biological integrity, diversity, and environmental health of the pitch pine-oak forest habitat type and associated coastal plain ponds and wetlands on Massasoit NWR to sustain native wildlife, especially species of conservation concern such as the federally listed northern red-bellied cooter.**

Objective B1.1. **Contribute to rangewide northern red-bellied cooter population recovery and long-term persistence of other native coastal plain pond biota by: (1) protecting 10 acres of existing pond habitat at Crooked Pond and all refuge-owned shoreline from human disturbance; (2) creating and maintaining 1 acre of high quality nesting habitat on the shorelines of Crooked, Island, Gunners Exchange, and Hoyt Ponds on Massasoit NWR; and, (3) increasing northern red-bellied cooter nest success to at least 60 percent by protecting nests from mammalian predators and increasing hatchling survival through headstarting.**

Rationale

The need for active management for northern red-bellied cooters (including habitat management) is described in chapter 2 and in the rationale for objective A1.1 under alternative A. In alternative B, however, we propose to expand our active management from ¼ acre to at least 1 acre of nesting habitat for northern red-bellied cooters on refuge lands. More resources would be directed toward improving existing nesting areas, as well as creating new nesting areas along additional pond shorelines. Please also see objective B3.1 for more information about landscape scale work off refuge.

As previously discussed in chapter 2, coastal plain pond and shoreline habitats also provide habitat for many other species occurring almost exclusively on coastal plain ponds. The plants of the pondshore community are particularly adapted to the nutrient-poor conditions, and although often restricted to that environment, are able to compete with more widespread plants that require more nutrients. Several Massachusetts plant species of greatest conservation need occur only in coastal plain ponds, including the globally rare species Plymouth gentian, rose coreopsis, and terete arrowhead, (MassWildlife 2015) all of which are documented from Massasoit NWR. Many rare plant species associated with coastal plain ponds are regionally rare species as well, as indicated by Brumback and Gerke (2013). Coastal plain pond shorelines are important habitat for dragonflies and damselflies (over 45 odonate species are known to occur on coastal plain ponds and several of those species are rare), and coastal plain ponds have been listed (White et al. 2014) as the most vulnerable odonate habitats in the northeastern United States. The water willow stem borer is a Massachusetts threatened (noctuid moth) species known from coastal ponds in MSSF that may also be present on Massasoit NWR pond shorelines. Larger ponds are used by migrating and wintering waterfowl. Sudden alterations to natural hydrologic regimes pose the greatest threats to these systems. Many Massachusetts coastal plain ponds are in a fragile balance (MassWildlife 2015).

Gunners Exchange, Hoyt and Island Ponds all host natural populations of northern red-bellied cooters and, like Crooked Pond, they all were among the early release sites chosen for headstarted hatchlings during the first few years of the program (USFWS 1994). These ponds are also within the 3,269-acre area designated as critical habitat. In alternative B, we would expand efforts to promote northern red-bellied cooter nesting by evaluating all refuge-owned shoreline on these ponds, and identifying areas where nesting habitat could be created or enhanced. We expect an additional 3/4 acres of habitat to be identified and managed through this expanded effort. Methods would be similar to those already described in chapter 2 and in objective A1.1, and are likely to include mechanical and hand tools to reduce encroaching low shrubby vegetation, reduce canopy cover and increase sun exposure, and (if necessary) loosen soil. Additionally, felled trees will be used to create additional turtle basking opportunities. The best basking sites have prolonged sun exposure, are easily accessible to turtles, and provide safety from predators and disturbance. Turtles often bask on logs that are partially in water and partially on the shore. These slanted logs give the turtles a choice to either climb completely out of the water or remain partially submerged.

All nests found in these expanded nesting areas would be enclosed with predator exclosures, as described in objective A1.1. We will carefully monitor hatch success of all nests to determine how well the exclosures are contributing to success. Additional non-lethal predator management techniques may also be explored and implemented under this alternative if nest success objectives are not being met. In particular, electric fencing has been an effective method for reducing predator impacts for other turtle nesting species (Geller 2012, Quinn et al. 2015) in nesting areas where depredation occurs. Electric fencing may be an effective means for preventing nest loss at Massasoit NWR if staff are unable to enclose nests immediately after eggs are laid. Trespass issues would likely persist under this alternative, but establishing a physical closure at nesting sites may prevent trespassers from entering these areas.

Land use practices (e.g. herbicide and insecticide use from forestry, agriculture, and mosquito abatement) that were implemented on or near Crooked Pond prior to refuge establishment may influence survival of the northern red-bellied cooter. Although the cranberry industry used a substantial amount of organochlorine-based and other pesticides in Plymouth County from the late 1940s to 1960s, there have been no studies to determine whether long-lived northern red-bellied cooters still carry pesticide burdens (USFWS 1994). Although Crooked Pond is currently protected and isolated from surface land uses that may contribute to contamination in the kettle-hole ponds, groundwater sources in the region could potentially become contaminated from such sources as lawn fertilizers, pesticide use on nearby agricultural lands, storm water run-off, and septic tanks. Under this alternative, it would be important for refuge staff to conduct baseline monitoring to determine the existing water quality conditions at Crooked Pond.

As previously discussed in chapter 2, water rises and falls in most Massachusetts coastal plain ponds with seasonal changes in the water table, periodically leaving an exposed shoreline in late summer, though in wet years the pondshore may remain inundated year-round. Dominant plants on the exposed shore as the water levels drop are herbaceous and graminoid species. As the water levels go down, any aquatic organic material is subjected to oxidation and removal from the system, changing the water-holding capacity of the pond’s substrate, and possibly making the pond more vulnerable during future water drawdowns. Groundwater connections provide cool, low-nutrient water to ponds, and would normally enhance water quality. In areas with polluted groundwater however, ponds can acquire the pollutants with negative effects on the habitat. In the winter, when there is little evaporation and much precipitation, the groundwater and ponds rise, and the ponds are recharged (MassWildlife 2015). Under alternative B, the refuge would coordinate with the MADEP and other partners to assure water quality is supportive of northern red-bellied cooters.

The need for clean water sometimes leads water companies or water districts to view conservation areas as ideal locations for public water supplies, without considering impacts to wetland dynamics when issuing water supply permits. Municipal and irrigation well withdrawals can lower water levels within a pond dramatically, allowing expansion of shrubs into the historically open bank shoreline areas. However, there is also a concern of rising groundwater levels due to climate change which leads to higher than normal water levels, preventing the natural water level cycling in the ponds. Shrub and tree encroachment threaten pond shorelines in areas with excessive withdrawal. Seasonally high water levels prevent tree and shrub encroachment, and seasonal low water is necessary to expose the pondshore for plant germination and growth. Excessive drawdown from pumping for water consumption or cranberry bog irrigation reduces natural fluctuations and allows woody species to advance down the shores. Use of coastal plain ponds as recipients of irrigation runoff from cranberry bogs introduces nutrients and pesticides into the water. The nutrients and pesticides can alter which species can survive, and encourage excessive growth of algae and vascular plants (MassWildlife 2015). Under alternative B, the refuge would support expanded collaborative research, including off-refuge surface water and groundwater withdrawal effects on refuge pond water quality, harmful algal bloom, and shoreline habitats.

USFWS

Forest habitat on Massasoit National Wildlife Refuge

As noted in chapter 2, an exotic invasive species that has recently invaded a number of Massachusetts coastal plain ponds is gray willow. Gray willow is not as averse to seasonally high water as native shrubs are, and seems to thrive along these pond shores, particularly where soil disturbance has occurred and poses a threat to the water willow, the willow stem borer host plant. Both fanwort and hydrilla are increasingly detected in Massachusetts coastal plain ponds and control of these species is very difficult. The control of nuisance aquatic plants, particularly submerged aquatic vegetation, often requires the use of herbicides at concentrations that can harm local populations of rare native plants and animals if present (MassWildlife 2015), or expensive manual and mechanical removal methods. Under alternative B, the refuge would assess and control aquatic non-native invasive species and other invasive species using various methods in coordination with partners.

Changes in climate and local weather patterns will likely affect aquatic systems by exacerbating or accelerating habitat degradation due to other identified threats (MassWildlife 2015). Warmer temperatures will warm water in coastal plain ponds faster than normal, and may make some ponds inhospitable to their suite of current species. Warming of surface and groundwater in coastal plain ponds may create conditions that favor invasive species, and increase growing seasons for harmful algal blooms. Additionally, increases in severe rain and snowfall events will increase runoff of pollutants from agricultural and urban areas into waterbodies. Increases in rain will also increase atmospheric deposition of pollutants, including nitrogen deposition. In addition to increased nutrient pollution from runoff and atmospheric deposition, increased surface water temperatures will allow longer growing seasons for nuisance aquatic plants and harmful algal blooms (MassWildlife 2015). Extended periods of drought could result in lowered water levels and the loss of littoral habitat, used for foraging, rearing, reproduction, and refuge for northern red-bellied cooters plus a myriad of other species including mussel, odonate, fish, and invertebrates.

Recent research indicates that the last two decades have been the wettest years in the Northeast in 500 years (Pederson et al. 2013, Newby et al. 2014, Weider and Boutt 2010). The Sustainable Water Management Initiative, administered by the MADEP, with input from multiple state agencies, is also supporting research by USGS into the degree of hydrological alterations imposed by water supply withdrawals and climate change (MassWildlife 2015). Additionally, the USGS has modelled the impact of sea level rise on the Sagamore and Monomoy flow lenses on Cape Cod. More low-lying coastal areas including near the refuge would have shallow depths to water (5 feet or less) for projected sea-level rises of 2, 4, and 6 feet above 2011 levels. The USGS study indicates that while the potential exists for groundwater inundation in some area, the effects of sea-level rise on depths to water and infrastructure likely will not be substantial on a regional level (Walter et al. 2016).

In addition, the northern red-bellied cooter's habitat may be impacted by climate change. The *Climate Change and Massachusetts Fisheries and Wildlife* report indicates that kettle hole ponds have a *medium vulnerability* rating (score of five with one low and seven high) for impacts from climate change under both the low and high global carbon emissions scenarios. This means that these ponds are *vulnerable* to climate change and at risk of being reduced or greatly reduced in extent under either emissions scenario. The factor most influencing this score is the vulnerability to aquatic invasive species (Manomet and MassWildlife 2010). If invasive species were to proliferate within refuge ponds such as Crooked Pond, essential vegetation for northern red-bellied cooters such as native water milfoil may be diminished. Climate change induced drought conditions could reduce groundwater table levels and subsequently lower water levels in Crooked Pond and other refuge ponds supporting northern red-bellied cooters. Warmer water temperatures could also decrease dissolved oxygen levels in the pond. Therefore monitoring water depth and dissolved oxygen are important to protecting the northern red-bellied cooter. See also objective B3.1 for a discussion of landscape scale (off-refuge) work under alternative B.

As previously discussed in chapter 1, Massachusetts has been collaborating with other northeastern state and Federal wildlife agencies and non-government conservation organizations to complete standardized surveys, assessments, and develop standardized monitoring protocols for species of conservation need and the habitats upon which they depend. The consistent and widespread use of common monitoring methodologies and survey protocols will help support regional assessments of the status and trends for SGCN and their habitats, such as the NEAFWA Monitoring and Performance Reporting Framework (NEAFWA 2008, see *http://rcngrants.org/content/regional-monitoring-and-performance-framework*).

Some of the regional and statewide surveys and assessments and standardized monitoring protocols completed or now in process with funding from the RCN Grant Program that are relevant for coastal ponds conservation include dragonflies and damselflies (odonates), freshwater aquatic habitats (Gawler 2008), and frogs. In addition, the NEAFWA also funded development of a database for regional invertebrate SGCN through a partnership with the Carnegie Museum of Natural History in Pittsburgh (Fetzner 2012). A simple results chain model (Margoluis and Salafsky 1998; Foundations of Success 2009) for assessing northern red-bellied cooter headstarting effectiveness was also developed. Another more complex, multiple (parallel) conservation action results chain model for Plymouth Gentian, another indicator of coastal plain pond health (ecological integrity) has also been developed to help assess effectiveness of conservation actions. Constructing and using results chains like these can illuminate the complexities in effecting conservation to managers, policy makers, regulators, and concerned citizens.

Strategies
Continue to:
- Use mechanical and hand tools (such as rototiller, rakes, shovels, axes, and chainsaws) to reduce encroaching shrubby vegetation, remove herbaceous vegetation, girdle large canopy trees, and loosen soil at two sites on the Crooked Pond shoreline by late May at least every third year.

- Protect northern red-bellied cooter nests with predator exclosures (nest enclosures) to protect eggs and emerging hatchlings at Crooked Pond.

- Coordinate with conservation partners and participate in the State headstarting program when northern red-bellied cooters successfully nest on the refuge.

- Support and facilitate collaborative research on northern red-bellied cooters on refuge lands to determine the population and factors limiting survival and reproduction, and establish short-term population objectives.

- Use temporary signs to establish a physical closure at northern red-bellied cooter nesting sites along the Crooked Pond shoreline annually from mid-May through mid-September, and address trespass issues as they occur.

- Make appropriate changes in management for northern red-bellied cooters within 6 months of completion of any 5-year reviews or recovery plan updates to accommodate updated recovery criteria, research needs, or any additional needs identified.

In addition:
Within 3 years of CCP implementation:
- Prioritize refuge-owned shoreline of Gunners Exchange, Hoyt, and Island Ponds for opportunities to create and expand nesting habitat for northern red-bellied cooters. Develop and implement appropriate strategies including mechanical and hand methods to reduce encroaching shrubby vegetation, remove herbaceous vegetation, girdle large canopy trees to increase sun exposure, and (if appropriate) loosen soil.

- Provide basking logs for northern red-bellied cooters refuge-wide by placing large, downed trees along pond shorelines.

- Protect northern red-bellied cooter nests with predator exclosures (nest enclosures) to protect eggs and emerging hatchlings refuge-wide. Implement additional non-lethal predator management techniques, such as electric fencing, if necessary to meet nest success objectives.

- Use temporary signs to establish physical closures at potential northern red-bellied cooter nesting sites refuge-wide, and particularly along refuge-owned shoreline of Island Pond, Gunners Exchange Pond, and Hoyt Pond annually from mid-May through mid-September. Address trespass issues as they occur.

- Assure that water quality is supportive of northern red-bellied cooters in coordination with MADEP and other partners.

- Assess and control aquatic non-native invasive species, and other invasive species using mechanical methods, herbicide, or biocontrol in coordination with the MADCR, the town of Plymouth, and other conservation partners.

- Collaborate with the MassWildlife and other state agencies to define invasive species of greatest risk and to find funding for research and conservation action for species that pose the greatest threat native coastal pond biota.

- Support expanded collaborative research, including off-refuge surface water and groundwater withdrawal effects on refuge pond water quality, harmful algal bloom, and shoreline habitats, to determine the population and factors limiting survival and reproduction of northern red-bellied cooters and other coastal pond species of conservation concern on refuge lands.

- Seek grants and funding partnerships to support seasonal staff and coastal plain pond biota activities.

See also objective B3.1 for landscape scale, off-refuge strategies.

Inventory and Monitoring Elements

Continue to:

- Collaborate with conservation partners to search nesting habitat along the Crooked Pond shoreline for nesting northern red-bellied cooter activity from late May through early August by walking through nesting areas at least once per week, and more often as time allows.

- Coordinate with conservation partners to install trail cameras at nesting sites to document nesting activity and trespass as time allows.

- Record location and monitor nest success (total eggs laid and hatched) if nests are found.

Within 3 years of CCP implementation:

- Collaborate with conservation partners to search nesting habitat refuge-wide for nesting northern red-bellied cooter activity from late May through early August by walking through nesting areas at least once per week, and more often as time allows.

- Record location and monitor nest success (total eggs laid and hatched) for all nests found refuge-wide.

- Monitor water quality by conducting baseline surveys in Crooked Pond (consistent with other sampling efforts in Plymouth, Massachusetts, including Secchi depth, pH, phosphorus, nitrogen, dissolved oxygen, and heavy metals). Monitor water quality every 10 years, or more frequently if baseline surveys results reveal factors of concern.

- Conduct baseline survey of aquatic plants, especially invasive species, on all refuge ponds beginning with Crooked Pond, and evaluate feasibility of control if detected. Document extent of aquatic invasive species every 5 years or more frequently if control is implemented.

- Survey refuge ponds to assess fish, invertebrate, and plant community structure.

- Monitor rare plant populations in and around refuge ponds to detect affects from human activities.

- Carry out monitoring and de novo sampling of freshwater mussel and odonate communities on refuge ponds in collaboration with MassWildlife, and track invasive invertebrate occurrence during native species surveys.

Objective B1.2.

Manage up to 200 acres of mixed pine-oak forest habitats on Massasoit NWR with prescribed burning, mechanical methods and other methods to (1) reduce fuel loading and wildland fire risk and (2) improve habitat for migratory bird species of conservation concern, such as ovenbirds, eastern towhees, eastern wood-pewees, and prairie warblers, by providing a mosaic of forest ages and structure over the 15-year period.

Rationale

The importance of reducing hazardous fuel loads and minimizing wildland fire risk was already discussed in the rationale for objective A1.2. Here we discuss the additional rationale for expanding prescribed burning and mechanical methods from a focus on fuel reduction, to non-native invasive species control for migratory bird and other species of conservation concern that may additionally benefit including New England cottontail, forest bat species, reptiles and amphibians, and invertebrates including pollinators. Because a large number of SGCN identified in the Massachusetts SWAP (MassWildlife 2015) inhabit them, pitch pine-oak upland forest, open oak woodlands, and enduring shrublands are a high priority for both additional land protection and increased restoration and management in Massachusetts, using both prescribed fire and mechanical treatment.


USFWS

Controlled burn on Massasoit National Wildlife Refuge

Historically, fires in Massachusetts likely resulted in a "shifting mosaic" of grasses and forbs, shrubs, and trees, typically with canopy cover of less than 60 percent (savanna, shrubland, and open oak woodland). These habitats are now considered very rare on the Massachusetts landscape (MassWildlife 2015). Historical return intervals for canopy-replacing wind and fire disturbance events vary across Massachusetts, and are generally shortest (40-150 years between severe fires and/or hurricanes) in the pitch pine-oak barrens of coastal and eastern Massachusetts, indicating that 10 to 31 percent of pitch pine-oak barrens naturally occurred in early successional (less than and up to 15 year-old) forest (Lorimer and White 2003). Historically, the largest individual wind and fire disturbance patch sizes appear to have exceeded 2,470 acres in pitch pine-oak barrens in the northeast (Lorimer and White 2003). Early successional habitats are currently less common in southern New England than in pre-settlement times (Litvaitis 1993, DeGraaf and Miller 1996). The impact of fire and beaver flooding on the landscape was curtailed by European settlement and subsequent development (Askins 2001). Where these rare savanna, shrubland, and open oak woodland habitats do still occur, they support a number of Massachusetts SGCN, particularly migratory birds, moths and butterflies, and plants. Absent disturbance, the savanna, shrubland, and open oak woodland "thicket," and other pitch pine-oak upland forest habitats eventually succeed to mature, closed-canopy forest.

Shrublands are relatively ephemeral, upland habitats that are dominated by low woody vegetation (generally less than 3 feet tall), with varying amounts of herbaceous vegetation and sparse tree cover according to the Massachusetts SWAP (MassWildlife 2015). Enduring shrubland habitats include young forest and pitch pine-scrub oak communities on relatively dry upland sites. Young forest (stand initiation stage) habitats are typically dominated by rapidly growing trees and shrubs, and generally occur when a mature forest canopy is disrupted, allowing sunlight to stimulate the growth of herbaceous and woody vegetation on the forest floor. During the stand initiation stage, the flush of woody and herbaceous vegetation on the forest floor provides food (e.g., berries, browse, and insects) and cover (e.g., shrubs, tree seedlings, and slash) resources for wildlife that is generally lacking in older forest. Overall, young forests support a great diversity of wildlife species and are a critical component of wildlife habitat at the landscape level (DeGraaf and Yamasaki 2001, 2003). Many wildlife species associated with young forests are habitat specialists with specific vegetation structure or area requirements, such as the New England cottontail and Chestnut-sided Warbler (DeGraaf and Yamasaki 2003). Relatively large (greater than 25 acre) patches of early successional habitat may be necessary to maintain viable populations of mammals associated with young forest (Litvaitis 2001).

The (young forest) stand initiation stage is characterized by high stem densities (e.g., 1,000 to greater than 10,000 stems per acre) and is relatively ephemeral, generally lasting about 10 years or until a young tree canopy forms, typically causing herbaceous and woody vegetation on the forest floor to die back. The competition for sunlight within a young forest canopy typically results in a rapid decline in stem density during the stem exclusion stage. Even-aged silvicultural practices can provide ecologically and economically sustainable early successional habitats for wildlife.

The 2015 Massachusetts SWAP states that the greatest management needs for open oak woodland and native grassland habitats in Massachusetts are prescribed fire (sometimes in combination with mechanical cutting) and control of invasive exotic vegetation. Landscape composition goals for state wildlife lands identified in the 2015 Massachusetts SWAP call for 15 to 20 percent young forest, as well as 10 to 15 percent late-successional forest, using modified even-aged silvicultural practices (aggregate retention cuts, and shelterwood retention cuts). In combination, these two management activities promote native grassland habitats (in terms of both species composition and structure), which in turn promote the persistence of animal species that depend on native grassland plants. Land-clearing machinery (mulching mowers, tree shears, or chippers) is often used to cut and mulch invading trees and large invasive shrubs within shrubland sites.

Control of invasive exotic plants is a vital component of shrubland management because invasive exotic species often thrive on disturbance, including disturbance caused by vegetation clearing. If left untreated, invasive exotic plants can quickly dominate sites and degrade natural communities. Invasive plant control is accomplished through mechanical, manual, and/or chemical methods, depending on the abundance of invasive plants. Glossy buckthorn (*Frangula alnus*) is documented in Massasoit NWR, and is included among the invasive plants identified in the Massachusetts SWAP as particularly problematic in young forests (MassWildlife 2015) in the state. MassWildlife has developed Best Management Practices (BMPs) for their personnel and contractors for the control of invasive species to limit the spread of these plants.

Human-accelerated climate change impacts on upland forests, open oak woodlands, and grasslands in Massachusetts identified in the Massachusetts SWAP (MassWildlife 2015) include increased growing season length, more extreme summer temperatures, and increased periods of summer drought, as well as more frequent winter freeze-thaw cycles (*http://nsrcforest.org/sites/default/files/uploads/templer09full.pdf*). Climate change also appears to be at least partially responsible for the recent and rapid spread of the southern pine beetle, a destructive insect pest, into more northern climes (Gan 2004). Southern pine beetles have been very abundant in the New Jersey pine barrens, and are now found in the Central Pine Barrens Preserve on Long Island, New York, where management efforts are being taken to control the beetle (New York State Department of Environmental Conservation, *http://www.dec.ny.gov/animals/99331.html* (accessed August 2016). It is possible, and in fact likely, that the Southern pine beetle will reach southeastern Massachusetts. Due to inherent resiliency and dependence on disturbance, the Massachusetts SWAP (MassWildlife 2015) identified pitch pine-oak upland forest as being at moderate risk from climate change, which may expand and migrate northward. Healthy and diverse oak woodlands and native grasslands in Massachusetts may also be more resilient to drought and other severe weather events (MassWildlife 2015). Climate change may cause a shift in species composition in young forest and enduring shrubland habitats in Massachusetts, but these habitats will be able to be maintained on the landscape with active management. MassWildlife, the University of Massachusetts-Amherst, and the Department's Northeast Climate Science Center are jointly developing a Fish and Wildlife Climate Action Tool to help simplify decision-making and inspire action to maintain healthy, resilient natural resources and communities for use by local decision-makers, conservation practitioners, and community leaders. This tool may be used by the refuge to manage mixed pine–oak forest habitats on the refuge.

As previously discussed in chapter 1, Massachusetts has been collaborating with other northeastern state and Federal wildlife agencies and non-government conservation organizations to complete standardized surveys, assessments, and develop standardized monitoring protocols for species of conservation need and the habitats upon which they depend. The consistent and widespread use of common monitoring methodologies and survey protocols will help support regional assessments of the status and trends for SGCN and their habitats, such as the NEAFWA Monitoring and Performance Reporting Framework (NEAFWA 2008, see *http://rcngrants.org/content/regional-monitoring-and-performance-framework.*)

Some of the regional and statewide surveys and assessments and standardized monitoring protocols completed or now in process with funding from RCN Grant Program that are relevant for pitch pine-oak upland forests and associated savanna, shrubland, and open oak woodland habitat conservation include New England cottontail (Fuller and Tur 2012), shrubland birds (McDowell 2011), and detailed avian indicators for assessing the magnitude of threats and the effectiveness of conservation measures (Northeast Coordinated Bird Monitoring Partnership 2007). In addition, the NEAFWA also funded development of a database for regional invertebrate species of greatest conservation need through a partnership with the Carnegie Museum of Natural History in Pittsburgh (Fetzner 2012). Service conservation partners continue constructing and using new results chain models (Margoluis and Salafsky 1998; Foundations of Success 2009) that can illuminate the complexities in effecting conservation for managers, policy makers, regulators, and concerned citizens.

Massasoit NWR is a relatively small refuge that cannot concurrently provide for multiple suites of forest songbirds by itself. However, management actions to reduce hazardous fuels would create and maintain a shifting mosaic of forest ages and structure likely to benefit many disturbance-dependent species of conservation concern over the 10 to 15-year CCP period.

Native Plants:
The unchecked spread of invasive plants threatens the biological diversity, integrity, and environmental health of all refuge habitats. In many cases, these plants have a competitive advantage over native plants and form dominant cover types, effectively reducing the availability of native plants as food and cover for wildlife. Prescribed burning and mechanical removal of invasive species would help in the control of glossy buckthorn and other invasive shrubs (see appendix A and chapter 2 for list of invasive plants).

Migratory Birds:
Within BCR 30, forested uplands provide habitat for the second highest number of priority bird species. Historically, the coastal communities within BCR 30 were dominated by a contiguous forest, but today these forests have become highly fragmented by 300 years of land clearing, agriculture, and human development (TNC 2006). Destruction and forest fragmentation in both breeding and wintering areas are factors in forest bird species declining abundance (Roth et. al 1996). Within Massasoit NWR and the surrounding region, a number of migratory birds depend on mixed pine-oak communities and associated shrublands. For this objective we focus on several songbird species that are of conservation concern, already present on the refuge, and that represent the habitat needs of other species of concern.

Ovenbird

Tom Benson

Ovenbirds are among the list of surrogate species (see chapter 2) in the North Atlantic LCC southeastern subregion. Despite their sensitivity to patch size, 16 percent of all landbirds recorded on the refuge during surveys conducted from 2001 to 2010 were ovenbirds, making this the most common bird species recorded. Ovenbirds nest in deciduous or mixed deciduous-conifer forests where deciduous trees predominate. These birds may be area sensitive and require a closed canopy structure and a relatively open understory (Neimi and Hanowski 1984). Preferred vegetative structure includes canopy heights of 52.5 to 72.2 feet with 60 to 90 percent canopy closure (Robbins et al. 1989). Patches characterized by few shrubs and small trees and an open forest floor provide nesting opportunities, although dense herbaceous vegetation may also be used. Some studies suggest that the minimum required acreage for breeding ovenbirds ranges from 247 to 2,186 acres (Robbins 1979, Robbins et al. 1989). However, a recent study conducted in an urban region outside of Boston, Massachusetts analyzed the presence of ovenbirds in patch sizes from 24 to

770 acres and found pairing success was high in all sites but was not significantly higher (statistically) in large versus small reserves. There was also no significant statistical difference in predation or parasitism. Density was significantly higher and territories for male ovenbirds were significantly smaller (statistically) in the large reserves (Morimoto et al. 2012), which may partly explain the high frequency with which ovenbirds were encountered during surveys at the refuge and the surrounding landscape. The models from this study suggest that northeastern U.S. habitats can support viable ovenbird populations with forest cover exceeding 40 percent and maintaining reserves that are approximately 300 acres and larger (Morimoto et al. 2012). Although these studies suggest the importance of open understory for nesting success among adults, some studies also indicate that juvenile ovenbirds use regenerating cleared areas that have a denser understory for foraging and predator protection (Pagen et al. 2000, Marshall et al. 2003).

The eastern towhee is a species of priority conservation concern due to regional declines (PIF 09), and it also has a High Priority ranking within BCR 30. It is also a surrogate species in the North Atlantic LCC northeastern subregion. Breeding bird survey data since the mid-1960s show eastern towhee population declines throughout southern New England, averaging -7.1 percent per year (Dettmers and Rosenberg 2000). The 2000 PIF report for this region indicates a level III management priority, i.e., management is needed to reverse or stabilize the population. One study in Plymouth, Massachusetts showed that suburban development within pine barren habitat had decreased eastern towhee populations by 50 percent (TNC 2009). The most likely explanation for this long-term, chronic decline is early successional habitat reversion to more mature forests in southern New England (Hagan 1993). During surveys conducted from 2001 to 2010, 9 percent of all landbirds recorded on the refuge were eastern towhees, making it the second most common landbird recorded. Eastern towhees rely on dense shrubland with small tree cover near the ground (Greenlaw 1996). This species thrives in native deciduous shrubs and vine tangles in mid- to late-secondary successional stages, with stems at least 6.6 feet tall, a well-developed litter layer and dense low cover extending to the leaf litter. The low cover may be continuous or discontinuous with patches of more open ground. Overstory trees may or may not be present, and if present, open-canopy (woodland) situations are favored. In general, eastern towhee densities are greatest in old field thickets and later stages of second growth, but are sometimes present in climax forest where the understory is well developed as well. Minimum territory size can be as large as 5 acres, but in high density nesting areas in Massachusetts as many as 1.5 pairs per acre have been documented (Greenlaw 1996). Management efforts for this species should seek to maintain habitat diversity, specifically to include an array of woody plant communities in mid-seral successional stages. Eastern towhees benefit from controlled burning, but burn frequency must be carefully considered. Regular disturbance in the form of fire, controlled logging, or heavy weather is necessary to maintain optimal eastern towhee habitat (Blake and Karr 1984).

Eastern wood-pewee, another species of concern present on the refuge is identified as a surrogate species in the Mid-Atlantic subregion of the LCC and breeds in every type of wooded community in the East (McCarty 1996). Breeding bird surveys show an overall -35.6 percent population decline for the period 1966 to 1993, with a -13.4 percent decrease from 1984 to 1993 (Price et al. 1995). Eastern wood-pewee comprised four percent of the total birds identified at the refuge during the 2001-2010 surveys. With warming temperatures due to climate change, it is expected that eastern species found more abundantly in southern regions, such as the eastern wood-pewee, could migrate further north with time. In general, forestry practices that maintain large tracts of intermediate aged forest with closed canopy and limited size clear cuts (greater than or equal to 24.7 acres), along with thinning to remove mature trees and woody growth less than 3 inches in diameter at breast height (dbh), should provide adequate habitat for eastern wood-pewees. In eastern deciduous habitats, eastern wood-pewee can be found in more open sites with low density canopy cover. Size of forest fragments does not appear to be an important factor in habitat selection (Blake and Karr 1987). The eastern wood pewee uses both edge and suburban habitats. Although they are able to breed in every forest type in the East (McCarty 1996), they prefer large tracts of intermediate age forest with more closed canopy and limited clearing (Price et al 1995). They have also been known to consistently select open park-like areas on xeric (dry) sites with limited canopy and low shrub density (McCarty 1996; Robbins et al. 1989). Because this species is common in both forest interiors and edges they are not sensitive to patch size (McCarty 1996; Robbins et al. 1989), and a mosaic type management effort with varying levels of succession would likely support eastern wood-pewee.

Prairie warblers are a highest priority species for BCR 30 and are a representative species for pitch pine-scrub oak habitats in the Service's northeast region. The prairie warbler is listed under the PIF 09 Plan (Dettmers and Rosenberg 2000) as a level III priority species with populations declining in this region. Prairie warblers do not occur in large numbers on Massasoit NWR, but do consistently nest along opening edges on the refuge. Prairie warblers utilize various shrubby plant associations lacking closed canopies for breeding, with trees scattered and a dense shrub layer present (Nolan Jr. et al. 2014). Fire-maintained habitats, such as pine barren, host this surrogate species. A study conducted in the pine barrens of New York (Beachy and Robinson 2008) showed that shrubland birds such as prairie warbler were twice as frequent and three times as abundant at sites that were not invaded by woody invasive plants. Prescribed burning and mechanical removal of invasive species would help control glossy buckthorn and other invasive shrubs (see appendix A and chapter 2 for a list of invasive plants). In a study by King et al. (2011), bird surveys were conducted pre- and post-thinning using prescribed burns for management. The surveys showed that early successional species such as prairie warbler and field sparrow were most abundant in scrub oak and thinned pitch pine conditions.

Whip-poor-will

William Majoros

Although not specifically listed in our objective, whip-poor-wills are also likely to benefit from increased management. Whip-poor-wills are a high priority species of conservation concern associated with forested upland habitats within BCR 30 (Steinkamp 2008). They are widely distributed in Massachusetts, but are declining. They occur most commonly in the woodlands of the southeastern coastal plain in Plymouth County and on the Cape and Islands, including Massasoit NWR. Declines in breeding populations are difficult to quantify because whip-poor-wills are under-sampled by existing breeding bird survey methodologies due to their nocturnal calling and cryptic behavior. Both long-term (1966 to1988) and short-term (1978 to1988) indices for breeding bird censuses (Sauer and Droege 1992) suggest small, annual declines (-0.01 percent long-term and -2.26 percent short-term) for U.S. central woodland regions and for eastern woodland regions (-0.70 percent long-term and -1.36 percent short-term). They favor dry deciduous or mixed forests with little or no underbrush. The degree of openness in forest understory appears more important than forest composition (Wilson 1985). Shade, proximity to open areas for foraging, and fairly sparse ground cover are key habitat elements (Eastman 1991). In Massachusetts, the whip-poor-will is found in lower elevations in dry oak and pine woodlands with occasional clearings. It nests on the ground in leaf litter, and feeds on moths and other flying insects. Causes for decline in some areas include habitat loss to agriculture and closing of forest openings due to forest succession.

Mammals:
New England cottontails may also benefit from forest management under this objective. Although not currently found on Massasoit NWR, they do occur on the adjoining MSSF, and providing potential habitat may increase the likelihood of future refuge occupancy. Litvaitis and Tash (2006) estimated the species only occupied 14 percent of its historical range as of 2004. Given the relative ease in which habitat management can provide suitable habitat for New England cottontail and the species' fecundity, habitat restoration can provide immediate conservation benefits.


Tom Barnes/USFWS

New England cottontail

New England cottontails are considered habitat specialists insofar as they depend on early-successional "thicket" habitats (Litvaitis 2001). These habitats can be found in association with abandoned agricultural lands, wetlands, clear cuts, coastal shrublands, scrub oak barrens, utility rights-of way, or other areas where disturbance has stimulated the growth of shrubs and other early-successional plants (Litvaitis 1993, Tash and Litvaitis 2007). New England cottontails are reluctant to venture from the cover these dense stands provide, demonstrating a close affinity for microhabitats with over 20,000 stems per acre (Barbour and Litvaitis 1993). New England cottontail populations decline rapidly as understory vegetation thins with maturing forests (Litvaitis 2001). Along with the vegetation structure within a habitat patch, the patch size must be considered when assessing its value as New England cottontail habitat. In smaller habitats, cottontails tend to deplete food resources during the winter, and as a result rabbits on smaller patches (less than 7 acres) tend to be in poorer body condition than rabbits on larger patches (greater than 12 acres) (Villafuerte et al. 1997). According to Barbour and Litvaitis (1993) small patches have higher mortality rates, acting as a sink for dispersing juveniles, and that for the continued existence of New England cottontails, larger patches of suitable habitat must be maintained.

The primary threat to the New England cottontail is habitat loss through succession. During the process of forest maturation stem density declines, and eventually the stems self-thin to such an extent that it becomes unsuitable. Fragmentation serves to further degrade habitat on a larger scale. Isolation of occupied patches by surrounding areas of unsuitable habitat, coupled with high predation rates, are causing local extirpation of New England cottontail from small patches (USFWS 2011). Maintaining and regenerating early successional habitat with a high density of shrub and thicket vegetation benefits New England cottontail recovery.

Management of the mixed pine-oak forests of Massasoit NWR may also benefit forest dwelling bats. Acoustic surveys are currently being conducted to determine which species are present on the refuge. The eastern red bat and northern long-eared bat are surrogate species within the southern New England subregion of the NALCC, and other bats under consideration for management due to declining numbers include big brown bat and silver-haired bat. In a study by Loeb and O'Keefe (2006), bats were more likely to be recorded in areas with sparse vegetation, farther from roads, and in early successional stands. Vegetation density was also the best predictor of habitat use by big brown and red bats, with both species recorded at points with sparse vegetation. Silver-haired bats forage in fairly open habitat in mixed wood forest areas near ponds. They roost in hollow trees and cavities under loose bark or bark folds (Barclay et al. 1988). Fires that cause overstory mortality and create canopy gaps may allow bats such as eastern red bat and big brown bat to forage more effectively (Edwards et al. 2000). Prescribed burns increase herbaceous and shrub growth that can increase abundance and diversity of insect prey. Care must be taken to prevent the loss of snags and green-reserve (wildlife) trees left as roosting habitat. Bats may benefit from fire creating new roost trees through direct or indirect fire mortality (via disease, insect or fungal attack). Fire can also decrease forest tree density and increase openings, thereby improving foraging space and travel corridors, allowing more light to reach and warm roost trees, and increasing insect prey diversity and abundance by increasing herbaceous and shrub growth.

Invertebrates, including pollinators:
Overall, shrublands are the most important natural community type for rare and endangered Lepidoptera in Massachusetts (Wagner et al. 2003). Rare species associated with shrublands in the northeastern U.S. tend to occur in enduring shrub habitats as opposed to ephemeral shrub habitats (Latham 2003), and this may be especially true for Lepidoptera (Wagner et al. 2003). Recent work in Massachusetts indicates that shrublands along power line corridors and at reclaimed abandoned field sites support a diverse assemblage of Lepidoptera, but do not typically support rare species of butterflies and moths (King and Collins 2005). Many invertebrates such as rare moths and butterflies in Massachusetts depend on pitch pine-scrub oak habitats. Each moth and butterfly species is often a specialist on a microhabitat such as frost barrens, river corridors, or late-successional stands and not found in all pitch pine-scrub oak types. In addition, many of the caterpillars of these species eat only pitch pine, scrub oak, or other specific larval host plants found only or mostly in pitch pine-scrub oak communities. Thus, to maintain these species metapopulations over time (long-term persistence), it is necessary to maintain pitch pine-oak in various stages of recovery from various kinds and severity of disturbances across large landscape areas.

Pollinators play a crucial role in flowering plant reproduction. A recent study of the status of pollinators in North America by the National Academy of Sciences found that populations of some native pollinators are declining, which may in part result from habitat loss, degradation, fragmentation, non-target effects of pesticides, competition from invasive species, and introduced diseases (National Academy of Sciences 2007). Although no moth or butterfly surveys have been conducted on the refuge, many rare species are known to be present within the neighboring conservation lands of the MSSF (see chapter 2). The persius duskywing (State-listed endangered) and frosted elfin (species of special conservation concern) can be found within the pine barren habitats of this region. Pine barrens buckmoth and Gerard's underwing moth are also species of concern in Massachusetts that may be found in this region. The water willow stem borer (State-threatened) is a moth species associated with the pondshore wetlands.

A two-year study currently underway will result in a significantly better understanding of the distribution and microhabitat needs of the Barrens tiger beetle and the purple tiger beetle in pitch pine-oak upland forest habitat in the MSSF adjoining Massasoit NWR. For insects, determining population trends and their causes is generally time and cost-prohibitive. Therefore, most surveys for Massachusetts insect SGCN (MassWildlife 2015) consist of presence-absence data by habitat. Future monitoring of these species, to the extent possible, should investigate correlations with habitat management and/or natural disturbance events. The life history and habitat requirements of some state-listed Massachusetts SWAP species that occur in pitch pine-scrub oak habitat (for example, the Barrens Metarranthis) are completely unknown. In order to better inform habitat management and other conservation efforts, research to elucidate the natural history of lesser known species is a priority under the 2015 Massachusetts SWAP. Research on the natural history of rare orchids associated with pitch pine-oak upland forest habitat is also a priority in the 2015 Massachusetts SWAP.

Strategies:
Continue to:
- Evaluate the entire refuge in the context of wildland urban interface risks and along in coordination with Service partners, facilitate planning of additional hazardous fuel reductions to protect neighboring communities.

- Utilize prescribed fire and mechanical clearing including mowing, cutting, and masticating in accordance with the approved FMP and Annual Burn Plans every 3 to 5 years initially to maintain approximately 75- to 100-foot wide shaded fuel breaks between the refuge and residential areas, and 10- to 25-foot fire breaks between burn units (see map 3-1). Transition to a 5- to 10- year interval on the northeastern portion of the Crooked Pond parcel over time. The target shaded fuel break effective width is 100 feet, and the target fire break effective width between burn units is 12 feet.

In addition:
Within 5 years of CCP implementation:
- Utilize prescribed fire in combination with mechanical mowing, cutting, and/or mastication (chipping/mulching) in accordance with the approved FMP and Annual Burn Plans to open forest and shrub canopies to increase sunlight reaching the forest floor, or to control invasive plant species.

- Implement prescribed fire on a 5- to 7-year cycle within all burn units on the Crooked Pond parcel.

- Mechanically maintain all fire breaks on all refuge parcels as needed.

- Refine existing cover type map via ground verification. Evaluate available data on forest structure and composition and determine if finer scale information is needed to evaluate baseline characteristics of forest habitat refuge-wide.

- Ensure management plans (such as the HMP) incorporate mechanical, prescribed fire and other techniques, and contain strategies to collaborate with utility ROW managers to achieve habitat objectives.

- Reduce invasive plants such that they are dominant on less than 10 percent (less than or equal to 21 acres) of upland acres.

- Facilitate and participate in relevant research that has conservation implications for priority species and habitat types and will inform management priorities.

- Consult regional and/or state conservation plans including (but not limited to) those existing for pitch pine-scrub oak and shrubland habitats, New England cottontail, bats, northern red-bellied cooters, and lepidopteran species during refuge habitat project planning, including prescribed burning. Coordinate refuge habitat project implementation with the MassWildlife, MADCR, and other local and regional conservation partners.

- Seek grants and funding partnerships to support seasonal staff and forest management projects.

Inventory and Monitoring Elements
Continue to:
- Document all management actions using GIS.

- Fulfill monitoring elements as outlined in annual burn plans to evaluate how well burn objectives are met.

Within 5 years of CCP implementation:
- Update the refuge-wide cover type map every 10 years.

- Collect existing historic information (including spatial information) about wildlife and habitat resources from partners and the community to inform priorities.

- Conduct breeding landbird surveys to document breeding bird response to management.

- Implement baseline nocturnal surveys for whip-poor-will to better understand refuge importance and determine if management should incorporate this species.

- Implement baseline surveys for invertebrate species (including rare species found on neighboring MSSF) to better understand species presence and abundance, and determine if management and long-term monitoring is warranted.

- Develop and implement surveys to track vegetation response to habitat management.

- Conduct forest composition surveys (species composition, structure, density, diameter at breast height) and additional surveys as warranted by protocols and guidelines.

- Work with partners or volunteers to develop a comprehensive list of plants with emphasis on rare species and non-native species (including spatial information) to help prioritize management actions.

- Conduct invasive species surveys (presence and infestation size).

GOAL 2:

Promote awareness and support for the protection of sensitive resources on Massasoit NWR through community outreach and opportunities for connecting the public to the refuge's natural resources.

Objective B2.1.

Within 5 years, work with partners and volunteers to expand opportunities to provide quality environmental education and interpretation programs, and enhance community outreach.

Rationale:
Under alternative B, we would rely primarily on refuge partners, local conservation groups such as Friends of MSSF, the Southeastern Massachusetts

Pine Barrens Alliance, and volunteers, as well as some refuge staff involvement, to provide interpretive programming or public information delivery on or associated with the refuge. The primary area this would occur is within the Crooked Pond parcel.

We want local residents and visitors to understand, appreciate, and support the Refuge System mission and the refuge's unique purpose. To accomplish this, we would update the refuge Website and use social media and the press to describe management actions and upcoming initiatives. We would also participate in at least one community event every four years and develop display materials to reach non-traditional audiences. Our standard practice of informing the public of prescribed burns would continue under alternative B.

Given current limitations with staff and funding, it is of utmost importance for us to reach out and collaborate with other conservation agencies and organizations in the region. These could include MADCR, MassWildlife, the town of Plymouth, Massachusetts Audubon Society, TNC, the Southeastern Massachusetts Pine Barrens Alliance, and others. It is through these partners that we would strive to develop an effective outreach program targeted at local communities and residents who may be unaware a national wildlife refuge is nearby. In addition, these partnerships are important to our biological program and we would continue to strengthen and develop collaborative initiatives with them to accomplish our objectives.

Further educating both the public and other regulatory agencies about the value of pitch pine-oak upland forest and coastal pond habitats and the issues related to their conservation are state priorities (MassWildlife 2015) through publications and other forms of public outreach (e.g. the Wildlife Management Institute Website dedicated to New England cottontail conservation). An ongoing Working Lands for Wildlife partnership between MassWildlife and the NRCS provides additional opportunity to make direct contact with private landowners focused on the importance of restoring and managing pitch pine-oak upland forest habitat. The Southeastern Massachusetts Pine Barrens Alliance is also locally active in public outreach and education about the unique values of and threats to pitch pine-oak upland forest (*http://www.pinebarrensalliance.org/*, accessed November 2015). Posters and booklets focusing on coastal pond conservation and management similar to one produced in 1999 by MassWildlife and the Wildlands Trust of Southeastern Massachusetts could be put on the refuge Website for public access. The Massachusetts SWAP (MassWildlife 2015) identifies several outreach actions focused on coastal plain pond conservation that the MassWildlife will undertake, that present opportunities for refuge staff to partner with, including: encouraging local conservation commissions to enforce the Massachusetts Wetlands Protection Act and town and regional bylaws restricting work in coastal plain ponds and the 100-foot buffer zones surrounding them; regulating and limiting the impacts of development, nutrients, and water withdrawals on coastal plain ponds, and; educating and informing the public about the values of coastal plain ponds and the issues related to their conservation, through state agency publications and other forms of public outreach, to instill public appreciation and understanding.

Eastern hognosed snake

Ohio DNR

Interpretation is one of the most important ways to increase visitor awareness of the Service's presence and role in the Plymouth area. Interpretation can help visitors understand refuge habitats, including the pitch pine-scrub oak and pond habitats, the importance of endangered species such as the northern red-bellied cooter, and the Refuge System mission. Interpretation programs can provide visitors with an understanding and appreciation of fish and wildlife ecology and help them understand their own role in the environment. Interpretation is one of the most important ways to increase visitor awareness of the Service's role in the protection and recovery efforts for the northern red-bellied cooter and habitat management for neotropical migratory bird species, bats, New England cottontail, rare invertebrates and plants, other species of conservation concern, and the uniqueness of pine barren communities.

Environmental education programs promote understanding and appreciation of natural and cultural resources and their conservation on all lands and waters in the national wildlife refuge system. Generally, conducting environmental education involves more than facilitating field trips. Formal environmental education requires that the programming meets national curriculum-based academic standards. Educating people about the significance of the refuge for birds and other wildlife will foster an appreciation of conservation and encourage them to make environmentally responsible decisions.

Expanding environmental education, interpretation, and community outreach as proposed under alternative B, requires additional seasonal staff, volunteers, enhanced partnerships, and other resources to fully implement.

Strategies:
Continue to:

- Allow occasional guided interpretative field trips on the refuge hosted by partners under a SUP.
- Use the refuge Website to provide information about the northern red bellied cooter and other important species in the coastal plain pond habitat and pine-oak forests.
- Disseminate the Refuge Complex brochure to provide information on refuge and wildlife management.
- Notify the public of large scale management activities (e.g., prescribed burns), their purposes, and possible impacts through press releases and the refuge Website.
- Manage the refuge volunteer program.
- Coordinate with local organizations to promote awareness about the refuge and its resources.

In addition to objective A2.1,
Within 5 years:

- Provide information about refuge resources and management at the library, partner facilities, and the Chamber of Commerce.
- On request, work with local educators to provide environmental education for local schools.
- Work with partners to develop and display traveling exhibits for libraries and community buildings to reach non-traditional audiences.

- Conduct Service-directed interpretive programs as requested along with partners, utilizing existing roads and trails on the refuge through Special Use Permits.
- At a minimum, participate in one local community event every 4 years.
- Develop an interpretative endangered species and species of greatest conservation concern education trunk to be used by teachers in local schools.
- Work with partners to conduct "Teach the Teacher" classes to provide information about the refuge, the northern red-bellied cooter and other species of conservation concern, and management of pine barren and coastal pond habitats.
- Seek grants and funding partnerships to support additional seasonal staff, environmental education programs, and community outreach activities.
- Hire a summer Visitor Services intern with refuge resources or through partnerships to focus on supporting these efforts.

Inventory and Monitoring Elements
- Record the number of SUPs issued for environmental education and interpretive guides.
- Record the number of participants in each program.
- Record number of events and number of attendees at the event.
- Record volunteer hours.
- Record number of times travelling display is utilized and record number of people that interact with exhibit.

Objective B2.2

Provide opportunities on the Crooked Pond parcel for visitors to engage in wildlife observation and photography on the refuge in a manner that minimizes disturbance to refuge habitats and wildlife.

Rationale:
Wildlife observation and photography are identified in the Improvement Act as priority public uses. Priority public uses are to receive enhanced consideration when developing goals and objectives for refuges. We like to partner with other agencies and organizations to connect adults and children with nature, thereby reducing "nature-deficit disorder." A growing body of research suggests that a lack of direct involvement with the outside world may be contributing to a variety of maladies affecting children in today's society (Louv 2005). By offering places and programs where children and their parents can observe wildlife in natural settings, and learn to appreciate wildlife, we will contribute to the growing national initiative to reconnect children with nature.

High quality wildlife observation and photography involves: (1) observation that occurs in a primitive setting and provides an opportunity to view wildlife and its habitats in a natural setting; (2) observation facilities that are safe and maximize opportunities to view the spectrum of species and habitats on the refuge; (3) observation opportunities that promote public understanding of and increased public appreciation for America's natural resources; (4) viewing opportunities that can inspire increased stewardship of our refuge resources; (5) facilities, when provided, that blend with the natural setting and provide viewing opportunities for all visitors, including persons with disabilities; (6) observers who understand and follow procedures that encourage the highest standards of ethical behavior in natural; (7) viewing opportunities that exist for a broad variety of visitors; and (8) observers who have minimal conflict with other priority wildlife-dependent recreational uses or refuge operations.

People enjoy being outdoors in natural areas. The National Survey of Fishing, Hunting, and Wildlife-Associated Recreation, published every five years by the Service, found that more than 90 million Americans, or 41 percent of the U.S. population age 16 and older, pursued outdoor recreation in 2011. They spent almost $145 billion that year pursuing those activities. About 72 million people observed wildlife, while 33 million fished and nearly 14 million hunted (USFWS and U.S. Census Bureau, 2014). About 82 percent of total expenditures came from non-consumptive recreation (recreation other than hunting and fishing) on national wildlife refuges. Fishing accounted for 12 percent of total expenditures, while hunting accounted for 6 percent.

Under Alternative B, visitors would be able to observe and photograph wildlife on special occasions when led by refuge staff or partners working under an SUP. Wildlife observation and photography might be the focus of a specially guided trip, or could occur when environmental education and interpretation is conducted. Dogs, horses, bicycles, and motorized vehicles would never be allowed on the refuge.

Strategies:
Within 1 year:
- Provide wildlife observation and photography staff or partner-led trips on the refuge.

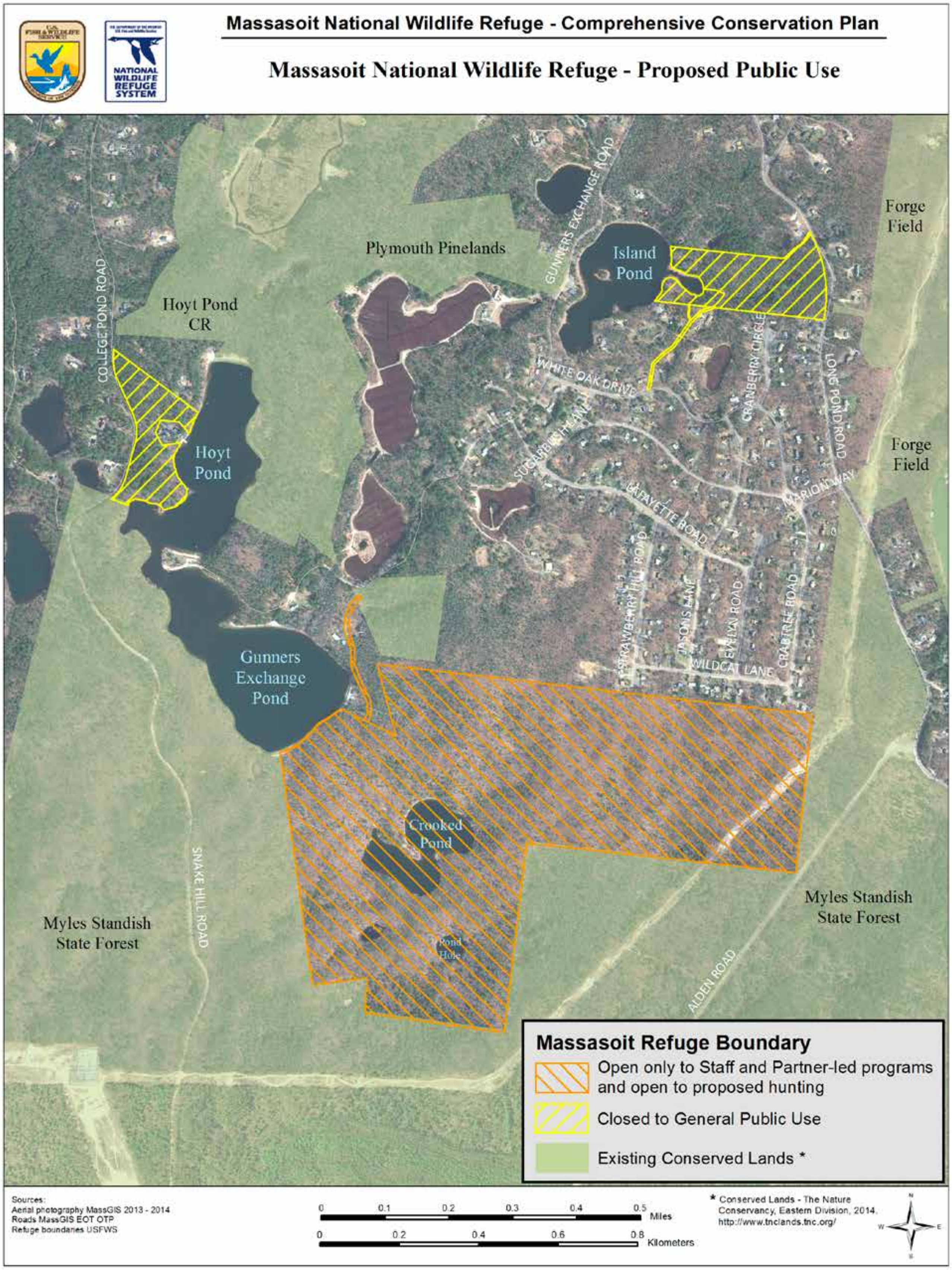
Inventory and Monitoring Elements
- Number of visitors engaged in wildlife observation and photography annually.
- Number of participants in trips to the refuge.

Objective B2.3. **Determine whether to open the Crooked Pond parcel to hunting, particularly deer and turkey hunting, within 5 years of CCP approval.**

Rationale
Based on the primary purpose for establishment of the refuge for the protection of an endangered species, and budgetary and staff constraints, Massasoit NWR has never previously been opened for any public use including hunting. Hunting is permitted in accordance with State regulations on lands adjoining the refuge, particularly on the MSSF where deer and turkey are the most common species hunted.

High density deer populations can result in increased incidences of Lyme disease, increased collisions with automobiles, and unhealthy deer populations (MassWildlife 2014) and wildlife habitat conditions. Since deer populations can exceed 30 deer per square mile annually in Massachusetts, hunting is a valuable means for MassWildlife to manage the populations while simultaneously providing opportunities for wildlife-dependent recreation. A study (MassWildlife 2014) of deer survivorship in MSSF indicated that deer density was 15 to 20 deer per square mile (Epsilon 2001 as referenced in MADCR 2011). This suggests refuge deer abundance currently is well above the 2014 Wildlife Management Zone 11 “target” of 6 to 8 deer per square mile average density. Opening the

Map 3-2. Alternative B Proposed Public Use.



refuge to deer hunting would assist MassWildlife's efforts to address deer overabundance in the immediate refuge vicinity, while providing additional opportunity for wildlife-dependent recreation in the area.

Under this alternative, the refuge would consider opening most of the Crooked Pond parcel to hunting; no other parcels would be opened to hunting. In order to open the refuge to hunting, refuge staff would be required to develop a separate, opening package including NEPA compliance, which requires a public comment period. All hunt seasons would be evaluated as part of this process. Hunting would occur in accordance with State regulations. In addition to safety zones, other buffer zones could be established to protect the northern red-bellied cooter. At a minimum, we anticipate that the refuge would open for archery deer, shotgun deer, muzzleloader deer, and wild turkey. The refuge would not construct any parking areas to support hunting on the refuge. Hunters would access the refuge from existing parking areas on abutting State lands. We do not anticipate requiring special permits issued by or on behalf of the Service in order to hunt on the refuge.

Strategies
Within 5 years:
- Evaluate all State hunt seasons and prepare a hunt opening package, including NEPA analysis and public review, to open the refuge to hunting, including deer and turkey hunting.

- If approved, prepare a refuge hunt plan and open for hunting for the selected seasons.

Inventory and Monitoring Elements
- Develop monitoring strategies to measure change, achievement of objective, and evaluate the hunt program, modify or restrict access, or adapt hunt management strategies as warranted.

- Coordinate with MassWildlife, MADCR and other State agencies to obtain any available harvest data for the refuge.

GOAL 3: **Enhance collaborations with Federal and State agencies, conservation organizations, and local communities to promote species and habitat conservation across the pitch pine-oak landscape in southeastern Massachusetts, and to support Massasoit NWR's purpose, and the Refuge System and Service missions.**

Objective B3.1. **Work with the northern red-bellied cooter recovery team and species experts to refine our understanding of species habitat requirements, methods for assessing habitat quality rangewide, and the factors limiting survival and reproduction. Also, work with these experts to determine high priority areas for habitat management across its range and determine suitable management actions.**

Rationale
The Service entered into a cooperative agreement during the writing of this CCP as discussed under objective A3.1. Alternative B expands these objectives and our participation in off-refuge work. Finalized protocols developed under the cooperative agreement referenced in objective A3.1 will allow us and our conservation partners to inventory, monitor, and evaluate more sites rangewide, and pilot habitat management techniques beyond 2016. In the near term, this information will help us evaluate how well we are meeting Recovery Plan goals, and whether current population levels satisfy down-listing or delisting criteria. It will also help us monitor future population changes and strategically direct our efforts on the ground.

USFWS

Northern red-bellied cooter and white-tailed deer at Crooked Pond

Successful northern red-bellied cooter recovery depends on hatchling survival and recruitment into the breeding population. The Revised Recovery Plan (USFWS 1994) and 5-Year Review (USFWS 2007) recommend studies to determine primary sources of mortality, hatchling predator issues, and other factors affecting turtle reproduction and survival. The plan also recommends continued natural history studies that include determination of habitat requirements, nest site selection preferences, the proportion of adult female turtles that nest annually or twice annually, and the age and size of turtles at reproductive maturity. Research on long-term survival of turtles indicates that successful management and conservation programs for long-lived organisms, such as turtles, will be those that recognize that protection of all life stages is necessary (Congdon et al. 1993). These and other studies continue to provide data needed to implement sound management. These studies should evolve as the data and knowledge base improves and new research goals are developed.

Additionally, there is a need for data on possible effects of pesticides, heavy metals, and other environmental contaminants on northern red-bellied cooters. Since many of the ponds are found in close proximity to commercial agriculture, the potential impact of insecticides and other chemicals used in agriculture or mosquito abatement should be investigated. Habitat alteration as a result of agricultural development and practices may also bear on the northern red-bellied cooter population status. Manipulation of aquatic vegetation, including herbicide use, may impact northern red-bellied cooter food resource quality and quantity. Unanswered questions about the effects of more recent chemical treatment that are less toxic to wildlife remain. The cranberry industry is the single largest water user in southeastern Massachusetts (Barbour et al. 1998) for irrigation and harvesting and many northern red-bellied cooter populations are dependent on the same water used by growers. The cranberry industry had a negative impact to the habitat of the northern red-bellied cooter through large water withdrawals and the use of herbicides and pesticides. However, the cranberry industry in Plymouth County has been very supportive of the recovery effort, and is now an important partner in the program (USFWS 2004). Our State partner, MassWildlife, has established cooperative relationships with cranberry companies and it is important to maintain these relationships and establish new ones.

Strategies
Continue to:
- Work with MassWildlife, Massachusetts Cooperative Fish and Wildlife Research Unit, and other partners to fulfill priority research objectives.

- Support efforts and research toward rangewide recovery of the northern red-bellied cooters.

Within 3 years of CCP implementation:
- Facilitate and as appropriate, participate in additional rangewide research relevant to northern red-bellied cooters when research has conservation implications and will inform future refuge management. Focus may include, but is not limited to:

  - Post-emergence survival of hatchlings.

  - Principal sources of mortality.

  - Impacts of predators.

  - Other natural and anthropogenic factors affecting northern red-bellied cooter survival, reproduction, and population growth.

- Work through MassWildlife to engage cranberry industry owners and other appropriate enterprises to avoid activities that may be harmful to northern red-bellied cooters and their habitats range-wide, as well as support recovery efforts.

- Pursue incentive programs for private landowner management of habitats for northern red-bellied cooters range-wide.

- Work with partners, to utilize the most current information on the Critical Habitat Area for the northern red-bellied cooter, and identify potential areas for land protection to benefit the species.

Inventory and Monitoring Elements
Continue to:
- Annually record the number of research projects funded and research objectives met.

Within 3 years:
- Facilitate implementing inventory, monitor, and evaluation of non-refuge sites identified as high priority by the Service and conservation partners.

Objective B3.2.

Work with local and regional wildland and structural fire management professionals to continue to protect communities at risk from wildfire.

Rationale
The rationale is the same as that previously discussed for objective A3.2.

Strategies:

Continue to

- Coordinate with abutters, private landowners, and conservation partners to ensure protection of communities at risk as well as natural resources.
- Work with the MADCR to implement 'Fire Wise' (*http://www.firewise.org*) educational programs in neighboring communities.
- Support other land management agencies with their fuel reduction projects by providing assistance through training, equipment, staff time, and technical expertise.

Inventory and Monitoring Elements

- Annually record the number of partnership hazardous fuel reduction projects the Service participates in.
- Annually record the number of Fire Wise programs implemented and number of attendees.
- Annually record the number of acres treated.

Objective B3.3. **Work with adjacent landowners, the MSSF, and other conservation organizations in the area to coordinate responsible use and enjoyment of the Massasoit NWR and surrounding public lands.**

Rationale

Opening the refuge to limited public access and use, would allow Massasoit NWR to play a key role in supporting conservation efforts in the surrounding area on town, State, private and partner lands. Staff would coordinate with others to ensure the management actions occurring on the refuge complement larger, landscape efforts while maintaining our focus on protecting the federally endangered northern red-bellied cooter and other species of conservation concern.


Jared Green

Measuring the size of a red bellied-cooter

Strategies
Within 1 year of CCP implementation:

- Refuge law enforcement will communicate threats to public safety and species protection with abutters and other conservation organizations.
- Coordinate with abutters, private landowners, and conservation partners to ensure protection of resources.
- Work with MSSF to post information on their Alden Road kiosk about the refuge, its species, and management practices, including prescribed burns.
- Increase law enforcement outreach to surrounding landowners.
- Identify other opportunities to provide refuge information at partner facilities.

Inventory and Monitoring Elements
None applicable

Summary of Alternatives

Table 3-1 below compares and contrasts what distinguishes the two management alternatives evaluated in detail in this draft CCP/EA. It highlights the management actions that are detailed in chapter 3. We recommend readers consult chapter 3, including the sections titled “Actions Common to All Alternatives” to understand the full range of what is proposed, and our rationale, under each alternative.

Table 3-1. Summary of Alternatives Matrix

Actions Common to All
Implementing adaptive management.
Monitoring and abating wildlife and plant diseases.
Conducting biological and ecological research and investigations.
Conducting non-lethal predator control.
Reducing hazardous fuels.
Providing limited environmental education or interpretation opportunities through refuge partners.
Fostering volunteers and partnerships.
Providing refuge staffing and administration.
Protecting resources and ensuring visitor safety.
Managing access or rights-of-way.
Prohibit Fishing.
Distributing refuge revenue sharing payments.
Completing stepdown management plans.
Protecting cultural resources.
Conducting additional NEPA analysis.

<table>
<tr><th>Refuge Resource or Program</th><th>Alternative A
Current Management</th><th>Alternative B
(Service-preferred) Expanded Management</th></tr>
<tr><td colspan="3">Goal 1: Perpetuate the biological integrity, diversity, and environmental health of the pitch pine-oak forest habitat type and associated coastal plain ponds and wetlands on Massasoit National Wildlife Refuge to sustain native wildlife, especially species of conservation concern such as the federally listed northern red-bellied cooter.

Responds to Issues: How will we effectively manage the habitat for the cooter while considering the management for a diversity of wildlife and plant species, including State-listed endangered and threatened species including rare moths and plants? What opportunities are there for protecting the New England cottontail? What role will prescribed burns play in habitat management?</td></tr>
<tr><td>Objective 1.1. Northern red-bellied cooter management</td><td>Objective A1.1. On the Crooked Pond parcel, contribute to rangewide northern red-bellied cooter population recovery by: (1) protecting 10 acres of existing pond habitat and associated shoreline from human disturbance; (2) creating and maintaining 1/4 acre of high quality nesting habitat for the northern red-bellied cooter; and (3) increasing nest success and hatchling survival.

Strategies
Continue to:
• Use mechanical and hand tools (such as rototiller, rakes, shovels, axes, and chainsaws) to reduce encroaching shrubby vegetation, remove herbaceous vegetation, girdle large canopy trees, and loosen soil at two sites on the Crooked Pond shoreline by late May at least every third year.
• Protect northern red-bellied cooter nests with predator exclosures (nest enclosures) to protect eggs and emerging hatchlings at Crooked Pond.
• Coordinate with conservation partners and participate in the State headstarting program when northern red-bellied cooters successfully nest on the refuge.
• Support collaborative research to determine the population and factors limiting survival and reproduction of northern red-bellied cooters on refuge lands, and establish short-term population objectives.
• Use temporary signs to establish a physical closure at northern red-bellied cooter nesting sites along the Crooked Pond shoreline annually from mid-May through mid-September, and address trespass issues as they occur.
• Make appropriate changes in management for northern red-bellied cooters within 6 months of completion of any 5-year reviews or recovery plan updates to accommodate updated recovery criteria, research needs, or any additional needs identified.</td><td>Objective B1.1. Contribute to rangewide northern red-bellied cooter population recovery and long-term persistence of other native coastal plain biota by: (1) protecting 10 acres of existing pond habitat and associated shoreline at Crooked Pond and all refuge-owned shoreline from human disturbance; (2) creating and maintaining 1 acre of high quality nesting habitat on the shorelines of Crooked, Island, Gunners Exchange, and Hoyt Ponds on Massasoit NWR; and, (3) increasing northern red-bellied cooter nest success to at least 60 percent by protecting nests from mammalian predators and increasing hatchling survival through headstarting.

Strategies:
In addition to objective A1.1, within 3 years of CCP implementation:
• Prioritize refuge-owned shoreline of Gunners Exchange, Hoyts, and Island Ponds for opportunities to create and expand nesting habitat for northern red-bellied cooters. Develop and implement appropriate strategies including mechanical and hand methods to reduce encroaching shrubby vegetation, remove herbaceous vegetation, girdle large canopy trees to increase sun exposure, and (if appropriate) loosen soil.
• Provide basking logs for northern red-bellied cooters refuge-wide by placing large downed trees along pond shorelines.
• Protect northern red-bellied cooter nests with predator exclosures (nest enclosures) to protect eggs and emerging hatchlings refuge-wide. Implement additional non-lethal predator management techniques, such as electric fencing, if necessary to meet nest success objectives.
• Use temporary signs to establish physical closures at northern red-bellied cooter nesting sites refugewide, and particularly along the refugewide shoreline of Island Pond, Gunners Exchange Pond, and Hoyts Pond annually from mid-May through mid-September. Address trespass issues as they occur.
• Assure that water quality is supportive of northern red-bellied cooters in coordination with MADEP and other partners.
• Assess and control aquatic non-native invasive species, and other invasive species using mechanical methods, herbicide, or biocontrol in coordination with the MADCR, the Town of Plymouth, and other conservation partners.</td></tr>
</table>

Refuge Resource or Program	Alternative A Current Management	Alternative B (Service-preferred) Expanded Management
Goal 1 (cont.): Perpetuate the biological integrity, diversity, and environmental health of the pitch pine-oak forest habitat type and associated coastal plain ponds and wetlands on Massasoit National Wildlife Refuge to sustain native wildlife, especially species of conservation concern such as the federally listed northern red-bellied cooter. **Responds to Issues:** How will we effectively manage the habitat for the cooter while considering the management for a diversity of wildlife and plant species, including State-listed endangered and threatened species including rare moths and plants? What opportunities are there for protecting the New England cottontail? What role will prescribed burns play in habitat management?		
Objective 1.1. Northern red-bellied cooter management (cont.)		• Collaborate with MassWildlife and other State agencies to define invasive species of greatest risk and find funding for research and conservation action for species that pose the greatest threat to native coastal pond biota. • Support expanded collaborative research, including off-refuge surface water and groundwater withdrawal effects on refuge pond water quality, harmful algal bloom, and shoreline habitats, to determine the population and factors limiting survival and reproduction of northern red-bellied cooters and other coastal pond species of conservation concern on refuge lands. • Seek grants and funding partnerships to additional seasonal staff.
Objective 1.2. Pine barren and shrubland habitat management	**Objective A1.2.** Manage 50 acres of mixed pine-oak forest and other upland habitats on the refuge to reduce hazardous fuel loading through mechanical and prescribed fire. **Strategies** *Continue to*: • Evaluate the entire refuge in the context of wildland urban interface risks and along with Service partners, facilitate planning of additional hazardous fuel reductions to protect neighboring communities. • Utilize prescribed fire and mechanical clearing including mowing, cutting, and masticating in accordance with the approved FMP and Annual Burn Plans every 3 to 5 years initially to maintain approximately 75- to 100-foot wide shaded fuel breaks between the refuge and residential areas, and 10- to 25-foot fire breaks between burn units. Transition to a 5- to 10-year interval on the northeastern portion of the Crooked Pond parcel over time. The target shaded fuel break effective width is 100 feet, and the target fire break effective width between burn units is 12 feet.	**Objective B1.2.** Manage up to 200 acres of mixed pine-oak forest habitats on Massasoit NWR with prescribed burning, mechanical methods, and other methods to (1) reduce fuel loading and wildland fire risk; and, (2) improve habitat for migratory bird species of conservation concern, such as ovenbirds, eastern towhees, eastern wood-peewees, and prairie warblers, by providing a mosaic of forest ages and structure over the 15-year period. **Strategies** *In addition to objective A1.2, within 5 years of CCP implementation:* • Utilize prescribed fire in combination with mechanical mowing, cutting, and/or mastication (chipping/mulching) in accordance with the approved FMP and Annual Burn Plans, to open forest and shrub canopies to increase sunlight reaching the forest floor, or to control invasive plant species. • Implement prescribed fire on a 5- to 7-year cycle within all burn units on the Crooked Pond parcel. • Mechanically maintain all fire breaks on all refuge parcels as needed. • Refine existing cover type map via ground verification. Evaluate available data on forest structure and composition and determine if finer scale information is needed to evaluate baseline characteristics of forest habitat refugewide. • Ensure management plans (such as the HMP) incorporate mechanical, prescribed fire, and other techniques, and contain strategies to collaborate with utility ROW managers to achieve habitat objectives. • Reduce invasive plants such that they are dominant on less than 10 percent (less than or equal to 21 acres) of upland acres.

Refuge Resource or Program	Alternative A Current Management	Alternative B (Service-preferred) Expanded Management
Goal 1 (cont.): Perpetuate the biological integrity, diversity, and environmental health of the pitch pine-oak forest habitat type and associated coastal plain ponds and wetlands on Massasoit National Wildlife Refuge to sustain native wildlife, especially species of conservation concern such as the federally listed northern red-bellied cooter. **Responds to Issues:** How will we effectively manage the habitat for the cooter while considering the management for a diversity of wildlife and plant species, including State-listed endangered and threatened species including rare moths and plants? What opportunities are there for protecting the New England cottontail? What role will prescribed burns play in habitat management?		
Objective 1.2. Pine barren and shrubland habitat management (cont.)		• Facilitate and participate in relevant research that has conservation implications for priority species and habitat types and will inform management priorities. • Consult regional and/or state conservation plans including (but not limited to) those existing for pitch pine–scrub oak and shrubland habitats, New England cottontail, bats, northern red-bellied cooters, and lepidopteran species during refuge habitat project planning, including prescribed burning. Coordinate refuge habitat project implementation with the MassWildlife, MADCR, and other local and regional conservation partners. • Seek grants and funding partnerships to support seasonal staff and forest management projects.
Goal 2: Promote awareness and support for the protection of sensitive resources on Massasoit NWR through community outreach and opportunities for connecting the public to the refuge's natural resources. **Responds to Issues:** What, if any, public access will be provided? What kinds of signage and interpretation can be used to increase the public's understanding of the resources, especially for the protection of the cooter, the consequences of misuse of sensitive areas on the refuge, and limitations on public access? How do we improve outreach for the refuge to the public and potential partners and stakeholders?		
Objective 2.1. Environmental education and interpretation	**Objective A2.1.** Provide environmental education and interpretation programming via permit or staff-led events, and conduct community outreach working through partnerships to inform the public about the refuge and its resources. **Strategies:** *Continue to:* • Allow occasional guided interpretative field trips on the refuge hosted by partners under a SUP. • Use the refuge Website to provide information about the northern red-bellied cooter and explain refuge management. • Disseminate the Refuge Complex brochure to provide information on refuge and wildlife management. • Notify the public of large scale management activities (e.g., prescribed burns), their purposes, and possible impacts through press releases and the refuge Website. • Manage the refuge volunteer program. • Coordinate with local organizations to promote awareness about the refuge and its resources.	**Objective B2.1.** Within 5 years, work with partners and volunteers to expand opportunities to provide quality environmental education and interpretation programs, and expand public information dissemination and community outreach. **Strategies:** In addition to objective A2.1, within 5 years: • Provide information about refuge resources and management at the library, partner facilities, and the Chamber of Commerce. • On request, work with local educators to provide environmental education for local schools. • Work with partners to develop and display traveling exhibits for libraries and community buildings to reach non-traditional audiences. • Conduct Service-directed interpretive programs as requested along with partners, utilizing existing roads and trails on the refuge through SUPs. • At a minimum, participate in one local community event every 4 years. • Develop an interpretative endangered species-species of conservation concern education trunk to be used by teachers in local schools.

Refuge Resource or Program	Alternative A Current Management	Alternative B (Service-preferred) Expanded Management
Goal 2 (cont.): Promote awareness and support for the protection of sensitive resources on Massasoit NWR through community outreach and opportunities for connecting the public to the refuge's natural resources. **Responds to Issues:** What, if any, public access will be provided? What kinds of signage and interpretation can be used to increase the public's understanding of the resources, especially for the protection of the cooter, the consequences of misuse of sensitive areas on the refuge, and limitations on public access? How do we improve outreach for the refuge to the public and potential partners and stakeholders?		
Objective 2.1. Environmental education and interpretation (cont.)		• Work with partners to conduct "Teach the Teacher" classes to provide information about the refuge, the northern red-bellied cooter, and other species of conservation concern, and management of pine barren and coastal pond habitat. • Seek grants and funding partnerships to support additional seasonal staff, environmental education programs, and community outreach activities. • Hire a summer Visitor Services intern with refuge resources or through partnerships to focus on supporting these efforts.
Objective 2.2. Wildlife Observation and Photography		**Objective B2.2.** Provide opportunities on the Crooked Pond parcel for visitors to engage in wildlife observation and photography on the refuge in a manner that minimizes disturbance to refuge habitats and wildlife. **Strategies:** *Within 1 year:* • Offer at least one wildlife observation and photography staff- or partner-led trip on the refuge.
Objective 2.3 Hunting		**Objective B2.3.** Determine whether to open the Crooked Pond parcel to hunting, particularly deer and turkey hunting, within 5 years of CCP approval. **Strategies:** *Within 5 years:* • Evaluate all State hunt seasons and prepare a hunt opening package, including NEPA analysis and public review, to open the refuge to hunting, including deer and turkey hunting. • If approved, prepare a refuge hunt plan and open for hunting for the selected seasons.

<table>
<tr><th>Refuge Resource or Program</th><th>Alternative A
Current Management</th><th>Alternative B
(Service-preferred) Expanded Management</th></tr>
<tr><td colspan="3">Goal 3: Enhance collaborations with Federal and State agencies, conservation organizations, and local communities to promote species and habitat conservation across the pitch pine-oak landscape in southeastern Massachusetts, and to support Massasoit NWR’s purposes and Refuge System and Service missions.

Response to Issues: What strategic approach will the Service take in landscape level land protection and conservation actions to expand the efforts toward the northern red-bellied cooter and New England cottontail recovery, and other shrubland-dependent species conservation?</td></tr>
<tr><td>Objective 3.1. Landscape-scale Land Protection and Conservation Collaboration.</td><td>Objective A3.1. Work with the northern red-bellied cooter recovery team and species experts to refine our understanding of species habitat requirements, methods for assessing the quality of habitat rangewide, and the factors limiting survival and reproduction. Also, work with these experts to determine high priority areas for habitat management across its range and determine suitable management actions.

Strategies:
Continue to:
• Work with MassWildlife, Massachusetts Cooperative Fish and Wildlife Research Unit, and other partners to fulfill priority research objectives.
• Support efforts and research toward rangewide recovery of the northern red-bellied cooter.</td><td>Objective B3.1. Work with the northern red-bellied cooter recovery team and species experts to refine our understanding of species habitat requirements, methods for assessing the quality of habitat rangewide, and the factors limiting survival and reproduction. Also, work with these experts to determine high priority areas for habitat management across its range, and determine suitable management actions.

Strategies:
In addition to Objective A3.1:

Within 3 years of CCP implementation:
• Facilitate and as appropriate, participate in additional rangewide research relevant to northern red-bellied cooters when research has conservation implications and will inform future refuge management. Focus may include, but is not limited to:
◆ Post-emergence survival of hatchlings.
◆ Primary sources of mortality.
◆ Impacts of predators.
◆ Other natural and anthropogenic factors affecting northern red-bellied cooter survival, reproduction, and population growth.
• Work through MassWildlife to engage cranberry industry owners and other appropriate enterprises to avoid activities that may be harmful to northern red-bellied cooters and their habitats rangewide.
• Pursue incentive programs for private landowner management of habitats for northern red-bellied cooters rangewide.
• Work with partners to utilize the most current information on the Critical Habitat Area for the northern red-bellied cooter, and identify potential areas for land protection to benefit the species.</td></tr>
</table>

Refuge Resource or Program	Alternative A Current Management	Alternative B (Service-preferred) Expanded Management
Goal 3 (cont.): Enhance collaborations with Federal and State agencies, conservation organizations, and local communities to promote species and habitat conservation across the pitch pine-oak landscape in southeastern Massachusetts, and to support Massasoit NWR's purposes and Refuge System and Service missions. **Response to Issues:** What strategic approach will the Service take in landscape level land protection and conservation actions to expand the efforts toward the northern red-bellied cooter and New England cottontail recovery, and other shrubland-dependent species conservation?		
Objective 3.2. Protect communities at risk from wildfire.	**Objective A3.2.** Work with local and regional wildland and structural fire management professionals to continue to protect communities at risk in southeastern Massachusetts to wildfire. **Strategies:** *Continue to:* • Coordinate with abutters, private landowners, and conservation partners to ensure protection of communities at risk as well as natural resources. • Work with the MADCR to implement "Fire Wise" educational programs in neighboring communities. • Support other land management agencies with their fuel reduction projects by providing assistance through training, equipment, staff time, and technical expertise.	**Objective B3.2.** Work with local and regional wildland and structural fire management professionals to continue to protect communities at risk from wildfire. **Strategies** Same as objective A3.2.
Objective 3.3. Community Outreach and Partnerships		**Objective B3.3.** Work with adjacent landowners, the MSSF, and other conservation organizations in the area to coordinate responsible use and enjoyment of the Massasoit NWR and surrounding public lands. **Strategies** *Within 1 year of CCP implementation:* • Refuge law enforcement will communicate threats to public safety and species protection with abutters and other conservation organizations. • Coordinate with abutters, private landowners, and conservation partners to ensure protection of resources. • Work with the MSSF to post information on their Alden Road kiosk about the refuge, its species, and management practices, including prescribed burns. • Increase law enforcement outreach to surrounding landowners. • Identify other opportunities to provide refuge information at partner facilities.

Chapter 4

USFWS

Northern red-bellied cooter on Massasoit National Wildlife Refuge

Environmental Consequences

- Introduction
- Effects on Air Quality
- Effects on Water Quality
- Effects on Soils
- Effects on Natural Community Types and Vegetation
- Effects on Biological Resources
- Effects on Climate Change
- Effects on Refuge Access and Public Uses
- Effects on Refuge Archaeological, Historical, or Cultural Resources
- Effects on Refuge Socioeconomic Resources
- Relationship between Short-term Uses of the Human Environment and Enhancement of Long-term Productivity
- Unavoidable Adverse Effects
- Potential Irreversible and Irretrievable Commitments of Resources
- Environmental Justice
- Summary of Environmental Consequences by Alternative

Introduction

This chapter describes the environmental consequences that we predict from implementing the two management alternatives presented in chapter 3. Where detailed information is available, we present scientific and analytic comparisons between alternatives and their anticipated consequences which we describe as "impacts" or "effects." In the absence of detailed information we make qualitative comparisons based on our professional judgment and experience. Specifically, we predict the effects of implementing the management actions and strategies for each of the alternatives: "Alternative A, Current Management," which serves as the baseline for comparing "Alternative B, Expanded Management" (Service-preferred alternative).

This chapter is organized by major resource headings. Under each heading, we discuss the beneficial and adverse effects likely to occur over the 15-year life span of the plan. Beyond the 15-year planning horizon, we give more speculative (greater uncertainty) descriptions of the direct, indirect, and cumulative effects expected. Table 4-1 at the end of the chapter is a side-by-side summary comparison of the expected effects by alternative. Concluding the chapter, we identify the irreversible and irretrievable commitment of resources from our proposed actions, as well as the relationship between short-term uses of the environment and long-term productivity, their cumulative effects, and the relationship to environmental justice.

As required by CEQ and Service regulations for implementing NEPA, we assessed the importance of the effects of the CCP alternatives based on their context and intensity. The scale of impacts ranges from local and site-specific to regional.

This chapter does not describe in any depth the consequences of certain types of actions that do not individually or cumulatively have any significant environmental impacts and are common to both alternatives described in chapter 3 for either alternative, especially "Service-preferred alternative." Each could be categorically excluded if proposed as a stand-alone action, and include:

- Research, resource inventories, monitoring and other resource information collection.
- Routine, recurring management activities and improvements such as planting native species or controlling invasive species.
- Small construction projects (e.g., fences, kiosk, interpretive signs).
- Issuance of new or revised management plans when only minor changes are planned.
- Law enforcement activities.

Effects on Air Quality

We evaluated the alternative management actions proposed that have the potential to improve or cause adverse air quality effects locally, in the region, and globally, including:

- Maintaining 209 acres of essentially continuous, natural vegetative cover across the refuge.
- Applying prescribed fires to manage mixed pine-oak shrubland, woodland, or forest areas.
- Applying herbicides to control invasive plants.
- Increased emissions from motor vehicle and motorized equipment use.

Air Quality Impacts Common to Both Alternatives

Massachusetts' air quality, including the refuge and immediate vicinity, is considered generally good, except ground level ozone. The nearest air quality monitoring station to the refuge in Brockton, Massachusetts has not however recorded an ozone standard violation over a 3-year average (MADEP 2012).

There will be minor air quality benefits from the pollutant filtering effects of maintaining 209 acres of upland and wetlands vegetation and coastal ponds. Trees (vegetation) filter some air pollutants and reduce the concentration of ambient ozone, SO_2, NO_2, CO, and fine particulate matter (PM10 and PM2.5), primarily through direct uptake and adhesion to stems and leaves (Escobedo et al. 2007).


Libby Herland/USFWS

Controlled burn underway at Massasoit National Wildlife Refuge

Potential air quality impacts from prescribed fire on human health and public welfare range from occupational exposure to smoke for firefighters to public health, soiling of materials (economic losses), public nuisance, and highway safety impacts from reduced visibility. Sandberg et al. (2002) provide a comprehensive overview of current knowledge about the effects of wildland fires (including prescribed fires) on air quality. The major pollutant of concern is fine PM—both PM10 (fine-10 micrometers or less) and PM2.5 (very fine—2.5 micrometers or less) particles (Sandberg et al. 2002). Studies indicate that 90 percent of all smoke particles emitted during wildland burning are PM10, and 90 percent of that PM10 particulate matter is PM2.5 (Ward and Hardy 1991). Particulates can reduce visibility or cause negative health effects for people with respiratory or cardiovascular illnesses (Hardy et al. 2001). Several population subgroups are more sensitive to fine particulates include asthmatics, children, the elderly, and individuals with cardiopulmonary disease.

The air emissions of greatest interest from prescribed burning include fine particulates (PM10 and PM2.5), CO, methane (CH_4), NO_x, SO_2, and other greenhouse gases including carbon dioxide that forms when elemental carbon combines with oxygen already in the atmosphere. While CO overexposure causes serious health problems and can prove fatal, CO is diluted and disperses rapidly as it mixes with ambient air downrange from the combustion source. As such, CO emissions are primarily an occupational health concern for prescribed burn personnel, not for the general public.

Prescribed fire can produce trace amounts of many different hydrocarbon compounds, a few of which are known to be harmful or toxic at higher concentrations. Wildland fuels typically contain less than 1 percent nitrogen, of which approximately 20 percent is converted to NO_x during combustion. Both hydrocarbons and NO_x are believed to be precursors for ozone formation once exposed to sunlight and warm temperatures in the atmosphere (Hardy et al. 2001).

Although long-term health effects from occupational smoke exposure remain unknown, evidence to date suggests that brief, intense smoke exposures can exceed short-term exposure limits in peak situations, such as for firefighters holding firelines downwind of an active prescribed burn. Work shift-average exposure only occasionally exceeds recommended instantaneous exposure limits set by the American Conference of Governmental Industrial Hygienists, and rarely exceeds Occupational Safety and Health Administration time-weighted average (TWA) limits (Reinhardt and Ottmar 2000; Reinhardt et al. 2000). Overexposure increases to 10 percent of the time if exposure limits are adjusted for hard breathing, extended hours, and high elevations which intensify the effects of many of the health hazards of smoke (Betchley et al. 1995, Materna et al. 1992, Reinhardt and Ottmar 2000, Reinhardt et al. 2000). Smoke exposure is a hazard for only short periods, is predictable, and therefore manageable. Fireline practices such as crew rotation, awareness training, and carbon monoxide monitoring can mitigate the hazard, allowing firefighters to focus on fire containment by lessening the distraction, discomfort, and health impacts of smoke exposure (Reinhardt and Ottmar 2000). The long-term health effects of occupational smoke exposure to wildland firefighters are unknown in spite of anecdotal evidence suggesting a greater incidence of cardiopulmonary disease and death compared to the general population (Sandberg et al. 2002).

Deposition of smoke particles on building surfaces, automobiles, clothing, and other objects reduces aesthetic appeal and can damage a variety of objects and structures (Baedecker et al. 1991). Smoke may also discolor artificial surfaces such as building bricks or stucco, requiring cleaning or repainting that can become an economic burden and reduce the useful life of soiled material (Maler and Wyzga 1976). Soiling from smoke also changes reflectance of opaque materials and reduces light transmission through windows and other transparent materials (Beloin and Haynie 1975). When very fine (PM2.5) smoke particles infiltrate indoor environments, soiling of fabrics, painted interior walls, and works of art may occur.

Nuisance smoke is the amount of smoke in the ambient air that interferes with a right or privilege common to members of the public, including the use or enjoyment of public or private resources (USEPA 1990). Nuisance smoke complaints are linked to impaired visibility, odors, and ash fallout. Acrolein (and possibly formaldehyde) in smoke at distances of 1 mile downrange from the fire source can cause eye and nose irritation, amplifying nuisance conditions (Sandberg and Dost 1990). Individuals within 1 mile of prescribed burn operations on Massasoit NWR may experience the irritating effects of acrolein or formaldehyde with unexpected wind direction shifts.

Smoke becomes a potential problem when it drifts into areas of human habitation. Perhaps the greatest nuisance effect of prescribed fire smoke is local, temporary visibility reduction in areas impacted by the dispersing smoke plume. Visitor enjoyment and satisfaction in the vicinity of the refuge may be diminished by reduced visibility (Sandberg et al. 2002). Smoke can impede drivers' ability to see the roadway and can contribute to loss of life and property damage at concentrations far below NAAQS. At night, smoke can be entrapped near the ground, combine with fog, and rapidly create low visibility leading to roadway accidents. The potential exists for limited smoke intrusions onto the public roads from refuge prescribed fires.

Potential impacts from long distance transport of "regional haze" on Class 1 areas such as national parks, monuments, or certain units of the NWPS are discussed later under Cumulative Effects.

Fires emit pollutants that are precursors for ozone formation such as volatile organic compounds and NO_X Burning during the summer "ozone" season has potential to cause greater impact to air quality when hot (e.g. above 90 °F), stagnant atmospheric episodes (and State issued air quality alerts) are more common. Ground-level ozone, a criteria NAAQS pollutant, has had past violations in eastern Massachusetts. Emissions from burning wildland fuels (especially NO_x) subjected to sunlight and warm temperatures, mixing with the regional atmosphere, as well as nitrate and indirectly sulfate aerosols, contribute to ozone formation (Sandberg et al. 2002). Stith et al. (1981) mapped ozone mixing ratios in an isolated, fresh, biomass-burning plume and measured low or negative changes in ozone values, attributed to titration by NO and low ultraviolet (UV) intensity. Near the top of the plume, 10 km downwind, and in smoke less than 1 hour old, they measured increases in ozone as high as 44 parts per billion. Ozone changes were positively correlated with high UV. Uncertainty still surrounds the magnitude of ozone formation in the smoke plume, the degree of mixing with pre-existing urban ozone sources and other precursors, and downward transport of ozone to ground level (Sandberg et al. 2002), such as during atmospheric subsidence events.

Fire behavior is the manner in which fire reacts to the fuels available for burning (DeBano et al. 1998), and is dependent on the type, condition, and arrangement of fuels, local weather conditions, topography, and in the case of prescribed fire, ignition pattern and rate. Important aspects of fire behavior include:

- Fire intensity (rate of energy release per unit area or unit length of fire perimeter, generally during the flaming combustion period).

- Rate of spread (rate of advancement of flaming front, length per unit time), crowning potential (involvement of tree and shrub foliage and spread within the canopy), smoldering potential (smoldering combustion of fuels that have been preheated or dried during the flaming stage).

- Residual smoldering potential (propagation of a smoldering combustion front within porous fuels such as rotten logs or duff, independent of preheating or drying).

- Residence time in the flaming, glowing, and smoldering (residual) stages of combustion (Sandberg et al. 2002).

These factors influence combustion efficiency, and the resulting pollutant chemistry and emission factor (Sandberg et al. 2002). Fire behavior guides Service and fire team smoke and emissions management efforts to minimize air quality impacts. The Eastern Massachusetts National Wildlife Refuge Complex Fire Management Plan (USFWS 2003) states, "The goals of smoke management on the refuges will follow goals enumerated by the National Wildfire Coordinating Group (2001): reduce fire emissions, enhance the dispersal of smoke plumes, steer smoke plumes away from smoke-sensitive areas, and coordinate the ignitions of prescribed burns. Smoke management practices will include maximizing combustion efficiency (to reduce particulate emissions)." Service staff and the fire management team choose fire and fuels manipulation techniques that complement meteorological scheduling for maximum smoke dispersion and favorable plume transport. Burn plans specify no burning when poor atmospheric mixing conditions are forecast. We use smoke dispersion and air quality information generated by the National Weather Service. We are required to obtain a "Spot Weather Forecast" prior to implementing any prescribed burn.

Prescribed fire emissions, including those from the refuge, are subject to regulation nationwide under the CAA by the USEPA and the MADEP in the interest of protecting human health and welfare. Massachusetts has an approved State Implementation Plan for Ozone Attainment (2008).

Past refuge prescribed burning was conducted in late fall or early spring. Prescribed burning during the growing season is proven to have the greatest effect on plant (especially understory plants) mortality, overall stand structure and composition change and therefore may be used under either of the alternatives. Burning during the summer "ozone" season has potential to cause greater impact to air quality when hot, stagnant atmospheric episodes (and State issued air quality alerts) are more common.

The refuge obtains an annual air quality permit from the MADEP, and a burn day authorization from the Plymouth Fire Department, and conducts burning operations in accordance with those authorizations. These permitting processes consider the expected quantity of emissions released over time (source strength), smoke plume rise, trajectory, and down range concentration (dispersion). We consider the current and expected daily air quality index issued by the MADEP, especially if burning during the summer ozone season. We avoid burning when air quality alerts are forecast or issued for the region, and are unlikely to be granted a burn permit anyway. If conducted on warm summer days, there is a very low chance refuge prescribed burn emissions may contribute to down range ground level ozone formation if actual atmospheric and weather conditions depart from those forecasted.

Under worst case scenarios prescribed burning efforts on Massasoit NWR over a 15 year period are not expected to adversely affect the region's air quality index (combines PM2.5 and 8-hour ground level ozone) given anticipated dispersion, atmospheric mixing, and the seasonal timing and frequency of prescribed burning under either alternative. No more than 50 refuge acres will be prescribed burned on any given day or in any one year under either alternative. Low intensity prescribed burning would release inconsequential amounts of other gases (Sandberg et al. 2002). Appropriate smoke management can minimize or nearly eliminate those negative effects. The consideration of wind speed, direction, and mixing heights is important in managing smoke. In planning our prescribed burns, we consider all these factors, and other environmental and geographical factors. We expect prescribed burning at the refuge to produce no significant long-term adverse air quality impacts. Neither management alternative would adversely affect regional air quality, including regional haze over the long term. Neither alternative would NAAQS for criteria air pollutants; both would comply with the CAA.

Air Quality Impacts of Alternative A (Current Management)

Beneficial Impacts

Hazardous Fuel Loading Reduction—Applying low to moderate intensity prescribed fire every 5-7 years on approximately 50 acres of the Crooked Pond parcel to reduce the excess buildup of woody debris (hazard fuels) in the understory on the refuge will decrease the long-term likelihood of large emission episodes, from large uncontrolled, high intensity wildfires. Less frequent, large, high intensity wildfires consume greater fuel (biomass) quantities and release greater total emissions in a short time period than do more frequent, but lower intensity and smaller prescribed burns.

Adverse Impacts

Hazardous Fuel Loading Reduction—Prescribed burning on 50 acres will be performed on a (5 to 7 years) rotational basis. There may be some localized (generally downwind, and within 10 miles or less), short duration (minutes to hours) decrease in air quality or brief, localized visibility impairment from fine particulates.

Particulates, consisting of small particles of ash, partly consumed fuel, and liquid droplets, can reduce visibility or cause negative health effects for people with respiratory illnesses. Carbon monoxide, carbon dioxide, hydrocarbon, and small nitrogen oxide releases are expected. However, low intensity prescribed burning, (such as the current refuge program), releases inconsequential amounts of these gases (Sandberg et al. 2002). Any short-term exposure, acute impacts likely include discomfort, and possibly health effects for some individuals, without violating NAAQS. At present, prescribed fires are not considered to be a significant cause of local/regional NAAQS nonattainment (Sandberg et al. 2002).

Under alternative A, the use of prescribed fire will continue within the Crooked Pond parcel as in the past decade. There are homes adjacent to refuge boundaries except where the MSSF abuts the refuge. It is standard protocol to notify the public in advance about any management efforts that may impact the surrounding area, especially when prescribed burning occurs. The fire team's knowledge of fire behavior (e.g., fire intensity, residual smoldering, rate of spread and crowning potential) and smoke management helps minimize air quality impacts and human exposure to smoke. Additional steps taken to reduce emissions include reducing fuel hazards through mechanical means prior to burning and keeping burn units small (Sandberg et al. 2002).

Emissions (hydrocarbons) released from heavy equipment and power tools during initial firebreak and fuelbreak establishment and periodic maintenance are expected infrequently for brief periods, but are not expected to significantly impact local or regional air quality.

Refuge Access and Public Uses—The refuge will remain closed to the public, therefore no additional transportation-related emissions generated by refuge visitors are anticipated.

Refuge Administration—Current management activities do not adversely affect local and regional air quality. A small amount of hydrocarbon emissions result from refuge activities, primarily emissions from vehicle transportation to and from the refuge, especially during the spring, summer, and fall when trips may occur weekly. Adverse air quality impacts would be very limited and temporary. The vehicle fleet at the refuge headquarters is becoming cleaner as older vehicles are replaced by low (hydrocarbon) emission hybrid vehicles. Refuge vehicle-related hydrocarbon emissions may actually decrease slightly from current levels, over the 15 year plan period.

Air Quality Impacts of Alternative B (Expanded Management, Service-preferred Alternative)

Beneficial Impacts

Habitat Management and Hazardous Fuel Loading Reduction—Applying low to moderate intensity prescribed fire every 5-7 years on up to 200 refuge acres for both habitat management and to reduce the excess buildup of woody debris (hazard fuels) in the understory will further decrease the long-term likelihood of large emission episodes, from large uncontrolled, high intensity wildfires.

Adverse Impacts

Habitat Management—Alternative B incorporates invasive plant treatment as necessary to maintain quality habitat and to promote biological integrity. Invasive plant treatment impacts to air quality would be localized and short-lived. Mechanical removal of invasive species would likely inject some dust and soil particles into the air for short periods (lasting only as long as required to remove the targeted plants). Chemical application in accordance with labeling and approved Pesticide Use Proposals would likely involve backpack sprayers to obtain optimal target specificity. There is still some potential to impact a wider area than is targeted from spray drift, to non-target sites. By not treating on windy days, and through careful calibration of spray nozzles to achieve the correct droplet size and application rate, spray drift is effectively minimized (USFWS 2009).

Products used are USEPA approved and labeled for the appropriate use. Some of the herbicides the Service most commonly uses are glyphosate, triclopyr, and imazapyr, but herbicide use is not exclusive to these chemicals. Service choice of methods of invasive species control is based on best management practices at the time of management and choice of herbicides is based on the invasive species present. We anticipate insignificant short-term, localized impacts to air quality from treating invasive plants.

Hazardous Fuel Loading Reduction—Under alternative B, there would be as much as 200 acres burned following the development of a HMP and the spatial FMP. Prescribed burning on up to 200 acres over the entire refuge will be performed on a (5-7 years) rotational basis, with no more than 50 acres burned on any given day or in any one year. Total prescribed burn impacts to air quality over the planning period may be as much as four times greater than alternative A. There may be some localized (generally downwind from burns, and within 10 miles or less), short duration (minutes to hours) decrease in air quality or brief, localized visibility impairment from fine particulates from individual burns.

Particulates, consisting of small particles of ash, partly consumed fuel, and liquid droplets, can reduce visibility or cause negative health effects for people with respiratory illnesses. Carbon monoxide, carbon dioxide, hydrocarbon, and small nitrogen oxide releases are expected. However, low intensity prescribed burning, (such as the current refuge program), releases inconsequential amounts of these gases (Sandberg et al. 2002).

The goals and practice of smoke management on the refuge discussed previously for alternative A apply to alternative B also. The fire team's knowledge of fire behavior (e.g., fire intensity, residual smoldering, rate of spread and crowning potential) and smoke management helps minimize air quality impacts and human exposure to smoke. Additional steps taken to reduce emissions include reducing fuel hazards through mechanical means prior to burning and keeping burn units small (Sandberg et al. 2002). Prescribed burn plans under alternative B would also address all conditions under which a burn would occur, and employ advanced public notification of any management practice, including prescribed burning efforts that may impact them. This is especially true in areas close to residential or commercial development such as the residential subdivision on the northern border of the Crooked Pond parcel and homes located on the ponds where the Service owns shoreline. Public outreach efforts would include factual information about potential human health impacts from prescribed fire smoke. Advanced notice will serve as a means of protecting the public from and minimizing human exposure to health effects that may occur should smoke drift towards the homes.

Stephanie Koch/USFWS

Fuel break along a previously burned unit

Although up to 4 times greater over the plan period than under alternative A, alternative B air quality impacts are not expected to be significant due to burn and smoke management measures, and public notification and outreach procedures the Service already has in place and is already implementing.

Emissions (hydrocarbons) released from heavy equipment and power tools during initial firebreak and fuelbreak establishment and periodic maintenance are expected infrequently for brief periods, but are not expected to significantly impact local or regional air quality.

Refuge Access and Public Uses—Under alternative B, wildlife observation and photography, interpretation, environmental education would be conducted on the Crooked Pond parcel by refuge or partner-led guided trips. Most of the Crooked Pond parcel could be opened seasonally for hunting, particularly deer and turkey hunting, following the completion of an assessment of all hunt seasons, preparation of an environmental assessment, completion of a public comment period, and development of a refuge hunt plan. It is anticipated that the majority of refuge visitors would be local residents. Therefore new refuge visitors under alternative B are not expected to generate significant increases in transportation-related (hydrocarbon) emissions that adversely impact air quality.

Refuge Administration—Increased hydrocarbon emissions from expanding refuge activities and staff site visits to provide enforcement and habitat management are expected. The vehicle fleet at the refuge headquarters is becoming more efficient, and cleaner as older vehicles are replaced by low (hydrocarbon) emission hybrid vehicles, offsetting hydrocarbon emissions from the slightly increased refuge staff trips and vehicle use. It is anticipated that the alternative B impacts on air quality would remain insignificant over the 15 year plan period.

Effects on Water Quality

We evaluated the alternative management actions that have the potential to help maintain and improve, or have potential to cause adverse effects to water quality in the ponds on or abutting the refuge, including:

- Maintaining 209 acres of essentially continuous natural vegetative cover, surface litter, and duff layers on refuge lands through area closures and applying BMPs.
- Mechanical vegetation treatments—cooter nesting site improvement, fire breaks and fuel breaks
- Use of herbicides to manage invasive species.
- The use of prescribed burns near the ponds' edges.
- Trail maintenance.

Water Quality Impacts Common to Both Alternatives

Local water quality benefits from the pollutant buffering and filtering effects of maintaining essentially continuous upland and wetlands vegetation across the 209 acre refuge landscape are expected. Trees (vegetation) filter some air pollutants that can enter ponds by atmospheric deposition. Vegetation, surface litter, and duff also slow, intercept, and filter out some pollutants from surface runoff before it can reach downslope waterbodies, or rainfall and runoff as it infiltrates the soil before it moves into the groundwater aquifer.

Because Crooked Pond is located within the parcel interior, surrounding vegetation and habitat serves as a buffer to the pond. Any drawdown or pollution

Crooked Pond on Massasoit National Wildlife Refuge

Kourtnie Bouley/USFWS

to the groundwater in the Plymouth area close to the refuge would more likely have a greater impact to Crooked Pond water levels and water quality than refuge management activities. Sources of pollution from nearby residential homes are more likely to impact the water quality on all refuge ponds but especially Gunners Exchange, Island, and Hoyt, with their residential shoreline development. Some year-round and summer homes on these ponds that can potentially adversely impact water quality within these ponds and groundwater quality, from septic systems, landscaping activities, swimming, or boating in the ponds. The Service has no direct authority over the use of ponds by residents who own shoreline and/or land abutting Gunners Exchange, Hoyt, and Island Pond or outside refuge boundaries. The Service is therefore dependent upon partnering with local and state government, our refuge neighbors, and non-government organizations to address any concerns with water quality in these ponds and surrounding lands. Water quality and land use regulation to protect water quality in these ponds rests with local government (Plymouth Conservation Commission), and the MADEP, and is therefore beyond the scope of this CCP (see also Cumulative Effects later in this chapter).

Under both alternatives, a network of constructed firelines (1.11 miles), constructed shaded fuelbreaks (2.49 miles), and existing roadbeds (1.57 miles) will be maintained to facilitate wildland fire suppression and prescribed burning. Machinery will be used to mow or masticate understory vegetation every 5-7 years on approximately 13.6 acres (6.5 percent) of the refuge to keep the network passable for fire equipment and personnel. Litter and duff layers remain largely undisturbed and intact. Slight increases in surface runoff are expected from this fuel and firebreak network for 1-2 growing seasons following treatment. Protective litter and duff layers will largely prevent post treatment soil erosion and downslope sediment transport in runoff into refuge waterbodies.

Refuge firelines (2.68 miles) typically have a 1.5 foot strip from which the protective litter and sometimes the duff layer are removed using leaf blowers and rakes, potentially exposing mineral soil in order to slow or halt the spread of a fire through surface fuels on up to 0.49 acres (worst case estimate). Between fires, firelines are normally allowed to accumulate leaf litter each fall. Because the protective litter layer is removed periodically, potentially exposing mineral soil, some soil erosion from these firelines could be transported downslope in surface runoff into refuge ponds from soil exposure until the next autumn "leaf-drop" (6-12 months).

Prescribed burns proposed in both alternatives are more frequent, smaller, less intense, and consume less vegetation, litter, and duff (fuel) than past large, high intensity wildfires. Prescribed burning water quality impacts will be less than those from past, higher intensity wildfires. Some research suggests that prescribed fire does not significantly impact the overland transport of nitrogen, phosphorous, or cations often released during fires (Kolka undated) to the degree seen from large, high intensity wildfires (Kolka undated, Richter et. al.1982). Decreasing the likelihood of large high intensity wildfires through hazard fuel reduction under both alternatives also reduces the long-term likelihood of large overland pollutant transport episodes to refuge ponds.

Neither management alternative would contribute to water quality degradation. Neither management alternative will violate Federal or State water pollution control regulations; and both will comply with the Clean Water Act.

Water Quality Impacts of Alternative A (Current Management)

Beneficial Impacts

Refuge Access and Public Uses—With little to no public use authorized, the generally good refuge water quality is likely to be protected. The Service will continue to enforce the laws that protect the natural resources, including those for which they have jurisdiction. Already, the Service abides by 660-FW 1 Wetland Policy and Action Plan (USFWS 1994b) which prevents further degradation of the ponds, especially Crooked Pond and its associated buffer zone, where the Service has full authority.

Adverse Impacts

Habitat Management—Mechanical clearing of brush, trees, and other vegetation to create canopy openings and improve northern red-bellied cooter nesting sites near Crooked Pond totals ¼ acre. Temporary disturbance of the sandy shoreline vegetation and soil in close proximity to the ponds could result

Northern red-bellied cooters basking on a log

USFWS

in some small-scale instances of erosion, and small quantities of soil sediment entering Crooked Pond. Vegetation closest to the shoreline is not disturbed, and root systems of shrubs on the pond shoreline are kept intact to help hold exposed soil in place. This minimizes or completely prevents sediment runoff from entering the pond, and any impacts are very localized and temporary, and therefore not significant.

Hazardous Fuel Loading Reduction—The impact of prescribed fire on water quality is directly linked to the impact on soil and resulting sediment in runoff (refer to Effects on Soils below) from burned areas. With any heavy precipitation event immediately following prescribed burning there may be an increase in runoff potentially impacting local water quality over the short-term (until vegetation recovery). Prescribed burning efforts are limited to current levels (50 acres) on the Crooked Pond parcel. Prescribed burning of two burn units will be performed on a (5-7 years) rotational basis, with no more than 50 acres (23.9 percent of the refuge) burned on any given day or in any one year. These two burn perimeters combined require 0.99 miles, 0.50 miles, and 0.45 miles respectively of the refuge fireline, existing roadbed, and 100 foot wide shaded fuelbreak network. This network requires (worst case estimate) up to 0.27 acres of potentially exposed mineral soil for firelines, and mechanical understory vegetation cutting on 7.68 acres for shaded fuelbreaks and access roads. In the intervals between fires, firelines are normally allowed to accumulate leaf litter each fall. Because the protective litter layer is removed periodically, potentially exposing mineral soil, some soil erosion is possible from these firelines that could be transported downslope in surface runoff into refuge ponds from soil exposure until the next autumn “leaf-drop” (6-12 months). Protective vegetative and litter cover typically recovers within 1 growing season following mechanical cutting of shaded fuel breaks, or prescribed burning.

Due to the dense post-burn vegetative cover, intact duff and litter layers, and gentle slopes of the treated burn units, no concerns with sediment-laden runoff from prescribed burn units into local water bodies are expected.

Refuge Access and Public Use—The refuge remains closed to public uses. Therefore any impacts to water quality from public use will be from unauthorized, illegal activities such as littering of pond shorelines from trespassers, oil or gas leaks from illegal ORVs near the pond edges, horseback riding, or pollution from swimming or boating.

Water Quality Impacts of Alternative B (Service-preferred Alternative)

Beneficial Impacts

Habitat Management—Native aquatic plants are an essential part of a freshwater aquatic system that provide habitat and refuge for aquatic wildlife, are a food source, and recycle oxygen and carbon dioxide (Rhode Island Department of Environmental Management Office of Water Resources 2014). Aquatic invasive plants can disrupt the ecosystem by out-competing beneficial native vegetation. Under some circumstances, if left unchecked aquatic invasive plants can “choke out” native plants and begin to cover a pond that would have otherwise been clear (Rhode Island Department of Environmental Management Office of Water Resources 2014). At this time, it is unknown what if any aquatic invasive plants exist in Crooked Pond. Refuge staff would monitor for invasive aquatic plants within Crooked Pond. If aquatic invasive plants become a concern, the Service would act in accordance with the IPMP, in collaboration with refuge partners and neighbors, to remove or control such species, protecting water quality and restoring the natural ecosystem function for the long-term.

Adverse Impacts

Habitat Management — Using herbicides or mechanical methods to control invasive plants could incur some short-term and localized risk to water quality (Shepard et al. 2004). Before any chemical is applied to refuge lands, Service policy and required project review ensures that water quality risk is evaluated and minimized. All products are used according to label instructions to minimize impacts on ground and surface waters (USFWS 2009). Only those herbicides specifically labeled for aquatic application are used on or near refuge waters. When used appropriately, these products pose negligible directly or indirectly impacts on water quality. Very often, herbicides are not needed. But when required for effective control, the Service selects the herbicide application that is most effective for the target species and least harmful to non-target organisms. Risk reducing measures include choosing optimal times of year to apply herbicides, reducing spray drift, and applying the minimum amounts needed to effectively control the target species. If chemical application is deemed necessary, it would likely be applied using backpack sprayers to obtain optimal target specificity from the close range of application.

Mechanical clearing of brush, trees, and other vegetation to create canopy openings and nesting sites for the northern red-bellied cooter near the shorelines of Crooked Pond, Hoyt Pond, and Island Pond total 1 acre. Temporary disturbance of the sandy shoreline and soil in close proximity to the ponds could result in some small scale instances of erosion, and small quantities of soil sediment entering the ponds. Service staff takes every precaution to minimize disturbance while conducting habitat management. Vegetation closest to the shoreline is not disturbed, and root systems of shrubs on the pond shore are kept intact to help hold exposed soil in place. This minimizes or completely prevents sediment runoff from entering the ponds, so any impacts are very localized, temporary and therefore not significant. Therefore, these impacts to water quality would be very localized and short-term, minimal and temporary, and therefore not significant under alternative B.

Hazardous Fuel Loading Reduction — Prescribed burning efforts would expand to most refuge upland acres (up to 200 acres) following HMP and spatial FMP completion. The impact of prescribed fire on water quality is directly linked to the impact on soil and resulting sediment in runoff (refer to Effects on Soils below) from burned areas. About 60 percent of this acreage drains into water bodies across moderate slopes (D. Walker 2013 personal communication). With any heavy precipitation event immediately following prescribed burning there may be an increase in runoff potentially impacting local water quality over the short-term (until vegetation recovery). Prescribed burning of 10 to 20 individual burn units will be performed on a (5-7 years) rotational basis, with no more than 50 acres (23.9 percent of the refuge) burned on any given day or in any one year. These burn perimeters combined require up to 1.11 miles, 1.57 miles, 0.57 miles, and 1.92 miles respectively of the fireline, existing roadbed, 100 foot wide and 12 foot wide shaded fuelbreak network, with only a portion (20-50 percent) needed in any single year in the absence of a large wildlife. This network requires (worst case estimate) up to 0.49 acres of potentially exposed mineral soil for firelines, and mechanical understory vegetation cutting on 13.6 acres for shaded fuelbreaks and access roads. In the intervals between fires, mineral soil firelines are normally allowed to accumulate leaf litter each fall. Because the protective litter layer is removed periodically to expose mineral soil, some soil erosion from these constructed firelines that could be transported by surface runoff into downslope waterbodies is possible from soil exposure until the next autumn “leaf-drop” (6-12 months). Protective vegetative and litter cover typically recovers within 1 growing season following mechanical cutting of shaded fuel breaks, or prescribed burning.

Due to the dense post-burn vegetative cover, intact duff and litter layers, and gentle slopes of the treated burn units, no concerns with sediment-laden runoff from prescribed burn units into local water bodies are expected. There is a low to moderate risk that nutrients released during prescribed burning may be transported overland into ponds and waterways downslope. However, this would be buffered by the duff and litter layer remaining following the prescribed burn (D. Walker, 2013 personal communication).

Refuge Access and Public Use—Under alternative B, the Crooked Pond parcel would be opened for staff or partner-led trips for wildlife observation and photography, interpretation, environmental education. We would assess opening most of the Crooked Pond parcel for hunting in accordance with State regulations, with an emphasis on deer and turkey hunting. Public use would be limited and light. Therefore water quality impacts from refuge public use are limited. New refuge visitors under alternative B are not expected to significantly impact existing water quality, with their impacts similar to those they are having on the adjoining MSSF. The limited wildlife observation, photography, environmental education and interpretation trips hosted by the Service or our partners will have no detectable impact to the water quality because access to the ponds, especially Crooked Pond, would remain restricted.

Effects on Soils

Soils are the structural matrix and nutrient source for plants and must be protected to sustain the variety of wetland, riparian, and upland habitats needed to meet refuge habitat and species management goals. Overall, refuge soils are productive and in good condition, with only localized erosion, compaction, or contamination problems.

We evaluated the alternative management actions with potential to benefit or adversely affect upland and refuge pond shoreline soils, including:

- Maintaining continuous vegetative cover, surface litter, and duff layers on refuge lands and applying BMPs.
- Using prescribed burning and mechanical methods to reduce fuel loads and restore mixed pine-oak habitats.
- Habitat management activities to benefit nesting northern red-bellied cooters, including tree-cutting, tree-girdling, and vegetation removal.
- Invasive species management.
- Refuge public use activities including environmental education, and interpretation, a public use trail connection, and seasonally opening part of the Crooked Pond parcel to deer and turkey hunting.
- Wildland fire suppression policies and methods.

Effects on Soils Common to Both Alternatives

Maintaining essentially continuous upland and wetlands vegetation across the refuge landscape as expected under both alternatives, helps protect against soil loss through erosion. Plant foliage and stems intercept rainfall, absorbing the impact that can erode underlying soil without protective vegetative cover. Vegetation, living and dead, especially plant roots help hold the soil in place when subjected to surface runoff, wind, or other erosive forces as well as helping maintain soil porosity and water holding capacity. When vegetative tissues die and are shed, they return organic matter and nutrients back into the soil that can be recycled and used by other plants and animals. These dead plant tissues are also the source of the litter and duff layers that also help protect the soil surface from erosive forces and help retain soil water that is essential for plant growth.

Fire elevates surface temperatures; mineralizes detritus, litter, and standing dead material; volatilizes some nutrients and organic matter; alters soil water-holding capacity; and alters soil animal species (micro—and macro-fauna) populations (Barbour et al. 1999).The effects on organic matter depend on the intensity and duration of the fire. Intense, long-duration fires such as those associated with wildfires consume more organic matter than the short-duration, low intensity prescribed fires proposed for Massasoit NWR under both alternatives. Nitrogen compounds volatilize and are lost at temperatures (212° to 392 °F); while, calcium, sodium, and magnesium usually are deposited on the soil surface and quickly recycled during post-burn vegetative recovery. Fire usually elevates soil pH, because of cation release, particularly in acidic soils. At higher temperatures (392° to 572 °F), large amounts of organic substances are lost, which can reduce soil cation exchange and moisture holding capacity.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Rototilling to prepare northern red-bellied cooter habitat

Removal of litter and duff may initially facilitate water infiltration; but, the loss of all litter and blackened soils may also accelerate evaporation, reducing soil water available for plant growth (water-holding capacity). There is little change in water repellency for most soil types, with cool fires (below 349 °F). Moderately hot fires (349° to 399 °F) increase water repellence, and extremely hot fires (above 399 °F) volatilize hydrophobic substances and may increase soil water repellence (Debano et al. 1998). After moderately intense fires, increased runoff may result in soil erosion.

Fire usually reduces soil fungi but increases soil bacteria, and may also remove pathogens. Fire often destroys nitrifying bacteria, so that post-fire soil nitrogen recovery is often dependent upon legumes and other nitrogen-fixing plants (Barbour et al. 1999). Fire may enhance soil microbial nitrogen fixation, due to the mineralization of nutrients and elevated pH levels in soils (Barbour et al. 1999). Prescribed fires conducted on the refuge under both alternatives should benefit soils in the short term by returning nutrients bound up in above ground plant biomass prior to the burn, back into the soil (Dudley and Lajtha 1993). The degree to which this occurs is dependent upon prescribed fire intensity (USFWS 2003b).

A risk of long-term soil damage (still evident on the refuge today from the catastrophic fires in the 1950's) from high intensity wildfires remains. But fuel load reduction planned under both alternatives will help minimize, but not eliminate that risk. Wildfires will be suppressed in a safe, prompt, and cost effective manner to minimize adverse impacts to resources and acreage. All initial attack or suppression will be done by the Plymouth Fire Department, and then the Massachusetts Department of Conservation and Recreation under existing agreements. Suppression methods chosen to accomplish safe, effective incident stabilization will leave minimum resource damage. The current Refuge Complex FMP (USFWS 2003b) provides more information on the refuge's objectives and strategies in regards to prescribed and wildfires.

Under both alternatives, a network of constructed firelines (1.11 miles), constructed shaded fuelbreaks (2.49 miles), and existing roadbeds (1.57 miles) will be maintained to facilitate wildland fire suppression and prescribed burning. Machinery will be used to mow or masticate understory vegetation every 5-7 years on approximately 13.6 acres (6.5 percent) of the refuge to keep the network passable for fire equipment and personnel. Litter and duff layers remain largely undisturbed and intact. Slight, increases in surface runoff are expected from this fuel and firebreak network for 1-2 growing seasons following treatment. Protective litter and duff layers will largely prevent post treatment soil erosion.

Refuge firelines (2.68 miles) have a 1.5 foot strip from which the protective litter and sometimes the duff layer are removed using leaf blowers and rakes, potentially exposing mineral soil in order to slow or halt the spread of a fire through surface fuels on up to 0.49 acres (worst case estimate). Between fires, firelines are normally allowed to accumulate leaf litter each fall. Because the protective litter layer is removed periodically, potentially exposing mineral soil to erosion from these firelines could be transported downslope in surface runoff into refuge ponds from soil exposure until the next autumn "leaf-drop" (6-12 months). Refreshing firelines as preparation for pre-planned prescribed burns would occur around the perimeters of burn units totaling no more than 50 acres in any given year under both alternatives. Wildfires are not predictable as to the time and place of ignitions, but the same network of firelines and methods will be used to suppress any unplanned wildfires within the refuge. Because the protective litter layer is removed periodically potentially exposing mineral soil, some soil erosion is possible from these firelines, from soil exposure until the next autumn "leaf-drop" (6-12 months).

Soil Impacts of Alternative A (Current Management)

Beneficial Impacts

Hazardous Fuel Loading Reduction—Prescribed burning would potentially return nutrients bound up in plant biomass back into the local soil, and locally enhance soil microbial nitrogen fixation in the short term on approximately 50 acres of the Crooked Pond parcel over the planning period. Given their short-term nature and the limited acreage, these are not expected to be significant beneficial soil impacts. Reducing hazardous fuel loading reduces the likelihood of high intensity wildfires, and the soil damage they can leave behind.

Adverse Impacts

Habitat Management—There may be some minor soil compaction and erosion on ¼ acre managed to create northern red-bellied cooter nesting habitat along the shoreline near Crooked Pond. The soil impacts will be temporary, localized, and therefore not significant. We expect none of the current management actions to significantly impact the soils over the long term.

Hazardous Fuel Loading Reduction—Refuge prescribed fires typically are low to moderate intensity fires, with limited surface soil temperature change (D. Walker, 2013 personal communication). Humidity levels and wind conditions are the greatest drivers of fire intensity, but a number of weather and fuel related parameters are identified and required for a prescribed burn. Low to moderate intensity prescribed burning will be performed on a (5-7 years) rotational basis, with no more than 50 acres (23.9 percent of the refuge) burned on any given day or in any one year. Prescribed burning is limited to the 50 acres (two burn units) in the northeast portion of the refuge which has little slope. Recent refuge prescribed fires consumed only part of the surface litter and duff layers, without transferring excessive heat into the underlying soils. Because a partial litter and a largely continuous surface duff layer will remain after burning, little soil erosion risk will result compared to that from a high intensity wildfire.

The two burn unit perimeters combined require 0.99 miles, 0.50 miles, and 0.45 miles respectively of the fireline, existing roadbed, and 100 foot wide shaded fuelbreak network. This network requires (worst case estimate) up to 0.27 acres of potentially exposed mineral soil for firelines, and mechanical understory vegetation cutting on 7.68 acres for shaded fuelbreaks and access roadbeds. In the intervals between fires, these firelines are normally allowed to accumulate leaf litter each fall. Because the protective litter layer and sometimes the duff layer is removed periodically to expose mineral soil, some soil erosion from these firelines is possible from soil exposure until the next autumn "leaf-drop" (6-12 months).

Using heavy equipment to create fire breaks may scarify soils in some areas or potentially compact soils. Implementing Best Management Practices helps to limit the amount of soil disturbance from equipment, and using 'low ground pressure' equipment reduces soil compaction potential. Future fire break maintenance can be done with much smaller and lighter equipment that will have little to no soil impact.

The Service, assisted by our partners, has demonstrated success conducting small-scale, short duration low to moderate intensity prescribed fires on confined areas on the Crooked Pond parcel. Those fires consumed only part of the surface litter and duff layers, and without transferring excessive heat into the underlying soils. We will continue using prescribed fires under alternative A to remove litter and light fuels and reduce the risk of adverse soil effects from high intensity wildfires. We expect direct or indirect impacts on upland soils to be negligible and not significant, limited by the short duration and low to moderate intensity burns, confined to the small, designated project area.

Refuge Access and Public Uses — The refuge remains closed to public use. Therefore soil impacts from public use will be confined to unauthorized, illegal activity. Currently trespass takes place at Massasoit NWR by mountain bikes and ORVs, and to a lesser extent horseback riding, resulting in localized soil compaction and erosion. The current level of trespass and commensurate soil damage is expected to continue under alternative A. Illegally accessed trails are deeply worn exposing the roots of trees and void of protective duff and litter in several locations and where trails are on slopes, water runoff and erosion is occurring. At times these mountain bike and ORV riders will cause significant soil disturbance in the turtle nesting sites adjacent to the pond shoreline which may lead to soil sediment entering refuge ponds.

Soil Impacts of Alternative B (Service-preferred Alternative)

Beneficial Impacts

Hazardous Fuel Loading Reduction — Prescribed burning would potentially return nutrients bound up in plant biomass back into the soil, and enhance soil microbial nitrogen fixation in the short term on approximately 50 acres of the Crooked Pond parcel over the planning period. Given their short-term nature and the limited acreage, these are not expected to be significant beneficial soil impacts. Reducing hazardous fuel loading reduces the likelihood of high intensity wildfires, and the soil damage they can leave behind.

Adverse Impacts

Habitat Management — Increased mechanical vegetation removal, including invasive plants, using hand or power tools, or heavy equipment can potentially cause localized soil disturbance and erosion until new plants establish. More soil disturbance associated with higher levels of invasive plant control is expected under alternative B. Any soil disturbed by the physical removal of plants will be tamped down and compacted, a standard refuge practice for any mechanical removal operation.

Herbicides approved by the Service would be used to control invasive plants as warranted. While the refuge would consider using various Service-approved herbicides, based on current use within the Refuge System we expect to use the herbicide glyphosate, formulated as Roundup® or Rodeo®, most often over the planning period. Other herbicides that could be used include imazapyr, triclopyr, and others approved by the USEPA. Research to find the best methods for controlling invasive plant species including chemical, mechanical, and biological means is ongoing. The best methods available at the time of application will be used. The level of review that Service policy requires before we can apply any chemical or biological methods on refuge lands ensures that the environmental risk is minimized, and all facets of the proposed use have been examined and justified. All products are used according to label instructions and approved Pesticide Use Proposals, to minimize impacts to soil.

There may be some minor soil compaction and erosion on 1 acre managed to create northern red-bellied cooter nesting habitat along the refuge pond shorelines. The soil impacts will be temporary, localized, and therefore not significant.

We expect negligible direct or indirect impacts on upland soils from habitat work. Expected soil impacts are limited in duration, of low to moderate intensity, and confined to small project areas. None of the proposed habitat management actions will adversely impact refuge soils over the long-term.

Hazardous Fuel Loading Reduction—Prescribed burning efforts would expand to most refuge upland acres (up to 200 acres) following HMP and spatial FMP completion. We would maintain all fires within their prescriptions to minimize the soil degradation, although impacts could occur in small areas. Low to moderate intensity prescribed burning of 10 to 20 individual burn units will be performed on a (5 to 7 years) rotational basis, with no more than 50 acres (23.9 percent of the refuge) burned on any given day or in any one year. Recent refuge prescribed fires consumed only part of the surface litter and duff layers, without transferring excessive heat into the underlying soils. Because a partial litter and largely continuous surface duff layer will remain after burning, little soil erosion risk will result compared to that from a high intensity wildfire.

Controlled burn on Massasoit National Wildlife Refuge

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These burn perimeters combined require up to 1.11 miles, 1.57 miles, 0.57 miles, and 1.92 miles respectively of the fireline, existing roadbed, 100-foot-wide and 12-foot-wide shaded fuelbreak network, with only a portion (20 to 50 percent) needed in any single year in the absence of a large wildfire. This network requires (worst case estimate) up to 0.49 acres of potentially exposed mineral soil for firelines, and mechanical understory vegetation cutting on 13.6 acres for shaded fuelbreaks and access roads. In the intervals between fires, these mineral soil firelines are normally allowed to accumulate leaf litter every fall. Because the protective litter layer is removed periodically to expose mineral soil, some soil erosion from soil exposure until the next autumn “leaf-drop” (6 to 12 months). Protective vegetative and litter cover typically recovers within 1 growing season following mechanical cutting of shaded fuel breaks, or prescribed burning.

Using heavy equipment to create fire breaks may scarify soils in some areas or potentially compact soils. Implementing Best Management Practices helps limit the amount of soil disturbance from heavy equipment, and using ‘low ground pressure’ equipment reduces soil compaction potential. Using heavy equipment to establish fire breaks is likely a one-time activity that will have short term impacts. Future fire break maintenance can be done with much smaller and lighter equipment that will have little to no soil impact. Hazard fuel reduction may also be achieved through the mowing of understory vegetation. Care is taken during these operations to avoid disturbing the soils. The smaller size and weight of mowing equipment will help to reduce soil compaction. This activity will either be a 1 time non-recurring event in preparation for prescribed fire, or repeated every 5 to 7 years in areas where prescribed fire cannot be used effectively.

Any impact to the soils under alternative B would be similar to those under alternative A, but on an up to fourfold larger scale. Similar to alternative A, the Service would use prescribed fires to remove only some of the litter and light fuels and avoid the adverse effects of high-intensity, severe wildfires on soil resources. Conducting all prescribed burns within their prescriptions will minimize soil loss, although adverse soil impacts may occur in small areas. The adverse effects from higher intensity fires are only likely to occur in the presence of a natural or human ignited wildfire.

Refuge Access and Public Uses—Occasional staff or partner –led trips on the Crooked Pond parcel could in time adversely impact soils through compaction, erosion, and sedimentation if not addressed (Pickering et al 2010).. Long-term effects of trampling include soil impacts like diminished soil porosity, aeration, and water and nutrient availability for plant growth through soil compaction (Roovers et al. 2004, Kuss 1986) but these are unlikely, as refuge visitation is expected to be light. Foot travel can, over time create eroded conditions; lug soles on hiking boots can exacerbate the problem. Large group activities, such as guided interpretation or environmental education on any trail used, is more likely to impact soil to a greater extent.

Service staff would monitor the refuge for soil damage, minimize use if necessary, and mitigate damage with soil stabilization and control measures (water bars, steps, re-routing, etc.) as needed. This is expected to mitigate any significant long-term soil impacts from authorized public use.

Trespass by mountain bikes and ORVs, and to a lesser extent by horseback riding, occurs on the refuge, resulting in soil compaction and erosion. This illegal trespass is expected to decline, but not be eliminated under alternative B. Illegally accessed trails are deeply worn exposing tree roots and are void of protective duff and litter in several locations, and where trails are on slopes, erosion is occurring. At times unauthorized mountain bike and ORV riders will cause localized soil disturbance adjacent to refuge pond shorelines. Greater enforcement and increased public outreach should reduce soil damage from illegal, unauthorized uses.

Effects on Natural Community Types and Vegetation

The variety of wetland and upland habitats and vegetative communities present on the refuge are essential to meeting and sustaining wildlife habitat and species management goals. Overall, refuge habitats remain productive and diverse as described in previous chapters. This section focuses on impacts to natural community types and current vegetation on the refuge. Wildlife impacts and responses to these structural and compositional vegetative changes are discussed under the Effects on Biological Resources section.

We evaluated the alternative management actions that have the potential to benefit or adversely affect key refuge pond shoreline and upland pine-oak communities, including:

- Utilization of prescribed burning and mechanical methods to reduce fuel loads and restore mixed pine-oak habitats.
- Habitat management activities to benefit nesting northern red-bellied cooters, including tree-cutting, tree-girdling, and vegetation removal.
- Invasive species management.
- Refuge public use activities including environmental education, and interpretation, a public use trail connection, and opening part of the Crooked Pond parcel to deer and turkey hunting.
- Wildland fire suppression policies and methods.

Effects on Natural Community Types and Vegetation Common to Both Alternatives

Pitch pine-scrub oak shrubland association (sandplain heathland community) often referred to as the “pine barren” community represents a unique ecological adaptation to dry, sandy soils and to fire, and dependence on fire for the maintenance of the natural community. The pine barren community (pitch pine-scrub oak shrubland association) is dominated by dense stands of native pitch pines which often have shoots that can regrow directly from the trunk after fire has killed the crown. The thick bark protects the trunk from damage unless the fire is very severe (TNC 2009). Basal stump sprouting following fire is also common for scrub oak. As the pitch pine-oak forest canopy becomes more open, shifting to a woodland structure over time with continuing mechanical thinning and prescribed fire management, understory vegetation (scrub oak shrubland and sandplain

USFWS

Mushrooms

heathland) will likely increase with more sunlight reaching the ground (Wildlife Management Institute 2012). Understory vegetation benefitting most are pitch pine-scrub oak shrubland association (and sandplain heathland community) plants, such as lowbush blueberry, black huckleberry, and scrub oak (refer to Natural Community Types and Vegetation section in chapter 2). Prescribed burning may over time also create more snags and downed trees that provide habitat for a variety of species (refer to biological impacts), although it often takes more than one season for snags to develop after burning (Carter et al. 2002).

White pines that tend to grow taller and create closed canopy conditions will be reduced (canopy cover and density) in white pine-oak and oak-pine forest areas managed using canopy thinning and prescribed burning.

Forest floor after a controlled burn on Massasoit National Wildlife Refuge

Libby Herland/USFWS

Under both alternatives, a network of firelines (1.11 miles), shaded fuelbreaks (2.49 miles), and existing roadbeds (1.57 miles) will be maintained to facilitate wildland fire suppression and prescribed burning. Machinery will be used to mow or masticate understory vegetation every 5 to 7 years to keep the network passable for fire equipment and personnel on approximately 13.6 refuge acres (6.5 percent) of the refuge's 209 acres. Refuge firelines (2.68 miles) typically have a 1.5 foot strip from which all vegetation and the protective litter and sometimes duff layer are removed on up to (worst case estimate) 0.49 acres. In the intervals between fires, these firelines are normally allowed to "go fallow." Wildfires are not predictable as to the time and place of ignitions, but the same network of firelines and methods will be used to suppress any unplanned wildfires within the refuge.

Unauthorized operation of ORVs occurs along the utility line right-of-way, unpaved roads, and unimproved trails on the refuge, creating problems on Massasoit NWR as on most public land in Massachusetts (MassWildlife 2015), and is likely continue under both alternatives. Specific impacts from mountain biking, dirt biking and all-terrain vehicle use include soil disturbance and compaction as well as trampling and killing of vegetation. Horseback riding damages plants, and horses may cause localized impacts to plants when confined. In pitch pine-oak upland forest habitats subjected to ORV traffic, the resulting disturbance of dry, nutrient-poor, sandy soils may take decades to revert to native vegetation once damaged. Such soil disturbance may also provide inroads for non-native invasive plant species. Exposed soil and an abundance of sunlight along roads and trails provide ideal conditions for establishment of invasive plant species that may be transported into the refuge in feed hay.

Impacts to refuge coastal pond hydrology and to habitat and vegetation structure from changing climate and land uses that are external to the refuge that would be the same for both alternatives are discussed under Cumulative Effects.

Natural Community Type and Vegetation Effects of Alternative A

Beneficial Impacts

Hazardous Fuel Loading Reduction—Essentially continuous forest cover will be maintained across the entire refuge (209 acre) land base throughout the plan period and in perpetuity. There will be shifts in natural community types and vegetation associations through mechanical cutting and prescribed burning efforts that will thin overstory and create canopy openings on 50 acres on the Crooked Pond parcel. Management will enhance pitch pine-oak woodland or forest association habitat on those 50 acres as periodic fire encourages restoration of fire-adapted plant species (Nowacki and Abrams 2008). An increase in canopy openings will result in an increased understory layer (scrub oak shrubland association, sandplain heathland community) beneath the canopy gaps across those 50 acres.

Adverse Impacts

Habitat Management—Mechanical clearing of brush, trees, and other vegetation on ¼ acre near Crooked Pond to improve northern red-bellied cooter nesting sites is at a very small scale, and vegetation impacts are not deemed significant.

Hazardous Fuel Loading Reduction—Prescribed burning two burn units will be performed on a (5 to 7 years) rotational basis, with no more than 50 acres (two burn units) burned on any given day or in any one year. The two burn unit perimeters combined require 0.99 miles, 0.50 miles, and 0.45 miles respectively of the fireline, existing roadbed, and 100 foot wide shaded fuelbreak network. This network requires (worst case estimate) up to 0.27 acres of exposed mineral soil for firelines, and mechanical understory vegetation cutting on 7.68 acres for shaded fuelbreaks and access roadbeds. In the intervals between fires, these mineral soil firelines are normally allowed to accumulate leaf litter every fall. All vegetation, including roots and the protective litter layer is removed periodically to expose mineral soil.

Opening forest overstory and creating canopy gaps, changes forest to vegetation structure and composition. Periodic fire discourages fire-intolerant species (Nowacki and Abrams 2008) so a decline in canopy dominance of white pine is expected on the 50 acres treated on the Crooked Pond parcel. As white pine stem canopy dominance declines over time, refuge white pine-oak and oak-pine forest association acres are expected to decrease by approximately 50 acres (35 percent).

On the remaining untreated 150 upland acres, white pine-oak and oak-pine forest association will persist and continue succeeding to a more mature state. Now overly abundant white pines, artifacts of decades of wildfire suppression, would continue to grow and understory density will decrease further refugewide. Further loss of remnant plants associated with pitch pine-scrub oak shrubland, woodland, or forest association (sandplain heathland community), such as huckleberry, hillside and lowbush blueberry, or scrub oak will result (TNC 2009).

None of the habitat type shifts and or vegetation structure and composition impacts expected are significant however. Essentially continuous forest cover will continue to be maintained across the entire refuge land base throughout the plan period and in perpetuity under alternative A.

Refuge Access and Public Uses — The refuge remains closed to public use. Therefore vegetation impacts from public use will be confined to unauthorized, illegal activity. Currently trespass takes place at Massasoit NWR by mountain bikes and ORVs, and to a lesser extent horseback riding, resulting in localized vegetation destruction or damage. The current level of trespass and commensurate plant damage is expected to continue. Illegally accessed trails have exposed roots of trees, are void of above ground vegetation and compacted, and therefore deter revegetation in several locations.

Natural Community Type and Vegetation Effects of Alternative A

Beneficial Impacts

Habitat Management — Invasive species control will benefit native plant communities and refugewide floral diversity. Invasive plants such as glossy buckthorn, hairy cat's ear, butterfly bush, Morrow's honeysuckle, oriental bittersweet, black locust, common reed, and common mullein would decrease. Surveillance monitoring of aquatic plants in Crooked Pond, including invasive species, would alert the staff to any new invasive species concerns which could then be addressed sooner (see northern red-bellied cooters discussions).

Hazardous Fuel Loading Reduction — Essentially continuous forest cover will be maintained across the entire refuge (209 acre) land base throughout the plan period and in perpetuity. There will be shifts in natural community types and vegetation associations through mechanical cutting and prescribed burning efforts that will thin overstory and create canopy openings on up to 200 acres (refugewide). Management, will enhance pitch pine-oak woodland or forest association habitat on up to 200 acres (refugewide), as periodic fire encourages restoration of fire-adapted plant species (Nowacki and Abrams 2008). An increase in canopy openings will result in an increased understory layer (scrub oak shrubland association, sandplain heathland community) beneath the canopy gaps across the entire refuge upland (up to 200 acres).

Prescribed burning efforts would expand to most refuge upland acres (up to 200 acres) following HMP) and spatial FMP completion. Prescribed burning 10 to 20 individual burn units will be performed on a (5 to 7 years) rotational basis, with no more than 50 acres (23.9 percent of the refuge) burned on any given day or in any one year. Hazard fuel reduction may also be achieved through the mowing of understory vegetation with low ground pressure equipment with mower attachments. This activity will either be a one time non-recurring event in preparation for prescribed fire, or repeated every 5 to 7 years in areas where prescribed fire cannot be used effectively.

A refugewide increase in pitch pine-oak shrubland (sandplain heathland community), woodland or forest association acres corresponding with a decrease in more ruderal species such as white pine as described above for alternative A is expected. Refuge forest lands would in time more closely approximate the range of historic conditions typical of

Firefighters gather for a briefing before a controlled burn.

Libby Herland/USFWS

these pitch pine-oak associations at the time of European contact. Understory density and height would vary widely across the refuge with canopy opening percentage and time since last fire. Over the long term, there would increasingly be a more uneven aged, patch-mosaic, forest woodland structure due to the variations in timing and intensity of prescribed burning and mechanized thinning across the refuge. Refuge staff would work closely with the utility company to manage the acreage near the utility line for early successional, shrub habitat resulting in less overall vegetation removal along and within the utility line right of way, sustaining the shrubland habitat long term.

Refuge Access and Public Uses — Illegal access may decrease with more visitors on the refuge to detect and report illegal activity or whose mere presence may deter trespass. Periodic evaluations of the condition of the 1.1-mile public trail, as well as unauthorized trails and service access roads will be made. This will help detect and prevent invasive plant spread along and from the trail corridors.

Adverse Impacts

Habitat Management — Invasive species control would have short-term adverse, localized impacts on vegetation. These include the removal of plants, herbicide application, trampling, and other potential damage to plant structure. These short-term negative impacts would be offset by providing long term benefits to native plant diversity and health across the refuge.

Hazardous Fuel Loading Reduction — The more mature, eastern white pine-dominated forest would decrease by up to 200 acres (refugewide). Under alternative B, there would be as much as 200 acres burned following the development of a HMP and spatial FMP. Prescribed burning 10-20 individual burn units on up to 200 acres will be performed on a (5-7 years) rotational basis, with no more than 50 acres (23.9 percent of the refuge) burned on any given day or in any one year. Additional impacts to vegetation would occur within the areas designated as fire breaks, where vegetation is removed and maintained for the preventing wildfires. Mowing understory vegetation with low ground pressure equipment with mower attachments may be used to prepare for burning or where prescribed fire cannot be used effectively.

The 10 to 20 burn perimeters combined require (worst case estimate) up to 1.11 miles, 1.57 miles, 0.57 miles, and 1.92 miles respectively of the fireline, existing roadbed, 100-foot-wide and 12-foot-wide shaded fuelbreak network. Only a portion (20 to 50 percent) of these is needed for prescribed burning in any single year, in the absence of a large wildfire. This network requires worst case estimate) up to 0.49 acres of unvegetated soil for firelines, and mechanical understory vegetation cutting on 13.6 acres for shaded fuelbreaks and access roads. In the intervals between fires, mineral soil firelines are normally allowed to accumulate leaf litter every fall. Vegetative cover typically is restored within one growing season following prescribed burning or mechanical cutting of shaded fuel breaks.

Opening forest overstory and creating canopy gaps, changes forest vegetation structure and composition. Periodic fire discourages fire-intolerant species so a decline in canopy dominance of white pine trees is expected on up to 200 acres treated refugewide. As white pine stem canopy dominance declines over time, refuge white pine-oak and oak-pine forest association acres are expected to decrease by approximately 140 acres (98 percent).

Refuge Access and Public Uses — With increased public access and the possible opening of the refuge to hunting on the Crooked Pond parcel, vegetative communities could experience localized trampling, and possibly crushing of individual plants in higher traffic areas. Short-term effects consist of deterioration of plant material itself. Long-term effects of trampling include direct vegetation damage, and indirect vegetation effects from soil compaction like diminished soil porosity, aeration, and water and nutrient availability for plant growth (Roovers et al. 2004, Kuss 1986). Compacted soils inhibit plants', particularly sensitive species', ability to revegetate affected areas (Hammitt and Cole 1998). Plant damage can include height and biomass reduction, species composition shifts, and the spread of weeds and plant pathogens (Pickering et al. 2010). Plants species adapted to wet or moist habitats are the most sensitive, and increased moisture content reduces the ability of the soil to support recreational traffic (Kuss 1986). Direct vegetation effects and indirect impacts from soil compaction would likely be localized, and not significant on a larger scale, because most of the refuge remains largely closed to public access, especially sensitive wetland and pond shoreline areas. The generally well to excessively drained sandy textured soils dominating the areas proposed for opening to public access are already impacted by illegal, unauthorized use and relatively resistant to further soil compaction.

Unauthorized, illegal activities may increase in terms of damage to refuge vegetation as more people "discover" Massasoit NWR. Damage from this activity that currently exists on the refuge includes vegetation trampling and breakage, and trail widening. Individuals engaging in unauthorized activities or trail use may find the openings created by additional fire breaks within the refuge forests particularly attractive. This could lead to further vegetation degradation through trampling and spread of invasive plants.

Opening portions of the refuge for public use creates the potential for spread and/or introduction of invasive species. Visitors could carry seeds in footwear, and unauthorized users could transport invasive plant seeds, horses can excrete seeds in their waste, and paddlers can spread invasive plants transported on contaminated canoes or kayaks. While any introduction or spread of invasive plants is a great concern, allowing limited public access as planned under alternative B is unlikely to result in any significant biological impact to the refuge natural community types and vegetation. Law enforcement will continue to patrol and monitor to deter unauthorized uses thereby reducing the risk for spreading or introducing invasive species. Removing downed brush and blocking trails can effectively reduce vegetation impacts of illegal uses. We will post and enforce refuge regulations and area closures as refuge resources permit. Increased education and awareness about refuge natural resources and reasons for refuge regulations may also decrease illegal activities.

Effects on Biological Resources

The various refuge pitch pine and pond habitats provide diverse habitat components to support northern red-bellied cooters, breeding migratory birds and other wildlife of conservation concern. We evaluated the alternative management actions that have the potential to impact northern red-bellied cooters, New England cottontails, migratory birds, mammals, fish, reptiles and amphibians, and invertebrates (including pollinators) including:

- Habitat management activities to benefit nesting northern red-bellied cooters, including tree-cutting, tree-girdling, and vegetation removal.
- Maintaining and enhancing open canopy (shrub) habitats within the pitch pine-oak forest through mechanical methods and prescribed burning.
- Controlling invasive species.

- Applying herbicides to maintain native species and control invasive plant species.
- Increased public use (wildlife disturbance).

Biological Impacts Common to Both Alternatives

A number of impacts to refuge coastal pond hydrology and to habitat and vegetation structure from changing climate and land uses that are external to the refuge will in turn impact refuge biological resources the same under both alternatives are discussed under Cumulative Effects.

For purposes of this impact analysis, it was assumed that species found in similar habitats located within MSSF likely also occur on the refuge.

Biological Impacts of Alternative A

Beneficial Impacts

Habitat Management—Northern red-bellied cooter—Clearing woody and herbaceous vegetation and allowing sunlight to penetrate to and warm the soil surface on ¼ acre along the Crooked Pond shoreline, will enhance cooter nesting and egg incubation benefitting hatching success and early hatchling survival (USFWS 1994). This can potentially shorten the incubation period, increase hatching success and early hatchling survival, and shift the current male-biased sex ratio of hatchlings toward more females. Using predator exclosures to prevent egg destruction and increase hatching success will also improve first year survival rates of northern red-bellied cooter hatchlings. Increasing the number of nests, nest hatching success, and first year hatchling survival all contribute to northern red-bellied cooter recovery objectives.

Mammals—Silver-haired bats that forage in fairly open habitat in mixed wood forest areas near ponds, and roost in hollow trees and cavities under loose bark or bark folds (Barclay et al. 1988) may benefit, if present, from clearing vegetation on ¼ acre near the Crooked Pond shoreline for northern red-bellied cooter nesting habitat.

Fish—There currently is no active management for fish in Crooked Pond, and only the shorelines of the other ponds are within Service jurisdiction. Therefore no impacts to fish species on the refuge are likely under alternative A.

Gray catbird

Bill Thompson

Hazardous Fuel Loading Reduction—Migratory birds—Prescribed burning and thinning 50 acres of mixed pine-oak forest will benefit early successional and shrub species such as prairie warblers and field sparrow, chestnut-sided warbler, black and white warbler, common yellowthroat, eastern towhee, and gray catbird. In a study by King et al. (2011), bird surveys conducted during pre—and post-thinning efforts combined with prescribed burns showed that early successional and shrub species such as prairie warblers and field sparrows were most abundant in scrub oak and thinned pitch pine conditions. Species such as chestnut-sided warblers, black and white warblers, common yellowthroats, eastern towhees, and gray catbirds were most common in the scrub oak communities. Prairie warblers, eastern towhees, and field sparrows were virtually absent in pitch pine forests prior to treatment, but occupied treated areas a year after thinning and increased thereafter. Research in the mid-1970s by Manomet Bird Observatory analyzed three pitch pine-scrub oak stands, comparing species abundance at intervals of two years, 10 years, and 20 years after a fire.


Kevin Fleming

Prairie warbler

The highest abundance and diversity were observed 10 years after the fire, and that regular fire disturbance enriched bird life, as long as the damage was not too devastating (Epsilon 2000). Representative species such as eastern towhees and prairie warblers, and other migratory birds preferring open canopy and dense understory, will potentially increase slightly (not significantly).

Eastern wood-pewee, another surrogate species, would benefit somewhat where canopy thinning creates open-park like areas on xeric (dry) sites with low shrub density (McCarty 1996; Robbins et al. 1989). In a Kendrick et al. (2013) study, there was no strong relationship between habitat measures studied and eastern wood-pewee nest success, clutch size, and fledgling rate, and they were common in both forest interiors and edges, over a wide range of tree cover, and insensitive to patch sizes (McCarty 1996; Robbins et al. 1989). Management practices that include thinning and removal of mature trees and woody growth will benefit wood pewee. As the recently burned 50 acres succeeds to a more dense state between prescribed fire treatments, it will likely temporarily (until the next fire treatment) support slightly increased eastern wood-pewee numbers. The remaining 150 acres of untreated mixed pine-oak upland forest will continue supporting breeding wood-pewee.

The remaining 150 acres of untreated mixed pine-oak upland forest will continue supporting breeding adult ovenbirds along with other surrogate bird species such as scarlet tanager that rely on closed canopy conditions. Juvenile ovenbirds use regenerating cleared areas that have a denser understory for foraging and predator protection near ovenbird breeding habitat (Pagen et al. 2000, Marshall et al. 2003), and will be able to find that on the 50 acres treated with prescribed burning and mechanical thinning. Alternative A will provide approximately 150 acres of interior closed canopy forests for breeding adult ovenbirds, and approximately 50 acres with more open canopy areas with denser shrubland nearby for juveniles. Other surrogate birds such as ovenbirds, more dependent on closed canopy conditions (Porneluzi et al. 2011), will benefit from allowing approximately 150 acres to succeed further toward forest interior conditions.

Bobcat


Gary Kramer/USFWS

<u>Mammals</u>—While there is future potential on Massasoit NWR for New England cottontail and northern long-eared bat (federally threatened), neither species is currently known to occur on the refuge or in the vicinity. Monitoring to date shows no evidence of New England cottontail on the refuge or the adjoining MSSF. Prescribed burning and mechanical thinning on 50 acres will create several patches with more open canopies and dense shrub understory, potentially suitable for future occupancy by New England cottontail.

There will be some beneficial impacts to other (non-listed) mammals under alternative A, especially to bats (see below). Based on preliminary acoustic data analysis (USFWS 2013a), bats believed present on the refuge include big brown, eastern red, silver-haired, tri-colored, and eastern small-footed bats. Bats will likely benefit somewhat from the creation of forest canopy openings on 50-acres where active vegetation management occurs. Canopy gaps created by thinning and prescribed burns may allow bats such as eastern red bat and big brown bat to forage more easily (Edwards et al. 2000). Decreased tree density and increased openings, may also improve travel corridors for bats as more light reaches and warms roost trees, and increases insect prey diversity and abundance through increased herbaceous and shrub growth (Taylor 2006, Carter et al. 2002). Loeb and O'Keefe (2006) found bats were more likely to be recorded in areas with sparse vegetation, farther from roads, and in early successional stands. This was especially true for big brown bat and red bat where vegetation density best predicted bat habitat use. Big brown bat abundance decreases greatly from deciduous forest biomes to coniferous forest biomes (Kurta et al. 1989), and therefore will benefit from the area where the forest canopies are more open. Fire may create new bat roost trees and snags by direct or indirect fire mortality, (via disease, insect or fungal attack), although it may take one or more seasons to develop after burning (Carter et al. 2002).

Given the relatively small total and treated refuge acreage impacted, none of the above local (refuge-level) changes in bat species abundance are expected to be significant at the larger landscape or population levels.

Other mammals preferring more open canopy conditions and a denser understory layer such as mice and voles would also indirectly benefit from the prescribed fire regime and thinning treatments on 50 acres. Denser understory often allows for better protection from predators along with more food resources for small mammals, such as mice and voles.

<u>Reptiles and amphibians</u>—Areas where herbaceous ground cover and a dense shrub layer occur, systems of decaying roots and stumps, and mammal tunnels all serve as hiding places and hibernacula for amphibians and reptiles. Best management practices for amphibians and reptiles in pine forests such as those on the refuge include maintaining and creating canopy gaps that allow species that need sunlight such as American toad, Fowler's toad, and eastern hognose snake to thrive. The approximately 150 acres that will maintain a more closed canopy are likely to benefit such species as spotted salamander, spring peeper, wood frog, and milk snake (Mitchell et al. 2006). Additional inventories (last done in 2001 and 2002) will be needed to determine the extent and population of various amphibians and reptiles on the refuge to increase our certainty about impacts management actions would have on them.

<u>Invertebrates, including pollinators</u>—There has been no monitoring or inventory of invertebrates, specifically moth and butterfly species or other pollinators, leaving much uncertainty about possible impacts. However, a variety of species have been observed by staff during other management activities (see appendix A). For purposes of this impact analysis, it is assumed that species found in similar habitats located within MSSF likely also occur on the refuge.

Rare butterfly and moth species that depend on sandplain heathland community or pitch pine-scrub oak shrubland, woodland, or forest association habitats, such as the Pine Barrens buckmoth, Gerhard's Underwing moth, and others, would benefit slightly from prescribed burning and thinning on 50 acres. Individual moth and butterfly species are often specialists in a single microhabitat, such as frost barrens, river corridors, or late-successional stands and therefore are not found in all variants of pitch pine-oak association habitats. Many caterpillars (larvae) of these species eat only pitch pine, scrub oak, or other specific plant hosts found only or mostly in pitch pine –scrub oak shrubland association or sandplain heathland communities. Periodic fires are critical to prevent invasion by vegetation which could shade out the host plants. Thus, maintaining populations of these pitch pine-scrub oak shrubland and sandplain heathland community specialist lepidopteran species over time requires maintaining patches in various stages of post-disturbance recovery across large, relatively contiguous sandplain landscapes. Prescribed burning and overstory thinning will allow more light to penetrate to the understory, favoring the host plants which attract these pollinators (Carter et al. 2002).

Refuge Access and Public Uses—Northern red-bellied cooter—Camera monitoring indicates some trespassing on the property. Temporary signs establishing visual and enforceable closures around the nesting sites during nesting and incubation seasons will help protect the cooter. Illegal collection of cooter eggs and other harassment by humans will be deterred, by keeping the refuge pond shorelines which cooters use for basking and nesting closed to public use, and by enforcing current regulations.

USFWS

American black duck

Migratory birds—The refuge will remain largely closed to public use year-round, minimizing human disturbance of migratory birds from authorized public use.

Mammals—The refuge will remain largely closed to public use year-round under alternative A, minimizing human disturbance of mammals from authorized public use.

Reptiles and amphibians—The refuge will remain largely closed to public use under alternative A, minimizing disturbance of amphibians and reptiles from authorized public use.

Fish—Crooked Pond will remain closed to public use, minimizing human disturbance to fish from authorized public use.

Adverse Impacts

Habitat Management—Northern red-bellied cooter—Locating and protecting existing cooter nests on the refuge and clearing ¼ acre of vegetation along Crooked Pond may disturb individual northern red-bellied cooters infrequently for brief periods, but no significant adverse impacts on the northern red-bellied cooter are expected.

Alternative A does not address the additional management needs mentioned in the 2007 Recovery Plan update (USFWS 2007) such as monitoring for predators, opening canopies along other refuge pond shorelines, monitoring and opening uplands for potential northern red-bellied cooter overland migration, and controlling invasive plants in the ponds.

Reptiles and amphibians—Herbicide use along the utility right-of-way may negatively impact invertebrate species to a limited extent, which will largely be mitigated through collaboration with the State and the utility company.

Hazardous Fuel Loading Reduction—Migratory birds—Migratory birds associated with closed canopy, forest interior conditions such as breeding ovenbirds and scarlet tanagers, will likely decline initially in the 50 acres treated with prescribed burning and mechanical thinning (King et. al. 2011, Pagen et. al. 2000, Marshall et. al. 2003). Forest interior breeding birds breeding in sub-optimal conditions, may experience lower nest productivity or fledgling survival. A key component to successful breeding of these birds is consideration of edges and patch sizes (Robbins et. al.1989). Prescribed burning will be performed on a (5 to 7 years) rotational basis, with no more than 50 acres burned on any given day or in any one year.

Mammals—There will be no significant adverse impacts to mammals, including bats. No adverse impacts to the New England cottontail are expected under this alternative. Monitoring to date shows no evidence of New England cottontail on the refuge or the adjoining MSSF (MADCR 2011). The approximately 150 acres of refuge uplands remaining untreated will continue maturing, and degrading dense understory structure required by New England cottontails.

Management activities such as prescribed burns naturally present a low direct mortality risk to small mammals. The impact is minor at the population level and generally of short (weeks to months) duration. Most mammals scurry out of the way, go underground or burrow under the duff and escape injury as low to moderate intensity flaming fronts move across an area. Direct mortality of some mammals, such as rabbits and raccoons, may occur during prescribed burns but is rare. Prescribed fire removes some protective cover, potentially exposing small rodents and rabbits to predation and cold. The extent of exposure largely depends on the proximity of available cover and predator (raptors, foxes, and feral cats) density in the area. Prescribed burning will be performed on 50 acres on a (5 to 7 years) rotational basis, with no more than 50 acres burned on any given day or in any one year. Prescribed burns on the refuge will therefore be small (50 acres or less), which means alternate escape cover is never more than 700 feet away for small mammals temporarily displaced by a prescribed fire or other habitat treatment.

Prescribed burning 50 acres can have short-term detrimental effects on bats by eliminating some snags and stumps used for roosting (Taylor 2006). Roosting bats may also be killed under intense fire conditions. Firebreaks can be raked around snags, or the bases can be sprayed with retardant to protect the snags (Carter et. al 2002).

Prescribed burns conducted during hibernation periods may abnormally shorten torpor, and increase the frequency and duration of arousal periods. Juveniles and adults that depend on torpor, a diurnal hibernation-like state, may be especially at risk because of the time required to arouse from torpor and take flight (Dickinson et al. 2010). Flightless neonatal bats, too heavy for the mother to carry, may be at greater risk from smoke than adults and juveniles (USFWS 2014). Prescribed burns on up to 500 acres and fires occurring when bats are rearing young (April-July) or in deep hibernation (mid-winter) can therefore have negative impacts on local populations. In the southeastern U.S., red bats sometimes hibernate in leaf litter and may be unable to escape burns conducted on very cold days (Taylor 2006). To minimize losses, prescribed fires should be set during warmer days (above 50° F per Loeb 2013) when bats are not in the leaf litter. This impact will most likely be minimal because refuge growing season prescribed burns are unlikely during the times when neonatal bats are still in their roost (Dickinson et al. 2009), or during mid-winter deep hibernation periods.

For insectivorous bats, food is primarily available from late spring to early autumn and absent during winter. Bats survive this winter energetic bottleneck by building body fat stores (depot fat) in late summer and early autumn, and by conserving metabolic energy through winter hibernation. Hibernators do not remain torpid throughout hibernation. Bouts of torpor last from days to weeks, interrupted by brief arousal episodes. White-nose syndrome, an emerging infectious disease that has killed over 5.5 million hibernating bats is named for the causative agent, a white fungus [*Pseudogymnoascus destructans* (Pd) formerly known as *Geomyces destructans* (Gd)], that invades the skin of torpid bats. Several bat species believed present seasonally on the refuge are vulnerable to white-nose syndrome. A recent study predicted that a primary cause of the increased mortality/disease associated with white-nose syndrome is abnormally shortened torpor bouts due to more frequent arousal episodes (Reeder et al.

2012). Prescribed burns conducted during hibernation periods may increase the rate of arousal periods. Therefore, short-term losses from prescribed fires must be weighed with the long-term benefits to the ecosystem that could potentially support and increase bat habitat.

The approximately 150 acres of refuge uplands remaining untreated will continue maturing to more white pine dominated habitat without natural disturbances. Bats now present in these areas that prefer more open canopy conditions such as big brown bats, will likely decrease locally.

Wood frog

Andrew MacLachlan/USFWS

Reptiles and amphibians—Prescribed burning will be performed on 50 acres on a (5 to 7 years) rotational basis, with no more than 50 acres burned on any given day or in any 1 year. Limited research has been conducted regarding the impact of prescribed burning on amphibians and reptiles. Some studies show that unlike other larger vertebrates, smaller and less mobile vertebrates such as amphibians and reptiles were more likely to experience relatively high rates of direct mortality from fire (Lyon et al 1978, Sinsch 1990). The moist, permeable skin and eggs of amphibians increase their vulnerability to heat and microhabitat drying (Stebbins and Cohen 1995). However, another study (Komarek 1969) indicated that amphibians and reptiles were more likely to respond in an adaptive manner that minimized mortality and appeared less disturbed by approaching fire. Some studies conducted through pre—and post-burn surveys during prescribed burns, found no statistically significant differences in the various populations of amphibians including American toad and wood frog (Ford et al. 1999 and Keyser et al. 2004) and red-backed salamander (Keyser et al. 2004). Greenberg and Waldrop (2008) found similar results that showed relative abundance of total salamanders, common salamanders, and total amphibians were unchanged by the fuel reduction treatments.

We anticipate short-term impacts on amphibian species from refuge prescribed fire activities. However, given the low-intensity and short flame-front residence time (duration), and relatively small burn area, we do not consider this to be a significant impact. According to a review by Russell et al. (1999), there are few reports of fire-caused injury to reptiles and amphibians, even though many of these animals, particularly amphibians, have limited mobility. The Crooked Pond and other micro-site features within and surrounding burn units may provide protective refugia from fire for refuge reptiles and amphibians, and breeding by aquatic species is expected to continue uninterrupted by fire (Russell et al. 1999).

Invertebrates, including pollinators—The approximately 150 acres of refuge uplands remaining untreated will be increasingly dominated by more mature tree species such as the already common white pine. On these untreated acres, a further decline in the rarer butterfly and moth species, including Pine Barrens buckmoth and Gerhard's underwing moth is expected. Other pollinators and invertebrate species may be present on more closed canopy conditions. These species will remain largely undetected in the absence of monitoring and inventory.

Refuge Access and Public Uses—Operation of ORVs is common along utility line rights-of-way, unpaved roads, and trails, and is a problem on most public lands in Massachusetts (MassWildlife 2015). Utility rights-of-way, unpaved roads, and trails in pitch pine-oak upland forest systems often attract sensitive species for nesting (e.g., Eastern Box Turtle), basking (e.g., Eastern Hog-nosed Snake), or foraging where ORV traffic may result in destruction of nests and burrows, and in direct wildlife mortality.

Migratory birds—The refuge will remain closed year round to the public, minimizing human disturbance to migratory birds from authorized public. Unauthorized use could potentially disturb and harm migratory birds if the limited enforcement capacity leads to further increases in illegal use during nesting and young rearing periods within closed areas.

Mammals—Unauthorized use will continue to disturb mammals on the refuge to a limited (not significant) extent. Utility rights-of-way, unpaved roads, and trails in pitch pine-oak upland forest systems often attract sensitive species where ORV traffic may result in direct mortality.

Reptiles and amphibians—Unauthorized use will continue to affect reptiles and amphibians on the refuge to a limited (not significant) extent. Utility rights-of-way, unpaved roads, and trails in pitch pine-oak upland forest systems often attract sensitive species for nesting (e.g., Eastern Box Turtle), basking (e.g., Eastern Hog-nosed Snake), or foraging where ORV traffic may result in direct mortality.

Fish—Unauthorized use will continue to affect fish in refuge ponds to a limited (not significant) extent.

Biological Impacts of Alternative B

Beneficial Impacts

Habitat Management—Northern red-bellied cooter—The mechanical and prescribed burning measures under alternative B would benefit the northern red-bellied cooter by extending optimal sunlight conditions that cooters need for nesting and incubation to all existing refuge pond shores (1 acre), currently restricted to small portions (less than ¼ acre) of the Crooked Pond shoreline, and compared with alternative A.

Clearing woody and herbaceous vegetation and allowing sunlight to penetrate and warm the soil surface on 1 acre along refuge pond shorelines, will enhance cooter nesting and (egg) incubation, benefitting hatching success and early hatchling survival. This can potentially shorten the incubation period, increase hatching success and early hatchling survival, and shift the current male-biased sex ratio of hatchlings toward more females.

The addition of basking sites created by large downed trees anchored in shallow waters (USFWS 2004) during mechanical thinning treatments along refuge pond shorelines will also benefit breeding cooters. With adequate sunlight, cooters can also attain sexual maturity and enter the breeding population sooner, and breed more frequently (USFWS 1994).

Surveillance monitoring, including invasive aquatic plants in refuge ponds, will alert refuge staff sooner, allowing control measures to be taken before invasive plants can dominate the native milfoil and other native aquatic plants (MassWildlife 2008) that northern red-bellied cooters rely on for food.

Locating and protecting existing nests with predator exclosures will expand somewhat, increasing hatching success and survival probabilities for first year northern red-bellied cooter hatchlings. Increased inventory and monitoring will assist in better understanding the impact of predators on northern red-bellied cooter nests and potential nest habitats created on refuge pond shorelines.

The range of potential northern red-bellied cooter habitats extends beyond refuge boundaries. Among the entire potential habitat for northern red-bellied cooters, only 10 percent is protected through permanent conservation. The remaining 90 percent of potential habitats are under private ownership, including as much as 50 percent of the population occurring in Federal Pond, a privately-owned pond owned by Federal Furnace Cranberry Company (USFWS 2007). For successful northern red-bellied cooter recovery, it is imperative that the Service, State, and other conservation organizations work with these private landowners to more fully engage them in recovery. Alternative B affords more opportunity to work with private landowners such as the nearby cranberry growers, residents along the shorelines of refuge and off-refuge ponds, and other landowners in the region interested in entering into management agreements. This alternative also increases law enforcement outreach with private landowners, further benefiting northern red-bellied cooter populations existing on nearby private lands. With increased research effort, Service conservation partners and refuge staff will become better informed to more strategically manage and protect the existing and potential cooter population rangewide, both on and off the refuge.

Mammals—Under alternative B, the Service would inventory and map invasive species and implement management efforts at priority sites on the refuge. Controlling invasive plants benefits mammals by maintaining the balance of food resources and native vegetative communities to which they are adapted for cover, nesting, and quality food resources. Those invasive species that pose the biggest threats to mammals are those that can quickly colonize an area and form dense, monotypic stands. Herbivorous mammals that depend on a variety of native food resources throughout the year would be adversely impacted by monocultures of invasive plants. For smaller insectivorous mammals, degradation of native plant diversity and structural integrity by invasion of exotics adversely impacts the biodiversity and availability of invertebrate food resources associated only with native floral assemblages. Early detection and control of invasive plants will help prevent non-native plant monocultures from displacing native plant and insect diversity which provides critical year round food resources for herbivorous and insectivorous mammals.

Silver-haired bats that forage in fairly open habitat in mixed wood forests near ponds may benefit if present, from clearing vegetation on 1 acre near refuge pond shorelines for northern red-bellied cooter nesting habitat.

Reptiles and amphibians—Controlling invasive species would benefit amphibians and reptiles by contributing to the restoration and propagation of native plants and associated insects that are essential food resources. Additional inventories will further inform the Service and our partners about the extent and population of various amphibians and reptiles, increasing certainty about management impacts on them.

Fish—If surveys proposed indicate a need for aquatic invasive plant control, fish favored by native aquatic plants would indirectly benefit indirectly from that control, but the benefit is limited and not expected to be significant.

Hazardous Fuel Loading Reduction—Northern red-bellied cooter—Prescribed burning and mechanical thinning on up to 200 upland acres will further benefit the northern red-bellied cooter, by extending increased sunlight reaching the forest floor beyond the immediate refuge pond shorelines. Most lands surrounding refuge ponds are now closed-canopy pine forests. These closed canopy forested pond shorelines, if provided with adequate sunlight, could become suitable cooter nesting and incubation habitat. Incubation takes 73 to 80 days at an average temperature of 77 °F. The microclimate at nesting sites can affect the sex ratio of hatchlings (Graham 1993) with cool nests producing more males (a male-biased sex ratio is currently documented on the refuge), and warm nests more females. Research suggests that providing nesting habitat with ample sunlight may benefit both hatching success and early hatchling survival (USFWS 1994).

Migratory birds—Up to 200 acres, nearly all refuge forested habitat, will be managed using prescribed burning (primarily) and/or thinning treatments to open the forest canopy and encourage low, dense shrub understory growth. Prescribed burning and thinning up to 200 acres of mixed pine-oak forest will benefit early successional and shrub species such as prairie warblers and field sparrow, chestnut-sided warbler, black and white warbler, common yellowthroat, eastern towhee, and gray catbird. Representative species such as eastern towhees and prairie warblers, and other migratory birds preferring open canopy and denser understory, will potentially increase (King et al. 2011) refugewide (locally), but is not expected to be measurable at regional or continental population scales.

Bill Thompson

Eastern wood peewee

Eastern wood-pewee are also likely to thrive refugewide under alternative B. Variability in fire intensity during individual burns, combined with rotating multiple small burn treatments across the refuge landscape over several years will provide the heterogeneity in stand structure preferred by the wood pewee. Patches of intermediate age forest with more closed canopy left where lower intensity fire spread occurs, will be in close proximity to open, park-like patches, and the entire gradient of conditions between these.

Juvenile ovenbirds that use regenerating cleared areas with a denser understory for foraging and predator protection near adult ovenbird breeding habitat, will find that on up to 200 acres treated with prescribed burning and mechanical thinning. Also, the HMP will identify patches to be reserved for migratory birds needing a more closed canopy habitat. This ensures that dense shrub juvenile ovenbird foraging and escape habitat is provided proximally to forest interior ovenbird nesting habitat, that is expected to remain available through the planning period and beyond on adjoining public and private lands.


CraigLewis/USFWS

White tailed deer

Mammals—Monitoring to date shows no evidence of New England cottontail on the refuge or the adjoining MSSF, so no significant direct short-term benefit to existing New England cottontail populations is anticipated under alternative B. However, under alternative B, treatments to create open canopies with a dense shrub understory, potentially suitable for future occupancy by New England cottontail would be extended to nearly all refuge forested uplands. This is consistent with the regional New England Cottontail Technical Team recommendations for the refuge and adjoining MSSF. Prescribed burning and mechanical thinning on up to 200 acres will create many patches with more open canopies and dense shrub understory, potentially suitable for future occupancy by New England cottontail.

The utility line present on the refuge, currently managed by the utility company and the State using mowing and herbicides to create a grass-shrub habitat, is also conducive to New England cottontail. By working collaboratively with utility right-of-way managers, the future potential for additional improved habitat connectivity and conditions for New England cottontail with the larger landscape surrounding the refuge increases.

There will be similar, but refuge-wide scale beneficial impacts to other (non-listed) mammals, especially to bats under alternative B. Bats suspected as present on the refuge (USFWS 2013) include big brown, eastern red, silver-haired, tri-colored, and eastern small footed bats. Bats will likely benefit from the creation of forest canopy openings on up to 200 acres where active vegetation management occurs. Canopy gaps created by thinning and prescribed burns may allow bats such as eastern red bat and big brown bat to forage more easily. Decreased tree density and increased openings, may also improve travel corridors for bats, as more light reaches and warms roost trees, and increases insect prey diversity and abundance through increased herbaceous and shrub growth. Fire may create new bat roost trees and snags by direct or indirect fire mortality, although it may take one or more seasons to develop after burning. Given the relatively small total refuge acreage impacted, none of the above local (refuge-level) changes in bat species abundance are expected to be significant at the larger landscape or population levels.

Other mammals preferring more open canopy conditions and a denser understory layer such as mice and voles would also indirectly benefit from the prescribed fire regime and thinning treatments on up to 200 acres (refugewide). Denser understory often allows for better protection from predators along with providing more food resources for small mammals such as mice and voles.

With deer density currently well above the 6 to 8 deer per square mile MassWildlife target range for Wildlife Management Zone 11, and given normal fecundity rates, opening most of the Crooked Pond parcel to deer hunting will not significantly impact local deer density or achievement of state deer management goals.

Reptiles and amphibians—Reptiles, and amphibians favored by open canopy conditions with a dense shrub understory, such as American toad, Fowler's toad, and eastern hognose snake are expected to benefit to an even greater (up to fourfold) degree from prescribed burning and thinning and on up to approximately 200 acres.

Invertebrates, including pollinators—As already discussed above under alternative A, invertebrate data for the refuge are generally lacking for most species. Rare butterfly and moth species that depend on sandplain heathland community or pitch pine-oak shrubland habitats, such as the Pine Barrens buckmoth and Gerhard's Underwing moth and others, will benefit refugewide from prescribed burning and thinning on up to 200 acres. Many caterpillars (larvae) of these species eat only pitch pine, scrub oak, or other specific plant hosts found only or mostly in pitch pine-scrub oak shrubland association or sandplain heathland communities. Prescribed burning and overstory thinning will allow more light to penetrate to the understory, favoring the host plants which attract these pollinators.

Expansion of moth and butterfly species inventory and monitoring, also gives Service staff and partners better information about lepidopteran species occurrence, allowing for more strategic, targeted, and proactive application of refuge vegetation treatments.

Collaboration with the utility company to manage for shrubland habitat along the power line would also benefit pollinators such as some moths and butterflies. Studies indicate that when managed properly, utility rights-of-way become suitable habitats for certain butterflies and moths (Wojcik and Buchmann 2012). Management strategies that increase edges, favor trees along sidelines, and increase bare ground provide better butterfly habitat (Carter and Anderson 1987). Sunlight is particularly important for basking behaviors that warm the body for flight (Smallidge et al. 1996).

Refuge Access and Public Uses—<u>Northern red-bellied cooter</u>—Camera monitoring indicates some trespassing on refuge property. Temporary signs establishing visual and more enforceable closures around the nesting sites during nesting and incubation seasons will afford a limited additional protection for the cooter. Illegal collection of cooter eggs and other harassment by humans will be further deterred by keeping the refuge pond shorelines which cooters use for basking and nesting closed to public use, and increased enforcement.

<u>Migratory birds</u>—Opening most of the Crooked Pond parcel to staff and partner-led wildlife observation and photography, interpretation and environmental education, increasing refuge outreach, as well as opening most of the Crooked Pond parcel seasonally to hunting, are unlikely to provide more than minimal (not significant) benefit to migratory birds from the increased stewardship ethic and awareness of refuge resources, including migratory birds, they will foster.

Field sparrow

Bill Thompson

Some decrease in unauthorized (illegal) use that can damage or destroy eggs and nests on or near the ground, or disturb incubating or brooding adults on nests with the greater staff presence and enforcement is expected.

<u>Mammals</u>—Opening the refuge to staff and partner-led to wildlife observation and photograph, interpretation and environmental education, increasing refuge outreach, as well as opening most of the Crooked Pond parcel seasonally to hunting, are unlikely to provide more than minimal (not significant) benefit to mammals from the increased stewardship ethic and awareness of refuge resources, including mammals, they will foster.

Adverse Impacts

Habitat Management — Northern red-bellied cooter — Locating and protecting existing cooter nests on the refuge and clearing 1 acre of vegetation along refuge ponds may disturb individual northern red-bellied cooters infrequently for brief periods, but no significant adverse impacts on the northern red-bellied cooter are expected. However, the increased cooter nest success, hatchling survival, earlier attainment of sexual maturity and greater breeding frequency expected from these activities will more than offset disturbance impacts from the activities. Therefore, no significant adverse impacts on the northern red-bellied cooter are expected under alternative B.

Reptiles and amphibians — Herbicide use for invasive species control could negatively impact amphibian eggs, larval stages, and tadpoles to a limited extent, but are expected to be largely mitigated by precautions during application. Herbicides and surfactants intended for terrestrial use can enter freshwater ponds and wetlands, where they can be lethal to developing amphibian eggs, larval stages, and tadpoles. Great care is exercised to mitigate potential damage by adhering strictly to label directions and approved Pesticide Use Proposals. We anticipate no significant adverse effects from herbicide application to control invasive species proposed under alternative B on amphibians or reptiles.

Fish — Herbicide use for invasive species control could adversely impact developing fish eggs and juvenile fish to a limited extent, but can be largely mitigated by precautions during application. Herbicides and surfactants intended for terrestrial use to enter freshwater ponds and wetlands, where they can be lethal to developing fish eggs and juvenile fish. Great care is exercised to mitigate potential damage by adhering strictly to label directions and approved Pesticide Use Proposals. Herbicide application for invasive species control is expected to have little to no impact on refuge fish populations given the precautions taken to avoid herbicide introduction into the wetland and pond areas.

Invertebrates, including pollinators — Herbicide use for invasive species control could adversely impact pollinators and other invertebrates to a limited extent, but can be largely mitigated by precautions during application. However, the level of review that Service policy requires before we can apply any chemical or biological methods on refuge lands (Pesticide Use Proposal process) ensures that the environmental risk is minimized and that all facets of the proposed use have been examined and justified. All products are used according to label instructions to minimize impacts to resources. There is evidence that overuse of herbicides along utility lines can harm pollinators including moths and butterflies (Wojcik and Buchmann 2012). Herbicide use along the utility right-of-way could negatively impact invertebrate species to a limited extent, but can be largely mitigated by precautions during application and collaboration with the State and utility company to minimize herbicide use along the utility line.

Hazardous Fuel Loading Reduction — Migratory birds — Under alternative B, there would be as much as 200 acres burned following the development of a HMP and the spatial FMP. Migratory birds associated with closed canopy, forest interior conditions such as breeding ovenbirds and scarlet tanagers will decline, but likely persist in lower numbers and density on up to 200 acres treated with prescribed burning and mechanical thinning. Suitable habitat will remain within the refuge, and on adjoining ownerships. Ovenbirds are found at higher populations in unthinned areas (King et al. 2011). As indicated in chapter 3 and discussed above under alternative A, adult ovenbirds are often patch-size (area) sensitive, interior forest birds (Porneluzi et al. 2011). The HMP will identify patches to be reserved for migratory birds needing a more closed canopy (interior forest) habitat. Prescribed burning on up to 200 acres over the entire

Crooked Pond in Autumn

Stephanie Koch/USFWS

refuge will be performed on a (5 to 7 years) rotational basis, with no more than 50 acres burned on any given day or in any one year. It is also anticipated that the forest interior habitat conditions ovenbirds, scarlet tanagers and their associates require will be readily available on adjoining public and private lands through this and subsequent planning periods. Therefore potential adverse impacts to forest interior associated migratory birds such as ovenbirds and scarlet tanagers will be limited across space and time, and are not expected to be significant under alternative B.

Mammals—Because there are currently no New England cottontail on the refuge or the adjoining MSSF (MADCR 2011) no direct, short-term adverse impacts are likely under alternative B. Potential direct mortality risk to small mammals such as rabbits, mice, and voles during prescribed burns on up to 200 acres is expected to be low (rare) and not significant, but may occur. Multiple small (25 to 70 acres) burn units allows rotating the prescribed fire and thinning treatments across the 200 upland refuge acres over several years. Prescribed burning on up to 200 acres over the entire refuge will be performed on a (5 to 7 years) rotational basis, with no more than 50 acres burned on any given day or in any one year. A slightly increased predation or winter cold exposure risk during immediate post-burn periods for mammals displaced by prescribed burn units is expected. But this increase is more than offset by improved protective cover for 5 to 7 years after burning. Rotating prescribed burn treatments as smaller patches across the refuge landscape over several years leaves ample area for rabbits and other small mammals displaced from burn units to find safe cover nearby and escape the burn area. Therefore, even with the larger area treated with prescribed fire and thinning under alternative B, no significant adverse impacts on existing mammal populations or on future potential New England cottontail habitat are expected from habitat management actions under alternative B.

Prescribed burns on up to 200 acres and fires occurring when bats are rearing young (April-July) or in deep hibernation (mid-winter) can have negative impacts on local bat populations. To minimize losses, prescribed fires should be set during warmer days (above 50° F). This impact will most likely be minimal because refuge growing season prescribed burns are unlikely during the times when neonatal bats are still in their roost or during mid-winter deep hibernation periods. Prescribed burning over the entire refuge will however be performed on a (5 to 7 years) rotational basis, with no more than 50 acres burned on any given day or in any one year.

<u>Reptiles and amphibians</u>—Short term impacts on amphibian species from prescribed burning and mechanical thinning up to 200 acres are expected. There is increased direct mortality risk. There is also increased indirect impact potential through increased risk of losing forest floor amphibian refugia to consumption by fire. Reptiles, and amphibians favored by more mature, closed canopy forest conditions are expected to decrease (Mitchell et al. 2006) as thinning and prescribed burning is expanded. Spotted salamander, spring peeper, wood frog, and milk snake are species that could be adversely impacted, but mitigation and adaptation may be possible. The HMP will identify areas of the refuge to be reserved for migratory birds needing a more closed canopy (interior forest) habitat that will similarly provide refugia for reptiles and amphibians such as spotted salamander, spring peeper, wood frog, and milk snake. Impacts to amphibian populations from timber harvesting can be minimized using modified even-aged silvicultural practices (aggregate retention cuts, and shelterwood retention cuts) (deMaynadier and Hunter 1995, Brooks 1999). Retaining 10 to 15 percent of the refuge uplands in late-successional forest patches as planned for state wildlife lands, according to the Massachusetts SWAP (MassWildlife 2015) will contribute to long-term persistence of less mobile, moisture sensitive amphibians such as redback salamander (DeGraaf and Yamasaki 1992 and 2002), wood frog, and mole salamanders. A shaded canopy is usually restored within 10 years, and redback salamander numbers typically recover to pre-cut levels within 30 years (DeGraaf and Yamasaki 2002), and there is generally no difference in numbers of salamanders in 60-year-old second-growth forest vs. old-growth forest (Pough et al. 1987). It is also anticipated that the forest interior habitat conditions which spotted salamander, spring peeper, wood frog, and milk snakes and their associates require, will be readily available through this next (and future) planning period on adjoining public and private lands.

Under alternative B, there would be as much as 200 acres burned following the development of a HMP and spatial FMP. Prescribed burning on up to 200 acres over the entire refuge will be performed on a (5 to 7 years) rotational basis, with no more than 50 acres burned on any given day or in any one year. Rotating prescribed burn treatments as smaller patches across the refuge landscape over several years still leaves ample area for reptiles and amphibians displaced from burn units to find safe cover nearby and escape the burn area. As with alternative A, the small burn units employed under alternative B means alternate escape cover is never more than 700 feet away for reptiles and amphibians displaced by a prescribed fire or other habitat treatment. Therefore, even with the larger area treated with prescribed fire and thinning under alternative B, no significant adverse impacts on reptiles or amphibians are expected from habitat management actions proposed. The refuge ponds and other micro-site features within and surrounding burn units may provide protective refugia from fire for refuge reptiles and amphibians, and breeding by aquatic species is expected to continue uninterrupted by fire (Russell et al. 1999).

Overall, with careful consideration of management practices and the impacts on amphibians and reptiles, we anticipate no significant adverse effects from prescribed burning or other hazardous fuel reduction actions proposed under alternative B.

Fish—Since no fish survey has been conducted by Service staff it is unclear what fish species exist in any of the ponds. As already discussed above under alternative A, prescribed burning would have little to no impact on fish populations given the precautions taken to avoid post-burn runoff into the wetland and pond areas.

Refuge Access and Public Uses—Northern red-bellied cooter—Staff and partner-led wildlife observation, photography, interpretation and environmental education will be conducted in a manner to ensure that disturbance to northern red-bellied cooters and their habitat does not occur. Although increasing public access increases disturbance risk to northern red-bellied cooter nesting areas, all access would be managed to ensure visitation does not interfere with breeding and nesting seasons for the cooter.

Other possible threats to the northern red-bellied cooter are the collection of eggs, individual turtles, and harassment by humans or their pets. Some potential for increased disturbance or harassment of northern red-bellied cooters from unauthorized users is expected, but is not deemed significant.

Migratory birds—Increased disturbance impacts to individual migratory birds may occur from authorized wildlife-dependent puboic use. Staff and partner-led wildlife observation, photography, interpretation and environmental education are expected to increase visitor use and human disturbance impacts just slightly. Impacts will vary by species involved and the type, level, frequency, duration and the time of year the disturbance occurs.

Bill Thompson

Brown thrasher

Beale and Monaghan (2004) found adverse effects to wildlife increased as number of users increased, and that an animal’s response to one visitor walking down a trail is entirely different than to a group of users walking down a trail. Miller et al. (1998) found bird abundance and nesting activities (including nest success) increased as distance from a recreational trail increased in both grassland and forested habitats. In this study, common species (e.g. American robin) were found near trails and rare species were found farther from trails. Disturbance can cause shifts in habitat use, abandonment of habitat, and increased energy demands on affected wildlife (Knight and Cole 1991). In some cases there is a clear link between the extent of disturbance and survival or reproductive success of individuals (e.g. Schulz and Stock 1993). But in many cases, disturbance acts in a more subtle way by reducing access to resources such as food supplies or nesting sites (Gill et al. 1996). Bird flight in response to disturbance can lower reproductive success by exposing individuals and nests to predators.

Evidence suggests species most likely to be adversely affected are those where available habitat is limited, constraining them to disturbed areas where they suffer reduced survival or reproductive success (Gill et al. 2001). Because of the diversity of habitats represented on the refuge directly connected to other large tracts of protected lands, any population level effects to migratory birds from refuge public use would be minimized by an abundance of habitat on the refuge and adjacent public lands.

By having refuge staff present or a partner agency guide refuge visitors, potential disturbance can be substantially reduced by keeping visitors in specific areas and minimizing noise levels. Alternative B helps deter illegal use and other potential wildlife harassment by humans by enforcing migratory bird regulations refuge-wide. Increased public use and access to the refuge as proposed and expected under alternative B is not expected to have significant adverse impacts on migratory birds.

Mammals—With no known presence of New England cottontail on the refuge the opening of the refuge to environmental education and interpretation, wildlife observation and photography, and deer and turkey hunting (no small mammal hunting) will not preclude future occupancy by the New England cottontail.

Slightly increased disturbance to individual small mammals is expected. Wildlife disturbance may be compounded by seasonal needs. For example, disturbance would cause some mammals to flee. During winter months, mammals that flee would consume stored fat reserves needed to survive the winter. Hammitt and Cole (1998) found white-tailed deer females with young are more likely to flee from disturbance than those without young. In addition, native carnivores (bobcats and coyotes) also appear to shift periods and areas of activity to avoid peak recreational use (George and Crooks 2006). With public use confined to small portions of the refuge at any given time, alternative B is not expected to have significant adverse impacts on mammals, including bats. Unauthorized use will also continue to affect refuge small mammals to a limited (not significant) extent.


Jared Green

Northern red-bellied cooter

Opening portions of the refuge to deer hunting in accordance with state regulations would result in direct mortality of individual wildlife harvested. We anticipate light hunting pressure. Nevertheless, recreational hunting at any level, including for deer and turkey, can be controversial. Before any hunting is authorized on the refuge, the Service will prepare a hunt opening package and associated NEPA documentation, including public notification, scoping, and invite public input on that hunt opening package and plan.

Reptiles and amphibians—Potential disturbance from staff and partner-led trips can be substantially reduced by keeping visitors in specific areas and minimizing noise levels. Alternative B helps deter illegal use and other potential wildlife harassment by humans by increasing patrols and enforcement refuge-wide. Unauthorized use will continue to affect reptiles and amphibians on the refuge, but to a lesser extent. Increased public use and access to the refuge as proposed and expected under alternative B is not expected to present significant adverse impacts on other reptiles and amphibians.

Fish—Unauthorized (illegal) use will likely continue to affect fish in refuge ponds to a limited (not significant) but lesser extent, due to increased presence by Service personnel, including law enforcement.

Effects on Climate Change

A summary of general climate change data and analyses, as well as information specific to Massachusetts was provided in chapter 2. In this section, we evaluated the alternative management actions for their potential to help mitigate or potential for increased atmospheric carbon emissions from refuge management activities to contribute to the impacts of climate change locally, in the region, and globally, including:

- The potential for enhancing habitat resiliency utilizing prescribed fires to manage pitch pine-oak forests.
- The potential for enhancing resiliency in habitats by controlling invasive species.
- Maintaining continuous vegetative cover, surface litter, and duff layers on refuge lands that sequester carbon, through area closures and applying BMPs.
- Atmospheric carbon emissions from vehicles, equipment, and prescribed burning efforts.

Climate Change Impacts Common to Both Alternatives

Unlike southern cooter populations, northern red-bellied cooter populations hibernate during winter in pond bottom substrates under the ice. With the potential for increased temperatures due to climate change, warmer conditions may shorten this hibernation period and lengthen the non-hibernation period, thereby increasing survival rates among these northern populations.

With respect to greenhouse gases responsible for climate change, plants absorb carbon dioxide and as a result, vegetated areas can act as important carbon sinks (Heath and Smith 2004; USEPA 2012). Carbon “sequestration” is essentially the process by which plants take up carbon dioxide through photosynthesis, and then store (sequester) it in plant biomass (wood, roots) and in the soil. Succession to forest stores the most carbon although the sequestration rate declines as trees mature (Heath and Smith 2004). Decomposition, functionally the inverse of photosynthesis, releases sequestered carbon back to the atmosphere, and decomposition rates increase in mature forests. Some carbon sequestered on or above the soil surface is however released back to the atmosphere whenever vegetation burns during wildfire or prescribed burn surface fire spread, partially reversing vegetation and soil carbon sequestering as with forest decomposition.

A 2012 assessment by Manomet Center for Conservation Sciences and the National Wildlife Federation looked at regional climate change vulnerability. Pine barren (pitch pine—scrub oak shrubland, pitch pine—oak woodland or forest associations, or sandplain heathland community) habitats are the least vulnerable (most resistant) to climate change forest types in the region. These naturally resilient forest types can withstand wildfire (with proper fuel load management), pest and invasive species outbreaks, often associated with climate change. Although these forests are vulnerable to non-climate stressors, with the reduction of fuel hazards, the risk of severe wildfires brought on by alternating cycles of increased precipitation and drought is reduced.

Climate Change Impacts of Alternative A

Beneficial Impacts

Hazardous Fuel Loading Reduction—Continued use of prescribed burns to manage fuel loads on 50 acres combined with expected climate change induced drought and other weather extremes, may create more favorable conditions for pitch pine-scrub oak persistence and expansion (Manomet Center for Conservation Sciences and the National Wildlife Federation 2012). Continuing hazardous fuel reduction will also reduce the high intensity wildfire threat, often exacerbated by the alternating cycles of extremes in precipitation and severe drought expected with changing climate.

Adverse Impacts
Hazardous Fuel Loading Reduction—There is the potential for slight, short-term increases in atmospheric carbon emissions during prescribed burning and from motorized equipment use during mechanized thinning. Prescribed burning will be performed on a (5-7 years) rotational basis, with no more than 50 acres burned on any given day or in any one year. The level of carbon emissions from habitat management will be insignificant compared to the emissions from a single large, high severity wildfire due to high fuel load accumulations without fuel treatments.

Refuge Administration—Atmospheric carbon emissions will result from round-trip motor vehicle travel by complex headquarters staff to work on the refuge. The staff increasingly utilizes lower emission vehicles to reduce atmospheric carbon emission contributions to global climate change. Because of the limited level of management, the carbon emissions from administrative activity expected are minimal, and not significant.

Climate Change Impacts of Alternative B

Beneficial Impacts
Habitat Management—Coastal ponds have a medium vulnerability to climate change as a result of the potential increase in invasive plants associated with climate change (Manomet Center for Conservation Sciences and MassWildlife 2010). Surveys of aquatic invasive plants with an evaluation of the need for management would potentially benefit refuge pond climate change resilience if control efforts were implemented sooner.

Hazardous Fuel Loading Reduction—Expanding prescribed burning and mechanical thinning for hazardous fuel reduction and habitat management to as much as 200 acres should increase resiliency of the refuge forests to climate change. Episodic greenhouse gas emissions from high intensity wildfires are less likely with fuel reduction on up to 200 acres. Invasive species monitoring and control would also increase, to maintain less than 10 percent cover in invasive species refuge-wide. Resiliency to climate change impacts of the natural plant communities and the restored habitats would increase the most under alternative B.

Carbon sequestration would differ based on the change in vegetation type, structure, and forest canopy closure by extending mechanical thinning and prescribed burning to as much as 150 additional acres of what is now relatively mature, closed-canopy eastern white pine dominated forest, a less climate change resilient type. The net offset effect of carbon sequestration from forest succession to the periodic carbon release back into the atmosphere during prescribed burning is however uncertain.

Adverse Impacts
Hazardous Fuel Loading Reduction—Increasing prescribed burning by up to 150 additional acres is expected to increase atmospheric carbon emissions by up to four times over the planning period. Prescribed burning up to 200 acres will be performed on a (5 to 7 years) rotational basis, with no more than 50 acres burned on any given day or in any one year. Rapid post-burn vegetative recovery and resumption of biological carbon sequestration of atmospheric carbon following low to moderate intensity, small scale prescribed fires is expected. This increased level of atmospheric carbon emissions would still be insignificant compared with those from a single large, severe wildfire fueled by heavy fuel

loads, as experienced in past decades. The use of power tools and equipment on the refuge would also produce small amounts of carbon emissions.

Refuge Access and Public Uses—Additional impacts on atmospheric carbon emissions may occur from the slight potential increase in visitation on the refuge could occur under this alternative. Atmospheric carbon emissions from increases in refuge visitor use would likely be negligible (insignificant) since most visits to the refuge would come from nearby residents or visitors already using the adjacent MSSF.

Refuge Administration—Additional atmospheric carbon emissions will result from more round-trip motor vehicle travel by complex headquarters staff to the refuge. The shift toward lower emission vehicles to reduce atmospheric carbon emission contributions to global climate change will offset emissions from increased refuge staff administrative vehicle use. Atmospheric carbon emissions would still be minimal (insignificant) compared with emissions from sources originating outside the refuge.

Effects on Refuge Access and Public Uses

We evaluated the alternative management actions with the potential to affect the level of opportunity and visitor experience of those major activities listed:

- Offering guided wildlife observation and photography trips by staff or refuge partners.
- Opening a portion of the Crooked Pond parcel seasonally to hunting, including deer and turkey hunting, in accordance with State regulations.
- Offering onsite environmental education and interpretation hosted by refuge staff or by refuge partners under special use permit.
- Increased outreach and Service visibility to promote resource stewardship and outdoor ethics.
- Increased partnerships with local, regional, and state recreational interests.
- Law enforcement activity and effectiveness on and off the refuge.

Refuge Access and Public Use Impacts Common to Both Alternatives

No beneficial or adverse impacts to refuge access and public uses are common to both alternatives.

Refuge Access and Public Use Impacts of Alternative A (Current Management)

Beneficial Impacts

Refuge Access and Public Uses—With continued closure of the refuge to public use, there will be no significant beneficial impact to refuge access and public use. The Service will have capability for limited oversight of vehicular and pedestrian traffic on the refuge. A very limited ability to educate a wider audience about the refuge's ecosystem and the sensitivity of habitats and associated wildlife will continue. The Service would continue providing limited programming, delivered primarily through refuge partners, as staffing, funding, and the interest and availability of Service partners allow.

Adverse Impacts

Refuge Access and Public Uses—Continued closure of the refuge effectively precludes most refuge public use and access opportunities throughout the planning period. Limited outreach, interpretation, and enforcement by the Service will not ensure compliance with Federal, State, and local endangered species or wetland protection laws on the refuge. A lack of awareness of the

Sign to protect northern red-bellied cooter nesting habitat

Libby Herland/USFWS

refuge boundaries and refuge policies, and improper and unauthorized use and access to sensitive areas of the refuge is expected to remain unchanged, and continue through the planning period.

Refuge Administration — The distance of the refuge from the Refuge Complex headquarters and current levels of staffing and funding limit the Service's ability to develop and deliver the programming content and messaging that fulfills the Service's educational goals and priority use mandates. The minimal level of interpretation that has occurred off the refuge related to the refuge's natural resources has been delivered principally through refuge partners. The Service would remain entirely dependent on the interest and availability of Service partners to deliver limited interpretive programming and outreach.

Refuge Access and Public Use Impacts of Alternative B (Service-preferred Alternative)

Beneficial Impacts

Refuge Access and Public Uses — Providing staff and partner-led guided visits to the Crooked Pond parcel and opening most of the Crooked Pond parcel seasonally to hunting will increase public access and public use. Wildlife observation, photography, interpretation, environmental education, and recreational hunting are all priority wildlife-dependent recreational activities that are not available under alternative A. Alternative B somewhat increases the Service's emphasis on interpretation provided through a more coordinated public use program. Staff and partner-led interpretive programs, partner-led environmental education programming and the development of more interpretive materials should increase public awareness of the refuge.

We expect increased public awareness of the presence of a refuge in the Plymouth region, about the importance of natural resources, human impacts on wildlife, and refuge policies.

Adverse Impacts

Refuge Access and Public Uses — Continued closure to public access of ecologically sensitive areas such as refuge pond shoreline nesting sites of the northern red-bellied cooter does limit public accessibility to pond shorelines. Even with the presence of wildlife observation and photography, environmental education and interpretation, and hunting, refuge staff would continue to limit activities that may impact the cooter. Onsite and offsite programs require expenditures and committing resources that could be available for other refuge programs. Additional authorized access to the refuge and its resources may also draw increased unauthorized use. It is unknown to what extent unauthorized use would occur with improved outreach efforts.

Effects on Refuge Archaeological, Historical, or Cultural Resources

We evaluated the alternative management actions that have the potential to protect or damage archaeological, historic, or other cultural resources located on the refuge, including:

- Using of prescribed burning for habitat management.
- Using mechanized equipment and power tools including tree-cutting, tree-girdling, mowing for habitat management.
- Invasive species management.
- Refuge public use activities including environmental education, and interpretation, a public use trail connection, and opening most of the Crooked Pond parcel seasonally to deer and turkey hunting.
- Wildland fire suppression policies and methods.
- Limited outreach, interpretation, and law enforcement on and off the refuge.
- Offering onsite environmental education and interpretation hosted by refuge staff or by refuge partners under a SUP.

Archaeological, Historical, or Cultural Impacts Common to Both Alternatives.

In protecting cultural and historical resources we are guided by specific Executive Orders, policies, laws, regulations, standards, and guidelines. Chapter 2, Refuge Archaeological, Historical, and Cultural Resources, described in more detail the refuge's resources. We will comply with all appropriate legal mandates to protect and manage refuge cultural resources. Any management actions with the potential to affect cultural resources require refuge manager review, as well as review by the Service's Regional Historic Preservation Officer, in consultation with the Commonwealth of Massachusetts SHPO and THPO as appropriate. Determining if particular actions within an alternative have the potential to affect cultural resources is an ongoing, well-established, and closely regulated process that will continue during the planning stages of any proposed projects under either alternative.

It is probable that unrecorded archaeological or cultural sites exist on current refuge lands. Many of these are likely to include Native American artifacts. The likelihood of locating other prehistoric or historic sites on the refuge is also high given the human settlement and land use history in the refuge vicinity. Regardless of alternative, the Service is responsible for managing and protecting archaeological and historic sites found on national wildlife refuges.

Archaeological, Historical, or Cultural Impacts of Alternative A

Minimal beneficial or adverse impacts to any archaeological, historical, or national resources are expected given precautions taken to protect any cultural, historical, or archaeological resources. The refuge will remain largely closed to public use. Northern red-bellied cooter management actions along the shoreline of Crooked Pond will be limited. Thinning and prescribed burning will be limited to 25 percent (or 50 acres) of the refuge within the northeastern corner of the Crooked Pond parcel. The limited law enforcement staff is not expected to prevent or detect many violations resulting from unauthorized public uses.

Archaeological, Historical, or Cultural Impacts of Alternative B

Beneficial Impact

Habitat Management and Hazardous Fuel Loading Reduction—There may be an increased opportunity to discover and protect sites and artifacts and further evaluate the cultural significance of the discovery site during project planning or implementation.

Refuge Access and Public Uses—There would be little or no beneficial impact to cultural resources from public use under this alternative. The slight increase in emphasis on environmental education and interpretation on and off the refuge would focus on the biological resources of the refuge as well as the Refuge System with little emphasis on cultural resources planned in the near-term in the absence of new cultural site/artifact discoveries.

Adverse

Habitat Management and Hazardous Fuel Loading Reduction—Minimal impact to cultural resources on the refuge from disturbance related to habitat management is expected. Although mechanical thinning and prescribed burning would potentially increase across the refuge under a HMP, the Service makes every effort to minimize new soil disturbance, identify and protect any sites or artifacts beforehand, or discovered during habitat management. Disturbance can occur through disturbing the top layer of soil that may serve as a protective layer for undiscovered artifacts. These areas would be limited to those small, localized areas disturbed through fire break creation, thinning and tree removal, or invasive species removal.

Refuge Access and Public Uses—A slight increase for potential disturbance to as yet undiscovered artifacts could result from a general increase in visitation. Hunting does not typically result in soil disturbance that might unearth buried artifacts. However, all visitation (except for hunting) would only occur when guided by refuge staff or partners. The likelihood of any destructive impacts from increased refuge public use will be minimal.

Effects on Refuge Socioeconomic Resources

We evaluated the alternative management actions that have the potential to contribute to or adversely impact the local and regional economies and quality of life, including:

- Refuge revenue sharing (in-lieu of tax revenue) to the town of Plymouth.
- Refuge visitor expenditures in the local economy.
- Refuge staff and work-related expenditures in the local economy.

Socioeconomic Impacts Common to Both Alternatives

Property ownership by the Federal Government effectively removes the property from the local, town of Plymouth tax base. Under both alternatives, the Service would continue somewhat offsetting tax revenue losses by making annual “revenue sharing” payments to the town in lieu of taxes, as provided by Congress. Under Refuge Revenue Sharing Act (16 U.S.C. 715s, as amended) local towns receive an annual payment for lands that have been purchased in full (fee simple acquisition) by the Service. In Massachusetts, payments are based on three-quarters of one percent (0.0075) of the appraised market value. In 2014, the payment to the town of Plymouth was $4,811 (see chapter 2 Revenue Sharing Payments). No major changes in the level of revenue sharing payments are expected unless Congress changes its annual revenue sharing appropriation.

The Congressional appropriation in recent years has tended to be less than the amount required to fully fund the authorized level of payments. Recent payments to local governments across many refuges have not equaled losses in tax revenue, but we expect these annual $4,000-$5,000 payments have negligible effect on the $32.89 million (2015) town of Plymouth annual operating budget. Some literature indicates that market values of homes adjacent to protected open space are frequently higher than properties elsewhere (Trust for Public Lands 2007). An increase in home values also increases property taxes for those homes and this increase in property values then leads to higher tax revenues. In addition, people may be more likely to move to an area that values the protection of natural resources for both wildlife and public enjoyment (Trust for Public Lands 2007).

Socioeconomic Effects of Alternative A (Current Management)

Beneficial Impacts

Refuge Access and Public Uses and Refuge Administration—The refuge will remain largely closed to the public. No additional beneficial impacts to the socioeconomic resources from visitors and staff expenditures are anticipated.

Refuge Administration—No staff are stationed permanently at the refuge. Refuge Complex biological and law enforcement staff conduct site visits frequently. The slight (not significant) benefit to the local economy from small purchases of goods and services in the local area during staff visits should remain little changed under alternative A.

Adverse Impacts

None.

Socioeconomic Effects of Alternative B (Service-preferred Alternative)

Beneficial Impacts

Refuge Access and Public Uses—Research has shown that by offering places where visitors can enjoy watching birds and other wildlife local economies benefit from increased sales at local businesses for food, lodging, fuel, and supplies, and associated tax revenues (USFWS 2006). Improved visitor access to the Crooked Pond parcel for interpretation, environmental education, wildlife observation and photography, and deer and turkey hunting will result. New interpretive and environmental education programs would include a more coordinated environmental education program with partners, occasional interpretive programs, and more interpretive materials. A slight increase in refuge visitation is expected, resulting in a corresponding slight increase in expenditures in the local community by refuge visitors. New net increases in expenditures by refuge visitors captured by the local economy will not be significant, since many of these new refuge visitors are expected to be local residents or already visiting MSSF.

Cumulative Effects

According to CEQ regulations on implementing the NEPA, a cumulative impact is an impact on the environment that results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions, regardless of what agency (Federal or non-Federal) or person undertakes the other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over time, including the actions of other agencies or organizations, if they are interrelated and influence the same environment. Potential cumulative impacts for the two alternatives described below considers the interaction of activities at the refuge with other actions occurring over a larger spatial and temporal frame of reference.

Under alternative B, refuge staff will increase participation with the North Atlantic LCC partners to identify focal areas for landscape conservation design, with land protection through a partnership effort likely to include Massasoit NWR, and the adjoining MSSF, and Mashpee Refuge. Because the geographic scope of this collaborative process greatly exceeds the boundaries of Massasoit NWR, and implementation of specific land protection measures remain several years off, analysis of the impacts from this future landscape scale plan are considered beyond the scope of this analysis and plan. Results from this landscape scale conservation design initiative will however inform future Massasoit NWR CCP revisions, refuge stepdown plans and related NEPA analysis, and other Service and conservation partner land protection and stewardship initiatives.

Air Quality

Although some areas in Massachusetts periodically experience high ozone levels, the location of the refuge ensures relatively good air quality. Neither of the proposed alternatives is expected to have significant cumulative adverse impacts on air quality in the Plymouth area or elsewhere in the region. Some short-term, local impact on air quality is expected from prescribed burns and from refuge visitors' automobile emissions. However, prescribed burns would only occur under FMP stipulations (see appendix D) specifically designed to minimize air quality impacts. We expect none of the activities on the refuge to contribute to any measurable incremental increase in ground ozone levels or other air quality parameters, by the air quality monitoring network.

Although the refuge would continue to use prescribed fires to manage pitch pine-oak shrubland, woodland, or forest habitats we anticipate that air quality impacts associated with those actions would be temporary and localized. The cumulative impacts of prescribed burning throughout a region may be short term and moderate (Zeng et al. 2008); the temporary and periodic nature of the proposed fire regime on Massasoit minimizes any contribution to potential cumulative effects in the region.

Prescribed fire smoke can combine with multiple other emission sources to create "regional haze" capable of transport over long distances before impairing visibility within federally designated mandatory Class 1 areas such as national parks, monuments, or units of the NWPS. For example, Massachusetts has been cited for impairing visibility in the Class 1 airshed over Acadia National Park in Maine (D. Walker 2013 personal communication). With no more than 50 acres of prescribed burning in on any single day or in any one year under either alternative, Massasoit NWR prescribed burning will not contribute significantly to regional haze over the planning period. Regional Haze Regulations are in place to address Class 1 area visibility impairment, and both alternatives will fully comply with these regulations.

Similarly, occasional herbicidal applications to refuge habitats will for the most part be applied using backpack sprayers and are very target specific. This means of application is not anticipated to have any impacts to air quality.

We expect neither alternative to contribute to significant adverse cumulative air quality impacts locally or regionally. Along with our partners, both alternatives will continue to contribute to improving air quality through cooperative land conservation and management of natural vegetated habitats.

Any increased landscape level, partnership-based conservation efforts by the Service would help maintain regional air quality by potentially preventing residential, agricultural, or commercial development. These kinds of developments can potentially increase ground level ozone, and other pollutants from buildings, automobiles, agriculture practices such as pesticide and fertilizer use, and industrial practices and regional haze episodes. Conservation and ecosystem restoration measures through management agreements with private, other public, and non-governmental (non-profit) landowners provide means for contributing to reduced emissions compared to those occurring if the landscape were to become more developed.

Water Quality

Changes in climate and local weather patterns will likely affect aquatic systems by exacerbating or accelerating habitat degradation due to other identified threats (MassWildlife 2015). Warmer temperatures will warm surface and groundwater entering coastal plain ponds faster than normal, creating conditions favoring invasive species, and longer growing seasons for harmful algal blooms (MassWildlife 2015). Additionally, increases in severe rain and snowfall events will increase runoff of pollutants from agricultural and urban areas into waterbodies. Recent research indicates that the last two decades have been the wettest years in the Northeast in 500 years (Pederson et al. 2013, Newby et al. 2014, Weider and Boutt 2010). Increases in rain will also increase atmospheric deposition of pollutants, including nitrogen deposition. The Sustainable Water Management Initiative, administered by the MADEP, with input from multiple state agencies, is supporting research by the USGS into the hydrological alterations induced by water supply withdrawals and climate change (MassWildlife 2015).

There would be no significant adverse cumulative effects to water quality under either alternative. We would continue using best management practices and measures to control erosion sediments in habitat management and any other ground-disturbing operations to ensure impacts are minimal. Because visitation would be minimal and new public use is directed away from surface waters, there no additional cumulative impacts to water quality through authorized refuge public use are expected under either alternative.

Any additional landscape level conservation potentially provides added water quality benefits for any ponds or waterways that are near but lie beyond the refuge boundaries. Landscape level design and land protection projects would prevent further degradation of refuge pond water quality ongoing off-refuge public use, cranberry or other agricultural production, or future commercial or residential development.

Any potential negative impact from invasive species management near water bodies, prescribed burning or mechanical thinning would also be very limited and localized under either alternative.

Soils

The greatest potential adverse impacts on refuge soils occur from prescribed burns and invasive plant control. Continued best management practices use for fostering forested-shrubland habitats, prescribed burning, trail maintenance, turtle nesting habitat improvement or when selecting various chemical, biological, or mechanical methods avoids significant adverse cumulative impacts on area soils. Under alternative B, removal of invasive plant species as needed and restoration of native plant communities will improve soil nutrient recycling, restore native soil biota, and restore soil fertility. We expect neither alternative to have a significant cumulative adverse impact on the soils within the refuge or the surrounding region.

Any future landscape conservation projects or management agreements with landowners would benefit soils by preventing other detrimental uses as stated above under the impacts to water quality sections.

Natural Community Types and Vegetation

As previously discussed in chapters 2 and 3, a number of potential impacts to refuge coastal pond water quality, hydrology and to habitat and vegetation structure from land uses that are external to the refuge are possible. Shrub and tree encroachment may threaten pond shorelines in areas with excessive groundwater withdrawal. Seasonally high water levels may prevent tree and shrub encroachment, while seasonal low water is necessary to expose the pond shorelines for plant rare germination and growth. Excessive drawdown from pumping for water consumption or cranberry bog irrigation may reduce natural fluctuations and allows woody species to advance down the shores. Use of coastal plain ponds as recipients of irrigation runoff from cranberry bogs can introduces nutrients and pesticides into the water, altering which species can survive, and encourage excessive growth of algae and vascular plants. Changes in climate and local weather patterns will likely affect aquatic systems by exacerbating or accelerating habitat degradation due to other identified threats (MassWildlife 2015) as previously discussed.

We expect neither alternative will have significant adverse cumulative impacts on the vegetation within the refuge. Prescribed burning would beneficially impact the fire-dependent natural community types and vegetation associations on the refuge and increase its resilience to climate change. Because pitch pine-scrub oak, pitch pine-oak woodland or forest, and sandplain heathland community habitat is unique and regionally important, efforts to restore the habitat through thinning and prescribed burning will contribute to landscape scale efforts to restore this habitat on a regional level. A majority of the refuge is surrounded by MSSF and any collaborative management efforts with MSSF are likely to benefit these important natural community and vegetation associations cumulatively. If increased landscape conservation efforts were to occur then the potential for managing and enhancing forested and shrubland habitat would occur over a much broader geographic scale than Massasoit NWR types.

Biological Resources

As previously discussed in chapters 2 and 3, and earlier in this chapter, sudden alterations to natural hydrologic regimes pose the greatest threats to coastal pond systems and the biological resources that depend upon them for habitat. Changes in climate and local weather patterns may exacerbate or accelerate habitat degradation due to other identified threats (MassWildlife 2015). Extended periods of drought with warmer water temperatures and lowered water levels may cause the loss of littoral habitat used for foraging, rearing, reproduction, and refuge by northern red-bellied cooters plus other species including mussel, odonate, fish, and invertebrates. Dragonfly and damselfly eggs and larvae may survive localized, short-term pond drawdowns for a time either in the stalks of vegetation (where many species lay their eggs) or in the mud of drying ponds. If all ponds in an area are drawn down too often, for too long or over too large an area, restocking by odonates, reptiles and amphibians is less likely.

Recent research indicates that the last two decades have been the wettest years in the Northeast in 500 years (Pederson et al. 2013, Newby et al. 2014, Weider and Boutt 2010). Seasonally high water levels may prevent the pond shoreline exposure for rare plant germination and growth. The nutrients and pesticides entering coastal ponds due through increased surface runoff and groundwater inflow events can alter which species can survive, and encourage excessive growth of algae and vascular plants.

Both alternatives considered in this CCP/EA maintain or improve refuge biological resources. The combination of our management actions with other partnering organizations such as MADCR, MassWildlife, and TNC through landscape scale conservation design efforts of the North Atlantic LCC could result in some, beneficial cumulative effects by:

- Increasing conservation and management of Federal and State-listed threatened and endangered species (i.e. northern red-bellied cooter, and candidate species New England cottontail) and other species of conservation concern including surrogate species.

- Increasing understanding of species and habitat relationships and limiting factors to conservation recovery.
- Using adaptive management and the best science available to manage and promote regionally important habitats and natural communities including the pitch pine-scrub oak shrubland association (sandplain heathland community) and coastal pond habitats.
- Preventing spread or reducing invasive species.

Additional monitoring and inventory information will facilitate decision-making with potentially wide-ranging, cumulative benefits for regional bird and wildlife populations. Collecting additional data about the northern red-bellied cooter on— and off-refuge, and monitoring the response to conservation and management actions of this and other wildlife and plant populations would help close existing knowledge gaps, thereby reducing uncertainty currently inherent is Service and partner stewardship decision-making. Sharing that knowledge among conservation partners would influence and improve natural resource decision-making across the entire region, with cumulative benefits on the biological environment over a broader landscape. In general, management actions would have a cumulative beneficial impact on the biological integrity, diversity, and environmental health of the pitch pine-scrub oak shrubland association (sandplain heathland community), and coastal pond community types in the region.

Native plant management, which includes restoring a more natural fire regime (historic range of variation), cumulatively benefits the biological environment by increasing and enhancing healthy soil biota, restoring and enhancing native plant resources, increasing resident wildlife populations of mammals, fish, reptiles, and amphibians, and enhancing invertebrate reproduction that sustains migratory birds, bats, reptiles and amphibians. Reducing invasive plants through management is not considered an adverse loss because these species are not components native biodiversity for the Massasoit NWR ecosystem.

Libby Herland/USFWS

Unauthorized trail behind homes at Massasoit National Wildlife Refuge

Refuge uses create local impacts individually, and as the number of uses increases over increasingly large areas have the potential create cumulative impacts on biota. Refuge uses are therefore limited to those which are formally determined to be compatible with the purposes for which the refuge was established and the National Wildlife Refuge System mission. No significant adverse cumulative impacts are expected under alternative B because the refuge would remain essentially closed to public use year-round except for staff or partner-led wildlife walks and educational activities and possibly hunting. We anticipate a low to moderate level of participation in hunting that could be offered if we proceed with developing a hunt program (which involves more analysis and public comment). There would also be no significant cumulative adverse effects to biological resources under either alternative because the changes in habitat components that we would manage for directly, or expect to realize through natural succession offset any harmful impacts incurred by human disturbance or trail use. When we review the Massasoit NWR compatibility determinations (at least every 10 to 15 years, see appendix B), we will consider new possible cumulative effects that may have accrued over intervening years, and will address them as necessary.

With increased Service involvement and support of offsite recovery efforts, the northern red-bellied cooter population has a greater chance for persistence and recovery under alternative B (Service-preferred alternative). Collaboration in research and landscape scale, strategic conservation design efforts increases the opportunity for increasing genetic variation within the cooter population by enhancing connectivity between occupied but currently isolated ponds that may be creating genetic bottlenecks due to inbreeding (USFWS 2007). Therefore, the increased off-refuge efforts for northern red-bellied cooter recovery that occur under alternative B would benefit the endangered northern red-bellied cooter population to a greater extent than current management (alternative A).

Only 10 percent of potential northern red-bellied cooter habitat is protected through permanent conservation. The remaining habitats are under private ownership. As much as 50 percent of the northern red-bellied cooter population occurs in Federal Pond, a single private pond owned by Federal Furnace Cranberry Company (USFWS 2007). Successful recovery of the northern red-bellied cooter requires the Service, the State, and other conservation organizations to engage more fully with private landowners to complete and implement landscape scale conservation design for northern red-bellied cooters. Alternative B affords more opportunities to work with private landowners such as the nearby cranberry growers, residents along the shorelines of refuge and off-refuge ponds, and other private and public landowners in the region interested in entering management agreements. Alternative B also allows for more law enforcement outreach with private landowners, further benefiting northern red-bellied cooter populations that may exist on private lands. In addition, increased research effort under alternative B will better inform refuge decisions on refuge-level management and protection impacting existing and potential northern red-bellied cooter populations both on and off the refuge.

Under alternative B (Service-preferred alternative), increased refuge staff participation in ongoing landscape scale partnership conservation design and land protection efforts will likely benefit shrubland dependent migratory birds, New England cottontail and other mammals (including some bats), some moth, butterfly, and other pine barren or shrubland specialist pollinators.

Climate Change

Our review of proposed actions in this CCP suggests that some activities may contribute negligibly, although incrementally, to stressors affecting regional climate change, specifically our prescribed burn program, the increased visitor access, and increased use of vehicles and equipment for refuge management. We discuss the direct and indirect impacts of these activities elsewhere in chapter 4, including measures to minimize the impacts of both. With respect to our equipment and facilities, we are trying to reduce our carbon footprint wherever possible and specifically on or surrounding the refuge by driving hybrid vehicles, along with reduced travel and other conservation measures.

Any increased landscape level, collaborative conservation efforts will help maintain regional air quality by potentially preventing residential, agricultural, or commercial development. These kinds of developments could potentially increase atmospheric carbon emissions from buildings, automobiles, agriculture, and industrial practices. The long-term growth of vegetation and interaction with the soils can sequester atmospheric carbon, thereby reducing atmospheric greenhouse gas concentrations. Conservation and ecosystem restoration measures through management agreements with private, other public, and non-governmental (non-profit) landowners provide means to increased carbon sequestration and curb atmospheric carbon emissions which would occur if the landscape is developed.

Climate change poses great challenges for migratory species management. National wildlife refuges have played a critical role in protecting migratory birds. Climate change is likely to impact habitats within refuges, underscoring the importance of climate change adaptation as part of refuge management. However, climate change is also likely to pose considerable risks to many migratory species throughout their ranges (Glick 2012). As Robinson et al. (2009) highlight, the life cycle of most migrants is tied to seasonal events such as availability of key food resources which may be altered under climate change. Under alternative B, we would monitor the impact of climate change on the refuge and detect impacts, especially on surrogate migratory birds.

Climate change may increase opportunities for invasive species to spread because of their greater adaptability to disturbance than some endemics. If this spread occurs, biological integrity and diversity on the refuge and potentially the entire surrounding landscape would decrease. Although a warming climate may assist the northern red-bellied cooter with warmer pond conditions, those benefits to cooters may be offset by invasive aquatic plants. Invasive species control, including extensive monitoring and control measures, is essential for avoiding larger impacts to biological diversity and integrity on the refuge and for recovery of the endangered cooter. A regional vulnerability assessment of the impacts of climate change on coastal ponds would provide information needed to benefit these habitats. Reducing invasive species would increase the resilience of habitats to climatic change.

Refuge managers will stay apprised of climate change and its specific local and regional effects on wildlife and their habitats, and use this information to adapt management techniques and strategies. Given the uncertainty regarding climate change and its impacts on the environment, traditional methods of management may become less effective in the future. An effective and well-planned monitoring program, coupled with an adaptive management approach, is essential in dealing with the uncertainty surrounding future climate change, and both are built into this CCP.

In our professional judgment, most of the management actions we propose would not exacerbate climate change in the region or project area, and in fact some might incrementally prevent or slow down local impacts. Proposed habitat management actions described in chapter 3 are intended to promote healthy, functioning forests and coastal pond habitats. We will implement an adaptive management approach as new information becomes available. We will control invasive plants, and pests, restore periodic fire to pitch pine-oak habitats, and develop and implement a detailed, stepdown Inventory and Monitoring Plan designed to test our assumptions and management effectiveness in light of on-going change and adjust future management accordingly.

Refuge Access and Public Uses

There would be no cumulative impact under alternative A from refuge access and public use because the refuge would remain largely closed. Under alternative B, public access and use of refuge lands is increased by guided wildlife-related walks and opening most of the Crooked Pond parcel for many or possibly all hunt seasons. There are other opportunities within the southeastern Massachusetts region, including the adjoining MSSF, that provide both wildlife-dependent and other recreational activities.

Refuge Archaeological, Historical, or Cultural Resources

No significant cumulative adverse impacts to archaeological, historical, and cultural resources are expected on the refuge under either alternative. Developing a cultural resource stepdown plan and overview will further alert refuge staff and the Service to the presence of any significant cultural resources on the refuge and contribute positively to both the knowledge base and protection of these resources.

Socioeconomic Environment

Neither alternative is expected to have a significant cumulative impact on the town or county economies. Neither alternative will alter demographic or economic characteristics of the local community. Neither will any actions proposed disproportionately affect any communities, or damage or undermine any businesses or community organizations. Implementing any of the alternatives would result in minor beneficial impacts on those communities nearest the refuge.

Under alternative B, increased refuge staff participation in additional landscape level conservation will potentially increase eco-tourism opportunities in the region. Additional lands protected through a regional landscape conservation design, may increase lands available for potential public use and potentially increase visitor expenditures captured by the local and regional economies. When private lands are protected for conservation purposes, there can be a loss of property tax revenues for the towns. Protection would likely occur through several methods including fee title, easements, management agreements, and collaborative efforts with other conservation organizations. Towns may consider taking land out of tax eligibility and into conservation status, a means of bypassing tax liability by property owners. This could potentially impact town budgets (Gattuso 2008).

Conventional wisdom among decision makers and taxpayers is that development is the “highest and best use” of vacant land for increasing tax revenues. The assumption is that larger tax revenues are likely to accrue for communities if they build out with homes rather than protect open space. But in most situations, this assumption proves incorrect. When open space is transformed into homes tax revenue does increase, but concurrently adds to the cost of providing services and infrastructure (i.e., streets, electric, water, and sewer lines, additional school or library services, and police and fire protection). Increased service and infrastructure costs typically exceed the tax revenues generated from residential development, a situation that may eventually lead to tax increases on residents (Crompton 2004). Increased conservation and open space protection can potentially alleviate the need for towns to provide increased public services and utilities, thereby offsetting any adverse impacts to town budgets. Revenue sharing payments would most likely continue at some level to also help to somewhat offset lost tax revenue. Crompton (2004) shows that the conservation of open space is an integral part of the health of local economies.

Landscape level land protection may also potentially adversely impact cranberry and other agricultural benefits to the local economy should land be removed from production (Gattuso 2008). The Service, through our conservation partners would attempt to work collaboratively with existing cranberry producers for habitat and species protection through management agreements before considering fee title purchase or other methods of acquisition.

Future landscape level conservation and acquisition in the region may cumulatively benefit the overall socioeconomic environment through a change in tax base for local communities, and/or shared revenues to offset tax revenue loss. Landscape level conservation may also attract more people to the region who prefer to visit or live near areas that are protected from development, thus providing a beneficial cumulative impact through an increase in tourism and residential growth near the protected areas.

Our working relationships with private landowners and others should improve in terms of responsiveness to inquiries and speed of joint projects under alternative B with increased staffing in key areas such as biology and law enforcement. The overall coordination and communication with the public should improve under alternative B.

More emphasis on education and outreach in alternative B should foster more understanding and appreciation of resource issues and needs, and could lead to increased political support and funding benefitting fish and wildlife resources on the refuge. The increased outreach of alternative B could also positively affect land use decisions outside the refuge by local governments and private landowners, and lead to increased fish and wildlife populations over a broader area. There would be minor benefits affiliated with revenue sharing payments and refuge spending under alternative B. Fully funding the additional staff in alternative B would also make a small, incremental contribution to employment and income in the local community.

Relationship between Short-term Uses of the Human Environment and Enhancement of Long-term Productivity

NEPA section 102(C) (iv) (CEQ regulations part 1502.16) requires Federal agencies to disclose the relationship between local short-term uses of the human environment and the maintenance and enhancement of long-term productivity. The Service expects that the proposed alternatives would lead to long-term productivity through the life of the CCP (15 years). This discussion focuses on the tradeoffs between short-term environmental costs and long-term environmental benefits.

Under both alternatives, our primary aim is to maintain or enhance the long-term productivity and sustainability of the natural resources on the refuge and in the surrounding landscape, including trust species such as the endangered northern red-bellied cooter, other species of conservation concern such as New England cottontail, and surrogate species including neotropical migratory song birds. Outreach and environmental education are included in alternative B to encourage visitors, nearby educators and school children, and the general public to be stewards of our environment and ensure they are informed about our unique natural resources. Encouraging people to support conservation efforts can ultimately lead to long-term environmental benefits. Our management actions, including controlling invasive plant species, managing for native pitch pine-scrub oak shrubland association (sandplain heathland community) vegetation, enhancing habitats for northern red-bellied cooter, New England cottontail and other surrogate species may have short-term insignificant adverse impacts, but would enhance long-term productivity of the refuge. Habitat management practices that mimic ecological and sustainable processes optimize the maintenance and enhancement of the biological diversity, integrity, and environmental health of those habitats for the long term.

Basking trap to catch northern red-bellied cooters

Jared Green

In summary, we predict that the alternatives would contribute positively toward maintaining and enhancing the long-term productivity of the refuge's natural resources, with sustainable beneficial cumulative and long-term benefits to the environment surrounding the refuge and minimal inconvenience or loss of opportunity for the American public

Unavoidable Adverse Effects

Unavoidable adverse effects are those actions that could cause significant harm to the human environment and that cannot be avoided, even with mitigation measures. There would be some minor, localized unavoidable adverse effects under alternative B. For example, installing signs or re-routing a section of trail has negligible adverse effects which are more than offset by the benefits of protecting resources and educating the public about the sensitivity of the refuge ecosystems. Public land ownership p entails an unavoidable impact on local governments due to the loss of property tax revenues. This loss is partially offset by refuge revenue sharing payments and the benefits of increased conservation to public health and wellbeing, and potential economic growth through the attraction to areas surrounded by conservation lands. None of the unavoidable adverse effects rise to the level of significance, and all would be mitigated so there would be no significant unavoidable adverse impacts under any of the alternatives.

Potential Irreversible and Irretrievable Commitments of Resources

NEPA section 102(C) (v) (CEQ regulations part 1502.16) requires Federal agencies to consider any irreversible and irretrievable commitment of resources that would be involved in the proposed action. Irreversible commitments of resources are those that cannot be reversed, except perhaps in the extreme long term or under unpredictable circumstances. An example of an irreversible commitment is an action that contributes to a species' extinction—once extinct, it can never be replaced. No irreversible commitments of resources are expected as a result of management activities on Massasoit NWR.

In comparison, irretrievable commitments of resources are those which can be reversed, given sufficient time and resources, but represent a loss in production or use for a period of time. We could consider the construction of kiosks and educational signs built in collaboration with partners as an irretrievable commitment of resources. However, we can dismantle those interpretive resources and restore the sites if resource damage is occurring. Similarly, prescribed burning and thinning to open forest canopies and encourage shrub understory are irretrievable resource commitments. However, we can discontinue those habitat treatments and allow natural forest succession to resume again at any point, and after several decades without such treatments most areas will return to conditions similar to those present today.

Environmental Justice

EO 12898 "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations" (February 11, 1994), requires that Federal Agencies consider as part of their action, any disproportionately high and adverse human health or environmental effects to minority and low income populations. Agencies are required to ensure that these potential effects are identified and addressed.

The USEPA defines environmental justice as, "the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies." In this context, fair treatment means that no group of people should bear a disproportionate share of negative environmental consequences resulting from the action.

Overall, we expect none of the alternatives to place disproportionately higher adverse environmental, economic, social, or health effects on minority or low-income persons or specific groups of people defined above. Wildlife observation, photography, environmental education, and interpretation are open to all who are willing to adhere to the established refuge rules and regulations or special use permit stipulations. Refuge deer and turkey hunting would be available equally to all individuals properly licensed to hunt in Massachusetts and that abide by all state hunting regulations and possessing required hunting permits.

None of the socioeconomic and environmental impacts we have identified would be localized or focused primarily or unequally on minority and low-income communities or individuals residing near the refuge. The local town and county would experience only very minor adverse effects along with some beneficial effects if the refuge is managed under either proposed alternative. Adverse impacts, such as minor increases in traffic and related emissions due to limited increased visitation at the refuge, would not disproportionately affect minority and low-income populations compared to other segments of the general population. The same is true of any negligible mobile-source air emissions from the operation of refuge equipment and vehicles. Beneficial impacts include maintaining natural vegetation that improves air and water quality, and; enhanced and free public use of the refuge.

We expect neither alternative to alter the demographic or economic characteristics of the local community. The actions we propose would neither disproportionately affect any communities nor damage or undermine any businesses or community organizations. Both alternatives maintain the existing forested landscape. Consequently, no significant adverse impacts would be expected including changes in the community character or demographic composition.

Summary of Environmental Consequences by Alternative

Table 4-1 below compares and contrasts the expected environmental consequences evaluated in detail in chapter 4, of the management actions proposed for each two management alternatives detailed in Chapter 3 of this draft CCP/EA.

Table 4-1. Summary Matrix of Environmental Consequences by Alternative.

Massasoit Refuge Resource	Type of Impact	Alternative A Current Management	Alternative B Expanded Management (Service-preferred Alternative)
Air Quality	**Common to Both Alternatives**	There will be minor air quality benefits from the pollutant filtering effects of maintaining 209 acres of upland and wetlands vegetation and coastal ponds. Trees (vegetation) filter some air pollutants and reduce the concentration of ambient ozone, SO_2, NO_2, CO, and fine particulate matter (PM10 and PM2.5), primarily through direct uptake and adhesion to stems and leaves. Potential air quality impacts from prescribed fire on human health and public welfare range from occupational exposure to smoke for firefighters to public health, soiling of materials (economic losses), public nuisance, and highway safety impacts from reduced visibility. The major pollutant of concern is fine particulates, both PM10 (fine: 10 micrometers or less) and PM2.5 (very fine: 2.5 micrometers or less) particles. Particulates can reduce visibility or cause negative health effects for people with respiratory or cardiovascular illnesses. Several population subgroups are more sensitive to fine particulates include asthmatics, children, the elderly, and individuals with cardiopulmonary disease. While CO overexposure causes serious health problems and can prove fatal, CO is diluted and disperses rapidly as it mixes with ambient air downrange from the combustion source. As such, CO emissions are primarily an occupational health concern for prescribed burn personnel, not for the general public. Although long-term health effects from occupational smoke exposure remain unknown, evidence suggests that brief, intense smoke exposures can exceed short-term exposure limits in peak situations, such as for firefighters holding firelines downwind of an active prescribed burn. Smoke exposure is a hazard for only short periods, is predictable, and therefore manageable. Fireline practices such as crew rotation, awareness training, and carbon monoxide monitoring can mitigate the hazard, allowing firefighters to focus on fire containment by lessening the distraction, discomfort, and health impacts of smoke exposure. When very fine (PM2.5) smoke particles infiltrate indoor environments, soiling of fabrics, painted interior walls, and works of art may occur. Individuals within 1 mile of prescribed burn operations on Massasoit NWR may experience the irritating effects of acrolein or formaldehyde with unexpected wind direction shifts. Perhaps the greatest nuisance effect of prescribed fire smoke is local, temporary visibility reduction in areas impacted by the dispersing smoke plume. Visitor enjoyment and satisfaction in the vicinity of the refuge may be diminished by reduced visibility. The potential exists for limited smoke intrusions onto the public roads from refuge prescribed fires. Burning during the summer "ozone" season has potential to cause greater impact to air quality when hot (e.g. above 90 °F), stagnant atmospheric episodes (and State issued air quality alerts) are more common. Ground-level ozone, a criteria NAAQS pollutant, has had past violations in eastern Massachusetts. Emissions from burning wildland fuels (especially NOx) subjected to sunlight and warm temperatures, mixing with the regional atmosphere, as well as nitrate and indirectly sulfate aerosols, contribute to ozone formation. Fire behavior guides Service and fire team smoke and emissions management efforts to minimize air quality impacts. Fire and fuels manipulation techniques are chosen that complement meteorological scheduling for maximum smoke dispersion and favorable plume transport. Burn plans specify no burning when poor atmospheric mixing conditions are forecast. The refuge obtains an annual air quality permit from the MADEP, and a burn day authorization from the Plymouth Fire Department, and conducts burning in accordance with those authorizations. We avoid burning when air quality alerts are forecast or issued for the region, and are unlikely to be granted a burn permit anyway. If conducted on warm summer days, there is a very low chance refuge prescribed burn emissions may contribute to down range ground level ozone formation if actual atmospheric and weather conditions depart from those forecasted. Under worst case scenarios prescribed burning efforts on Massasoit NWR over a 15 year period are not expected to adversely affect the region's air quality index given anticipated dispersion, atmospheric mixing, seasonal timing, and frequency of prescribed burning under either alternative. No more than 50 refuge acres will be prescribed burned on any given day or in any one year under either alternative. We expect prescribed burning at the refuge to produce no significant long-term adverse air quality impacts. Neither management alternative would adversely affect regional air quality, including regional haze over the long term. Neither alternative would violate NAAQS for criteria air pollutants; both would comply with the CAA.	

Massasoit Refuge Resource	Type of Impact	Alternative A Current Management	Alternative B Expanded Management (Service-preferred Alternative)
Air Quality (cont.)	**Beneficial**	Applying low to moderate intensity prescribed fire every 5 to 7 years on approximately 50 acres of the Crooked Pond parcel to reduce the excess buildup of woody debris (hazard fuels) in the understory on the refuge will decrease the long-term likelihood of large emission episodes, from large uncontrolled, high intensity wildfires.	Applying low to moderate intensity prescribed fire every 5 to 7 years on up to 200 refuge acres for both habitat management and to reduce the excess buildup of woody debris (hazard fuels) in the understory will further decrease the long-term likelihood of large emission episodes, from large uncontrolled, high intensity wildfires.
	Adverse	Prescribed burning on 50 acres over the entire refuge will be performed on a (5 to 7 years) rotational basis, with no more than 50 acres burned on any given day or in any one year. There may be some localized (generally downwind from burns, and within 10 miles or less), short duration (minutes to hours) decrease in air quality or brief, localized visibility impairment from fine particulates. Carbon monoxide, carbon dioxide, hydrocarbon, and small nitrogen oxide releases are expected. However, low intensity prescribed burning, releases inconsequential amounts of these gases. The fire team's knowledge of fire behavior and smoke management helps minimize air quality impacts and human exposure to smoke. Additional steps taken to reduce emissions include reducing fuel through mechanical means prior to burning, and keeping burn units small. Emissions (hydrocarbons) released from heavy equipment and power tools during initial firebreak and fuelbreak establishment and periodic maintenance are expected infrequently for brief periods, but are not expected to significantly impact local or regional air quality. The refuge will remain closed to the public; therefore no additional transportation-related emissions generated by refuge visitors are anticipated. A small amount of hydrocarbon emissions result from refuge activities, mostly vehicle transportation to and from the refuge, especially during the spring, summer, and fall when trips may occur weekly. Adverse air quality impacts would be very limited and temporary. The vehicle fleet at the refuge headquarters is becoming cleaner as older vehicles are replaced by low (hydrocarbon) emission hybrid vehicles. Refuge vehicle-related hydrocarbon emissions may actually decrease slightly from current levels, over the 15 year plan period.	Invasive plant treatments would incorporate mechanical, chemical, or biological control as necessary. Impacts to air quality would be localized and short-lived. Mechanical removal of invasive species would likely inject some dust and soil particles into the air, for short periods. Chemical application in accordance with labeling and approved Pesticide Use Proposals would likely involve backpack sprayers to obtain optimal target specificity. There is still some potential to impact a wider area than is targeted through spray drift to non-target sites. By not treating on windy days, and through careful calibration of spray nozzles to achieve the correct droplet size and application rate, spray drift is effectively minimized. We anticipate insignificant short-term, localized impacts to air quality from treating invasive plants. Prescribed burning on up to 200 acres over the entire refuge will be performed on a (5 to 7 years) rotational basis, with no more than 50 acres burned on any given day or in any one year. Total prescribed burn impacts to air quality over the planning period from prescribed burns may as much as four times greater than alternative A. There may be some localized (generally downwind from burns, and within 10 miles or less), short duration (minutes to hours) decrease in air quality or brief, localized visibility impairment from fine particulates. Carbon monoxide, carbon dioxide, hydrocarbon, and small nitrogen oxide releases are expected. However, low intensity prescribed burning, releases inconsequential amounts of these gases. The fire team's knowledge of fire behavior and smoke management helps minimize air quality impacts and human exposure to smoke. Additional steps taken to reduce emissions include reducing fuel through mechanical means prior to burning, and keeping burn units small. Although up to 4 times greater over the plan period than under alternative A, alternative B air quality impacts are not expected to be significant due to burn and smoke management measures, and public notification and outreach procedures the Service already has in place and is already implementing.

Massasoit Refuge Resource	Type of Impact	Alternative A Current Management	Alternative B Expanded Management (Service-preferred Alternative)
Air Quality (cont.)			Emissions (hydrocarbons) released from heavy equipment and power tools during initial firebreak and fuelbreak establishment and periodic maintenance are expected infrequently for brief periods, but are not expected to significantly impact local or regional air quality. New refuge visitors under alternative B are not expected to generate significant increases in transportation-related (hydrocarbon) emissions to adversely impact air quality. Increased hydrocarbon emissions from expanding refuge activities and staff site visits to provide enforcement and habitat management are expected. The vehicle fleet at the refuge headquarters is becoming cleaner as older vehicles are replaced by low (hydrocarbon) emission hybrid vehicles, offsetting hydrocarbon emissions from the increased refuge staff vehicle use. It is anticipated that the alternative B impacts on air quality would remain insignificant over the 15 year plan period.
Water Quality	**Common to Both Alternatives**	Local water quality benefits from the pollutant buffering and filtering effects of maintaining essentially continuous upland and wetlands vegetation across the 209-acre refuge landscape are expected. Trees (vegetation) filter some air pollutants that can enter ponds by atmospheric deposition. Vegetation, surface litter, and duff also slow, intercept, and filter out some pollutants from surface runoff before it can reach downslope waterbodies, or rainfall and runoff as it infiltrates the soil before it moves into the groundwater aquifer. Any drawdown or pollution to the groundwater in the Plymouth area close to the refuge would more likely have a greater impact to Crooked Pond water levels and water quality than refuge management activities. Some year-round and summer homes on refuge ponds can potentially adversely impact surface water and groundwater quality, from septic systems, landscaping activities, swimming, or boating. The Service has no direct authority over the use of ponds by residents who own shoreline and/or land abutting Gunners Exchange, Hoyt, and Island Pond or outside refuge boundaries. Under both alternatives, a network of constructed firelines (1.11 miles), shaded fuelbreaks (2.49 miles), and existing roadbeds (1.57 miles) will be maintained to facilitate wildland fire suppression and prescribed burning. Machinery will be used to mow or masticate understory vegetation every 5 to 7 years on approximately 13.6 acres (6.5 percent) of the refuge to keep the network passable for fire equipment and personnel. Litter and duff layers remain largely undisturbed and intact. Slight increases in surface runoff are expected from this fuel and firebreak network for one to two growing seasons following treatment. Protective litter and duff layers will largely prevent post treatment soil erosion and downslope sediment transport in runoff into refuge waterbodies. Refuge firelines (2.68 miles) typically have a 1.5-foot strip from which the protective litter and sometimes the duff layer are removed using leaf blowers and rakes, potentially exposing mineral soil in order to slow or halt the spread of a fire through surface fuels on up to 0.49 acres (worst case estimate). Between fires, firelines are normally allowed to accumulate leaf litter each fall. Because the protective litter layer is removed periodically, potentially exposing mineral soil, some soil erosion from these firelines could be transported downslope in surface runoff into refuge ponds from soil exposure until the next autumn "leaf-drop" (6 to 12 months). Prescribed burns proposed in both alternatives are more frequent, smaller, less intense, and consume less vegetation, litter, and duff (fuel) than past large, high intensity wildfires. Prescribed burning water quality impacts will be less than those from past, higher intensity wildfires. Decreasing the likelihood of large high intensity wildfires through hazard fuel reduction under both alternatives also reduces the long-term likelihood of large overland pollutant transport episodes to refuge ponds. Neither management alternative will contribute to water quality degradation. Neither management alternative will violate Federal or State water pollution control regulations, and both will comply with the Clean Water Act.	

Massasoit Refuge Resource	Type of Impact	Alternative A Current Management	Alternative B Expanded Management (Service-preferred Alternative)
Water Quality (cont.)	**Beneficial**	With little to no authorized public use, the generally good refuge water quality is likely to be protected.	Refuge staff would monitor for invasive aquatic plants within Crooked Pond and address any identified concerns. If aquatic invasive plants become a concern, the Service would act in accordance with the IPMP, in collaboration with refuge partners and neighbors, to remove or control such species, protecting water quality and restoring the natural ecosystem function for the long-term.
	Adverse	Mechanical clearing of brush, trees, and other vegetation to create canopy openings and improve northern red-bellied cooter nesting sites near Crooked Pond totals ¼ acre. Temporary disturbance of the sandy shoreline vegetation and soil in close proximity to the ponds could result in some small-scale instances of erosion, and small quantities of soil sediment entering Crooked Pond. Vegetation closest to the shoreline is not disturbed, and root systems of shrubs on the pond shoreline are kept intact to help hold exposed soil in place. This minimizes or completely prevents sediment runoff from entering the pond, so any impacts are very localized, temporary, and therefore not significant. Prescribed burning efforts are limited to current levels (50 acres) on the Crooked Pond parcel. Prescribed burning of two burn units will be performed on a (5 to 7 years) rotational basis, with no more than 50 acres (23.9 percent of the refuge) burned on any given day or in any one year. These two burn perimeters combined require 0.99 miles, 0.50 miles, and 0.45 miles respectively of the refuge fireline, existing roadbed, and 100-foot wide shaded fuelbreak network. This network requires (worst case estimate) up to 0.27 acres of potentially exposed mineral soil for firelines, and mechanical understory vegetation cutting on 7.68 acres for shaded fuelbreaks and access roads. In the intervals between fires, firelines are normally allowed to accumulate leaf litter each fall. Because the protective litter layer is removed periodically, potentially exposing mineral soil, some soil erosion is possible from these firelines that could be transported downslope in surface runoff into refuge ponds from soil exposure until the next autumn "leaf-drop" (6 to 12 months). Protective vegetative and litter cover typically recovers within one growing season following mechanical cutting of shaded fuel breaks, or prescribed burning.	Using herbicides or mechanical methods to control invasive plants could incur some short-term and localized risk to water quality. Before any chemical is applied to refuge lands, Service policy and required project review ensures that water quality risk is evaluated and minimized. All products are used according to label instructions to minimize impacts on ground and surface waters. Only those herbicides specifically labeled for aquatic application are used on or near refuge waters. When used appropriately, these products pose negligible directly or indirectly impacts on water quality. Very often, herbicides are not needed. But when required for effective control, the Service selects the herbicide application that is most effective for the target species and least harmful to non-target organisms. Risk reducing measures include choosing optimal times of year to apply herbicides, reducing spray drift, and applying the minimum amounts needed to effectively control the target species. If chemical application is deemed necessary, it would likely be applied using backpack sprayers to obtain optimal target specificity from the close range of application. Mechanical clearing of brush, trees, and other vegetation to create canopy openings and improve northern red-bellied cooter nesting sites near Crooked Pond, Hoyt Pond, and Island Pond totals 1 acre. Temporary disturbance of the sandy shoreline and soil in close proximity to the ponds could result in some small scale instances of erosion, and small quantities of soil sediment entering the ponds. Vegetation closest to the shoreline is not disturbed, and root systems of shrubs on the pond shoreline are kept intact to help hold exposed soil in place. This minimizes or completely prevents sediment runoff from entering the pond, so any impacts are very localized, temporary, and therefore not significant.

Massasoit Refuge Resource	Type of Impact	Alternative A Current Management	Alternative B Expanded Management (Service-preferred Alternative)
Water Quality (cont.)	**Adverse (cont.)**	Due to the dense post-burn vegetative cover, intact duff and litter layers, and gentle slopes of the treated burn units, no concerns with sediment-laden runoff from prescribed burn units into local water bodies are expected. The refuge remains closed to public uses. Therefore any impacts to water quality from public use will be from unauthorized, illegal activities such as littering of pond shorelines by trespassers, oil or gas leaks from illegal ORVs near the pond edges, horseback riding, or pollution from swimming or boating.	Prescribed burning efforts would expand to most refuge upland acres (up to 200 acres) HMP and spatial FMP completion. Prescribed burning of 10 to 20 individual burn units will be performed on a (5 to 7 years) rotational basis, with no more than 50 acres (23.9 percent of the refuge) burned on any given day or in any one year. These burn perimeters combined require up to 1.11 miles, 1.57 miles, 0.57 miles, and 1.92 miles respectively of the fireline, existing roadbed, 100 foot wide and 12 foot wide shaded fuelbreak network, with only a portion (20 to 50 percent) needed in any single year in the absence of a large wildlife. This network requires (worst case estimate) up to 0.49 acres of potentially exposed mineral soil for firelines, and mechanical understory vegetation cutting on 13.6 acres for shaded fuelbreaks and access roads. In the intervals between fires, mineral soil firelines are normally allowed to accumulate leaf litter each fall. Because the protective litter layer is removed periodically to expose mineral soil, some soil erosion from these constructed firelines that could be transported by surface runoff into downslope waterbodies is possible from soil exposure until the next autumn "leaf-drop" (6 to 12 months). Protective vegetative and litter cover typically recovers within 1 growing season following mechanical cutting of shaded fuel breaks, or prescribed burning. Due to the dense post-burn vegetative cover, intact duff and litter layers, and gentle slopes of the treated burn units, no concerns with sediment-laden runoff from prescribed burn units into local water bodies are expected. There is a low to moderate risk that nutrients released during prescribed burning may be transported overland into ponds and waterways downslope. However, this would be buffered by the duff and litter layer remaining following the prescribed burn. Visitors would be able to access the Crooked Pond parcel only when accompanied by staff or partners working under an SUP, and most of the Crooked Pond parcel could be opened seasonally for hunting. Potential water quality impacts from refuge public use are limited. New refuge visitors under alternative B are not expected to significantly impact existing water quality, with their water quality impacts similar to those they are having on the adjoining MSSF. The limited environmental education and interpretation hosted by the Service or our partners will have no detectable impact to the water quality because access to the ponds, especially Crooked Pond, would remain restricted. Greater enforcement and increased public outreach, should reduce water quality impacts from illegal, unauthorized uses, more than alternative A.

Massasoit Refuge Resource	Type of Impact	Alternative A Current Management	Alternative B Expanded Management (Service-preferred Alternative)
Soils	**Common to Both Alternatives**	Maintaining essentially continuous upland and wetlands vegetation across the refuge landscape as expected under both alternatives, helps protect against soil loss through erosion. Plant foliage and stems intercept rainfall that can erode exposed soil. Vegetation, living and dead, especially plant roots help hold the soil in place when subjected to surface runoff, wind, or other erosive forces and help maintain soil porosity and water holding capacity. When vegetative tissues are shed, they return organic matter and nutrients to the soil that can be recycled and used by other plants and animals. Dead plant tissues accumulate to form the litter and duff layers that help protect the soil surface from erosive forces and help retain soil water essential for plant growth. Fire elevates surface temperatures; mineralizes detritus, litter, and standing dead material; volatilizes some nutrients and organic matter; alters soil water-holding capacity; and alters soil animal species (micro- and macro-fauna) populations. Intense, long-duration fires such as those associated with past wildfires consume more organic matter than the short-duration, low intensity prescribed fires proposed for Massasoit NWR under both alternatives. Nitrogen compounds volatilize and are lost at low temperatures (212° to 392 °F); while, calcium, sodium, and magnesium usually are deposited on the soil surface and quickly recycled during post-burn vegetative recovery. At higher temperatures (392° to 572 °F), large amounts of organic substances are lost, which can reduce soil cation exchange and moisture holding capacity. Removal of litter and duff may initially facilitate water infiltration; but, the loss of all litter and blackened soils may accelerate evaporation reducing soil water available for plant growth (water-holding capacity). Moderately hot fires (349° to 399 °F) can increase water repellence, and extremely hot fires (above 399 °F) volatilize hydrophobic substances and may increase soil water repellence. After moderately intense fires, increased runoff may result in soil erosion. Fire usually reduces soil fungi but increases soil bacteria, and may also remove pathogens. Fire often destroys nitrifying bacteria, so that post-fire soil nitrogen recovery is often dependent upon regrowth of legumes and other nitrogen-fixing plants. Fire may enhance this nitrogen fixation, due to the mineralization of nutrients and elevated pH levels in soils. Prescribed fires conducted on the refuge under either alternative should benefit soils in the short term by returning nutrients bound up in above ground plant biomass prior to the burn, back into the soil. A risk of long-term soil damage (still evident on the refuge today from the catastrophic fires in the 1950's) from high intensity wildfires remains. But fuel load reduction planned under both alternatives will help minimize, but not eliminate that risk. Wildfires will be suppressed in a safe, prompt, and cost effective manner to minimize adverse impacts to resources and acreage. Under both alternatives, a network of constructed firelines (1.11 miles), constructed shaded fuelbreaks (2.49 miles), and existing roadbeds (1.57 miles) will be maintained to facilitate wildland fire suppression and prescribed burning. Machinery will be used to mow or masticate understory vegetation every 5 to 7 years on approximately 13.6 acres (6.5 percent) of the refuge to keep the network passable for fire equipment and personnel. Litter and duff layers remain largely undisturbed and intact. Slight, increases in surface runoff are expected from this fuel and firebreak network for 1-2 growing seasons following treatment. Protective litter and duff layers will largely prevent post treatment soil erosion. Refuge firelines (2.68 miles) have a 1.5 foot strip from which the protective litter and sometimes the duff layer are removed using leaf blowers and rakes, potentially exposing mineral soil in order to slow or halt the spread of a fire through surface fuels on up to 0.49 acres (worst case estimate). Between fires, firelines are normally allowed to accumulate leaf litter each fall. Because the protective litter layer is removed periodically, potentially exposing mineral soil to erosion from these firelines could be transported downslope in surface runoff into refuge ponds from soil exposure until the next autumn "leaf-drop" (6 to 12 months). Refreshing firelines as preparation for pre-planned prescribed burns would occur around the perimeters of burn units totaling no more than 50 acres in any given year under both alternatives. Wildfires are not predictable as to the time and place of ignitions, but the same network of firelines and methods will be used to suppress any unplanned wildfires within the refuge. Because the protective litter layer is removed periodically potentially exposing mineral soil, some soil erosion is possible from these firelines, from soil exposure until the next autumn "leaf-drop" (6-12 months).	

Massasoit Refuge Resource	Type of Impact	Alternative A Current Management	Alternative B Expanded Management (Service-preferred Alternative)
Soils (cont.)	**Beneficial**	Prescribed burning would potentially return nutrients bound up in plant biomass back into the soil, and enhance soil microbial nitrogen fixation in the short term on approximately 50 acres of the Crooked Pond parcel over the planning period. Given their short-term nature and the limited acreage, these are not expected to be significant beneficial soil impacts. Reducing hazardous fuel loading reduces the likelihood of high intensity wildfires, and the soil damage they can leave behind.	Prescribed burning would potentially return nutrients bound up in plant biomass back into the soil, and enhance soil microbial nitrogen fixation in the short term on up to 200 refuge acres over the planning period. Given their short-term nature and the limited refuge acreage, these are not expected to be significant beneficial soil impacts. Reducing hazardous fuel loading reduces the likelihood of high intensity wildfires, and the soil damage they can leave behind.
	Adverse	There may be some minor soil compaction and erosion on ¼ acre managed to create northern red-bellied cooter nesting habitat along the shoreline near Crooked Pond. The soil impacts will be temporary, localized, and therefore not significant. Low to moderate intensity prescribed burning will be performed on a (5 to 7 years) rotational basis, with no more than 50 acres (23.9 percent of the refuge) burned on any given day or in any one year. Prescribed burning is limited to the 50 acres (two burn units) in the northeast portion of the refuge which has little slope. Recent refuge prescribed fires consumed only part of the surface litter and duff layers, without transferring excessive heat into the underlying soils. Because a partial litter and a largely continuous surface duff layer will remain after burning, little soil erosion risk will result compared to that from a high intensity wildfire. The two burn unit perimeters combined require 0.99 miles, 0.50 miles, and 0.45 miles respectively of the fireline, existing roadbed, and 100-foot-wide shaded fuelbreak network. This network requires (worst case estimate) up to 0.27 acres of potentially exposed mineral soil for firelines, and mechanical understory vegetation cutting on 7.68 acres for shaded fuelbreaks and access roadbeds. In the intervals between fires, these firelines are normally allowed to accumulate leaf litter each fall. Because the protective litter layer and sometimes the duff layer is removed periodically to expose mineral soil, some soil erosion from these firelines is possible from soil exposure until the next autumn "leaf-drop" (6 to 12 months). Using heavy equipment to create fire breaks may scarify soils in some areas or potentially compact soils. Implementing Best management Practices helps to limit the amount of soil disturbance from equipment, and using 'low ground pressure' equipment reduces soil compaction potential. Future fire break maintenance can be done with much smaller and lighter equipment that will have little to no soil impact.	Increased mechanical vegetation removal, including invasive plants, using hand or power tools, or heavy equipment can potentially increase localized soil disturbance and erosion until new plants establish. Any soil disturbed by the physical removal of plants will be tamped down and compacted. Herbicides approved by the Service would be used to control invasive plants as warranted. The best methods available at the time of application will be used. All products are used according to label instructions and approved Pesticide Use Proposals, to minimize impacts to soil. There may be some minor soil compaction and erosion on 1acre managed to create northern red-bellied cooter nesting habitat along the refuge pond shorelines. The soil impacts will be temporary, localized, and therefore not significant. We expect negligible direct or indirect impacts on upland soils from habitat work. Expected soil impacts are limited in duration, of low to moderate intensity, and confined to small project areas. None of the proposed habitat management actions will adversely impact refuge soils over the long-term. Low to moderate intensity prescribed burning of 10 to 20 individual burn units will be performed on a (5 to 7 years) rotational basis, with no more than 50 acres (23.9 percent of the refuge) burned on any given day or in any one year. Recent refuge prescribed fires consumed only part of the surface litter and duff layers, without transferring excessive heat into the underlying soils. Because a partial litter and a largely continuous surface duff layer will remain after burning, little soil erosion risk will result compared to that from a high intensity wildfire.

Massasoit Refuge Resource	Type of Impact	Alternative A Current Management	Alternative B Expanded Management (Service-preferred Alternative)
Soils (cont.)	**Adverse (cont.)**	We expect direct or indirect impacts on upland soils to be negligible and not significant, limited by the short duration and low to moderate intensity burns, confined to the small, designated project area. The refuge remains closed to public uses. Therefore any soil impacts from public use will be from unauthorized, illegal activities. Trespass by mountain bikes and ORVs, and to a lesser extent horseback riding, occurs on the refuge. This trespass and commensurate soil damage is expected to continue. Illegally accessed trails are deeply worn exposing the roots of trees and void of protective duff and litter in several locations and where trails are on slopes, water runoff and erosion is occurring. At times these mountain bike and ORV riders will cause soil disturbance in the turtle nesting sites adjacent to the pond shoreline.	These burn perimeters combined require up to 1.11 miles, 1.57 miles, 0.57 miles, and 1.92 miles respectively of the fireline, existing roadbed, 100-foot-wide and 12-foot-wide shaded fuelbreak network, with only a portion (20 to 50 percent) needed in any single year in the absence of a large wildfire. This network requires (worst case estimate) up to 0.49 acres of potentially exposed mineral soil for firelines, and mechanical understory vegetation cutting on 13.6 acres for shaded fuelbreaks and access roads. In the intervals between fires, these mineral soil firelines are normally allowed to accumulate leaf litter every fall. Because the protective litter layer is removed periodically to expose mineral soil, some soil erosion from soil exposure until the next autumn "leaf-drop" (6 to 12 months). Protective vegetative and litter cover typically recovers within 1 growing season following mechanical cutting of shaded fuel breaks, or prescribed burning. Using heavy equipment to create fire breaks may scarify soils in some areas or potentially compact soils. Implementing Best management Practices helps to limit the amount of soil disturbance from equipment and using 'low ground pressure' equipment reduces soil compaction potential. Future fire break maintenance can be done with much smaller and lighter equipment that will have little to no soil impact. Conducting all burns within their prescriptions will minimize soil loss, although adverse soil impacts may occur in small areas. The adverse effects from higher intensity fires are only likely to occur in the presence of a natural or human induced wildfire. Pedestrian access on the Crooked Pond parcel would be limited to guided activities, and most of the Crooked Pond parcel would be opened seasonally for some hunting, most likely including deer and turkey hunting. These uses could in time impact soils through compaction, erosion, and sedimentation if not addressed. Long-term effects of trampling include soil impacts like diminished soil porosity, aeration, and water and nutrient availability for plant growth through soil compaction. Foot travel can, over time create eroded conditions; lug soles on hiking boots can exacerbate the problem. Large group activities, such as guided interpretation or environmental education on any trail used, is more likely to impact soil to a greater extent. However, we do not anticipate many guided trips will occur annually.

Massasoit Refuge Resource	Type of Impact	Alternative A Current Management	Alternative B Expanded Management (Service-preferred Alternative)
Soils (cont.)	**Adverse (cont.)**		The majority of the refuge's 209 acres would however remain largely closed to public use. Additionally, Service staff would monitor trails for soil damage, minimize use if necessary, and mitigating damage with soil stabilization and erosion control measures (water bars, steps, re-routing, etc.) can be undertaken promptly as needed. This is expected to mitigate any significant long-term soil impacts from authorized public use. Trespass by mountain bikes and ORVs, and to a lesser extent horseback riding, occurs on the refuge, resulting in extensive soil compaction and erosion. This illegal trespass is expected to decline, but not be eliminated under alternative B. Illegally accessed trails are deeply worn exposing tree roots and are void of protective duff and litter in several locations and where trails are on slopes, erosion is occurring. At times unauthorized mountain bike and ORV riders will cause localized soil disturbance to refuge pond shorelines. Greater enforcement and increased public outreach should reduce soil from illegal, unauthorized uses.
Natural Community Types and Vegetation	**Common to Both Alternatives**	As the pitch pine-oak forest canopy opens, shifting to a woodland structure over time with continuing mechanical thinning and prescribed fire management, understory vegetation (scrub oak shrubland and sandplain heathland) will likely increase with more sunlight reaching the ground. Understory vegetation benefitting most are pitch pine-scrub oak shrubland association (and sandplain heathland community) plants, such as lowbush blueberry, black huckleberry, and scrub oak. Prescribed burning may over time also create more snags and downed trees that provide habitat for a variety of species, although it often takes more than one season for snags to develop after burning. White pines that tend to grow taller and create closed canopy conditions will be reduced (canopy cover and density) in white pine-oak and oak-pine forest areas managed using canopy thinning and prescribed burning. Under both alternatives, a network of firelines (1.11 miles), constructed shaded fuelbreaks (2.49 miles), and existing roadbeds (1.57 miles) will be maintained to facilitate wildland fire suppression and prescribed burning. Machinery will be used to mow or masticate understory vegetation every 5 to 7 years to keep the network passable for fire equipment and personnel on approximately 13.6 refuge acres (6.5 percent) of the refuge's 209 acres. Refuge firelines (2.68 miles) typically have a 1.5 foot strip from which all vegetation and the protective litter and sometimes duff layers are removed on up to (worst case estimate) 0.49 acres. In the intervals between fires, these firelines are normally allowed to "go fallow." Wildfires are not predictable as to the time and place of ignitions, but the same network of firelines and methods will be used to suppress any unplanned wildfires within the refuge. Unauthorized operation of ORVs occurs along the utility line right-of-way, unpaved roads, and unimproved trails on the refuge, creating problems on Massasoit NWR as on most public land in Massachusetts, and is likely continue under both alternatives. In pitch pine-oak upland forest habitats subjected to ORV traffic, the resulting disturbance of dry, nutrient-poor, sandy soils may take decades to revert to native vegetation once damaged. Such soil disturbance may also provide inroads for non-native invasive plant species. Exposed soil and an abundance of sunlight along roads and trails provide ideal conditions for the establishment of invasive plant species that may be transported into the refuge in feed hay.	

Massasoit Refuge Resource	Type of Impact	Alternative A Current Management	Alternative B Expanded Management (Service-preferred Alternative)
Natural Community Types and Vegetation (cont.)	**Beneficial**	Essentially continuous forest cover will be maintained across the entire refuge (209 acre) land base throughout the plan period and in perpetuity. There will be shifts in natural community types and vegetation associations through mechanical cutting and prescribed burning efforts that will thin overstory and create canopy openings on 50 acres on the Crooked Pond parcel. Management will enhance pitch pine-oak woodland or forest association habitat on those 50 acres as periodic fire encourages restoration of fire-adapted plant species. An increase in canopy openings will result in an increased understory layer (scrub oak shrubland association, sandplain heathland community) beneath the canopy gaps across those 50 acres.	Invasive species control will benefit native plant communities and refugewide floral diversity. Invasive plants such as glossy buckthorn, hairy cat's ear, butterfly bush, Morrow's honeysuckle, oriental bittersweet, black locust, common reed, and common mullein would decrease. Surveillance monitoring of aquatic plants in Crooked Pond, including invasive species, would alert the staff to any new invasive species concerns which could then be addressed sooner. Essentially continuous forest cover will be maintained across the entire refuge (209 acre) land base throughout the plan period and in perpetuity. There will be shifts in natural community types and vegetation associations through mechanical cutting and prescribed burning efforts that will thin overstory and create canopy openings on up to 200 acres (refugewide). Management will enhance pitch pine-oak woodland or forest association habitat on up to 200 acres (refugewide), as periodic fire encourages restoration of fire-adapted plant species. An increase in canopy openings will result in an increased understory layer (scrub oak shrubland association, sandplain heathland community) beneath the canopy gaps across the entire refuge (up to 200 acres). Refuge forest lands would in time more closely approximate the range of historic conditions typical of these pitch pine-oak associations at the time of European contact. Understory density and height would vary widely across the refuge with canopy opening percentage and time since last fire. Over the long term, there would increasingly be a more uneven aged, patch-mosaic, woodland structure due to the variations in timing and intensity of prescribed burning and mechanized thinning across the refuge. Refuge staff would work closely with the utility company to manage the acreage near the utility line for early successional, shrub habitat resulting in less overall vegetation removal along and within the utility line right of way, sustaining the shrubland habitat long term. Illegal access may decrease with more visitors on the refuge to detect and report illegal activity or whose mere presence may deter trespass.

Massasoit Refuge Resource	Type of Impact	Alternative A Current Management	Alternative B Expanded Management (Service-preferred Alternative)
Community Types and Vegetation (cont.)	**Adverse**	Mechanical clearing of brush, trees, and other vegetation on ¼ acre near Crooked Pond to improve northern red-bellied cooter nesting sites is at a very small scale, and vegetation impacts are not deemed significant. Prescribed burning two burn units will be performed on a (5 to 7 years) rotational basis, with no more than 50 acres (two burn units) burned on any given day or in any one year. The two burn unit perimeters combined require (worst case estimate) 0.99 miles, 0.50 miles, and 0.45 miles respectively of the fireline, existing roadbed, and 100-foot-wide shaded fuelbreak network. This network requires (worst case estimate) up to 0.27 acres of unvegetated soil for firelines, and mechanical understory vegetation cutting on 7.68 acres for shaded fuelbreaks and access roadbeds. In the intervals between fires, these mineral soil firelines are normally allowed to accumulate leaf litter every fall. All vegetation, including roots and the protective litter layer is removed periodically to expose mineral soil. Opening forest overstory and creating canopy gaps, changes forest vegetation structure and composition. Periodic fire discourages fire-intolerant species so a decline in canopy dominance of white pine trees is expected on the 50 acres treated on the Crooked Pond parcel. As white pine stem canopy dominance declines over time, refuge white pine-oak and oak-pine forest association acres are expected to decrease by approximately 50 acres (35 percent).	Invasive species control would have short-term adverse, localized impacts on vegetation. These include the removal of plants, herbicide application, trampling, and other potential damage to plant structure. These short-term negative impacts would be offset by providing long term benefits to native plant diversity and health across the refuge. Prescribed burning 10 to 20 individual burn units on up to 200 acres, will be performed on a (5 to 7 years) rotational basis, with no more than 50 acres (23.9 percent of the refuge) burned on any given day or in any one year. Mowing understory vegetation with LGP equipment with mower attachments may be used to prepare for burn or where prescribed fire cannot be used effectively. The 10 to 20 burn perimeters combined require worst case estimate) up to 1.11 miles, 1.57 miles, 0.57 miles, and 1.92 miles respectively of the fireline, existing roadbed, 100-foot-wide and 12-foot-wide shaded fuelbreak network. Only a portion (20 to 50 percent) of these is needed in any single year in the absence of a large wildlife. This network requires (worst case estimate) up to 0.49 acres of unvegetated, soil for firelines, and mechanical understory vegetation cutting on 13.6 acres for shaded fuelbreaks and access roads. In the intervals between fires, mineral soil firelines are normally allowed to accumulate leaf litter every fall. Vegetative cover typically is restored within one growing season following prescribed burning or mechanical cutting of shaded fuel breaks. Opening forest overstory and creating canopy gaps, changes forest vegetation structure and composition. Periodic fire discourages fire-intolerant species so a decline in canopy dominance of white pine trees is expected on up to 200 acres treated refugewide. As white pine stem canopy dominance declines over time, refuge white pine-oak and oak-pine forest association acres are expected to decrease by approximately 140 acres (98 percent).

Massasoit Refuge Resource	Type of Impact	Alternative A Current Management	Alternative B Expanded Management (Service-preferred Alternative)
Community Types and Vegetation (cont.)	**Adverse**	On the remaining untreated 150 upland acres, white pine-oak and oak-pine forest association will persist and continue to succeeding to a more mature state. Now overly abundant white pines, artifacts of decades of wildfire suppression, would continue to grow and understory density will decrease further refugewide. Further loss of remnant plants associated with pitch pine-scrub oak shrubland, woodland, or forest associations (sandplain heathland community), such as huckleberry, hillside and lowbush blueberry, or scrub oak will result. None of the habitat type shifts and or vegetation structure and composition impacts expected are deemed significant. The refuge remains closed to public use. Therefore vegetation impacts from public use will be confined to unauthorized, illegal activity. Currently trespass takes place at Massasoit NWR by mountain bikes and ORVs, and to a lesser extent horseback riding, resulting in localized vegetation destruction or damage. The current level of trespass and commensurate plant damage is expected to continue. Illegally accessed trails have exposed roots of trees, are void of above ground vegetation and compacted, and therefore deter revegetation in several locations.	With increased public access and use of the refuge and opening deer and turkey hunting on the Crooked Pond parcel, vegetative communities could experience localized trampling and possibly crushing of individual plants in high traffic areas. Short-term effects consist of the deterioration of plant material itself. Long-term effects of trampling include direct vegetation damage, and indirect vegetation effects from soil compaction like diminished soil porosity, aeration, and water and nutrient availability for plant growth. Compacted soils inhibit plants, particularly sensitive species', ability to revegetate affected areas. Plant damage can include height and biomass reduction, species composition shifts, and the spread of weeds and plant pathogens. Plants adapted to wet or moist habitats are the most sensitive. Direct vegetation effects and indirect impacts from soil compaction would likely be localized, and not significant on a larger scale, because most of the refuge remains largely closed to public access, especially sensitive wetland and pond shoreline areas. Unauthorized, illegal activities may increase in terms of damage to refuge vegetation as more people "discover" Massasoit NWR. Damage from activity that currently exists on the refuge includes vegetation trampling and breakage, and trail widening. Individuals engaging in unauthorized activities or trail use may find the openings created by additional fire breaks within the refuge forests particularly attractive. Opening portions of the refuge for public use creates the potential for spread and/or introduction of invasive species. Visitors could carry seeds in footwear, and unauthorized users could transport invasive plant seeds on tires, horses can excrete seeds in their waste, and illegal paddlers can spread invasive plants transported on contaminated canoes or kayaks. While any introduction or spread of invasive plants is a great concern, allowing limited public access is unlikely to result in any significant biological impact to the refuge natural community types and vegetation. Law enforcement will continue to patrol and monitor to deter unauthorized uses thereby reducing the risk for spreading or introducing invasive species. Removing downed brush and blocking unauthorized trails can effectively reduce vegetation impacts of illegal uses. We will post and enforce refuge regulations and area closures as refuge resources permit. Increased education and awareness about refuge natural resources and reasons for refuge regulations may also decrease illegal activities.

Massasoit Refuge Resource	Type of Impact	Alternative A Current Management	Alternative B Expanded Management (Service-preferred Alternative)
Biological Resources	**Common to Both Alternatives**	A number of impacts to refuge coastal pond hydrology and to habitat and vegetation structure from changing climate and land uses that are external to the refuge will in turn impact refuge biological resources the same under both alternatives are discussed under Cumulative Effects. For purposes of this impact analysis, it was assumed that invertebrate pollinator species found in similar habitats located within MSSF likely also occur on the refuge.	
	Beneficial ***Northern red-bellied cooter***	Clearing woody and herbaceous vegetation and allowing sunlight to penetrate to and warm the soil surface on ¼ acre along the Crooked Pond shoreline, will enhance cooter nesting and egg incubation, benefitting hatching success and early hatchling survival. This can potentially shorten the incubation period, increase hatching success and early hatchling survival, and shift the current male-biased sex ratio of hatchlings toward more females. Using predator exclosures to prevent egg destruction and increase hatching success will improve first year survival rates of northern red-bellied cooter hatchlings. Camera monitoring indicates some trespassing on the property. Temporary signs establishing visual and enforceable closures around the nesting sites during nesting and incubation seasons will help protect the cooter. Illegal collection of cooter eggs and other harassment by humans will be deterred by keeping the refuge pond shorelines which cooters use for basking and nesting closed to public use, and by enforcing current regulations.	Surveillance monitoring, including invasive aquatic plants in refuge ponds, will alert refuge staff sooner, allowing control measures to be taken before invasive plants can dominate the native milfoil and other native aquatic plants that northern red-bellied cooters rely on for food. Clearing woody and herbaceous vegetation and allowing sunlight to penetrate to and warm the soil surface on 1 acre along the Crooked Pond shoreline, will enhance cooter nesting and egg incubation, benefitting hatching success and early hatchling survival. This can potentially shorten the incubation period, increase hatching success and early hatchling survival, and shift the current male-biased sex ratio of hatchlings toward more females. The addition of basking sites created by large downed trees anchored in shallow waters during mechanical thinning treatments along refuge pond shorelines will also benefit potential breeding cooters. With increased sunlight, refuge cooters can attain sexual maturity and enter the breeding population sooner, and breed more frequently. Locating and protecting nests with predator exclosures will expand somewhat, increasing hatching success and survival probabilities for first year northern red-bellied cooter hatchlings. Increased inventory and monitoring will assist in better understanding the impact of predators on northern red-bellied cooter nests and potential nest habitats created on refuge pond shorelines. With increased research effort, Service conservation partners and refuge staff will become better informed to more strategically manage and protect the existing and potential cooter population rangewide, both on and off the refuge. Prescribed burning and mechanical thinning on up to 200 upland acres further benefit the northern red-bellied cooter, by extending increased sunlight reaching the forest floor beyond the immediate refuge pond shorelines. Most lands surrounding refuge ponds are now closed-canopy pine forests. These closed canopy forested pond shorelines, if provided with adequate sunlight, could become additional suitable cooter nesting and incubation habitat.

Massasoit Refuge Resource	Type of Impact	Alternative A Current Management	Alternative B Expanded Management (Service-preferred Alternative)
Biological Resources (cont.)	**Beneficial** ***Northern red-bellied cooter (cont.)***		Alternative B affords more opportunity to work with private landowners such as the nearby cranberry growers, residents along the shorelines of refuge and off-refuge ponds, and other landowners in the region interested in entering into management agreements. This alternative also increases law enforcement outreach with private landowners, further benefiting northern red-bellied cooter populations existing on nearby private lands. Camera monitoring indicates some trespassing on refuge property. Temporary signs establishing visual and more enforceable closures around the nesting sites during nesting and incubation seasons will afford a limited additional protection for the cooter. Illegal collection of cooter eggs and other harassment by humans will be further deterred by keeping the refuge pond shorelines which cooters use for basking and nesting closed to public use, and increased enforcement. Some decrease in unauthorized (illegal) use, especially off-road vehicles near pond shorelines with the greater staff presence and enforcement is expected.
	Migratory birds	Prescribed burning and thinning 50 acres of mixed pine-oak forest will benefit early successional and shrub species such as prairie warbler and field sparrow, chestnut-sided warbler, black and white warbler, common yellowthroat, eastern towhee, and gray catbird. Representative species such as eastern towhee and prairie warbler, and other migratory birds preferring open canopy and dense understory, will potentially increase slightly (not significantly). Eastern wood-pewee, another surrogate species, would benefit somewhat where canopy thinning creates open park-like areas on xeric (dry) sites with low shrub density. The remaining 150 acres of untreated mixed pine-oak upland forest will continue supporting breeding wood-pewee. The remaining 150 acres of untreated mixed pine – oak upland forest will continue supporting breeding adult ovenbirds along with other surrogate bird species such as scarlet tanager that rely on closed canopy conditions.	Prescribed burning and thinning up to 200 acres of mixed pine-oak forest will benefit early successional and shrub species such as prairie warbler and field sparrow, chestnut-sided warbler, black and white warbler, common yellowthroat, eastern towhee, and gray catbird. Representative species such as eastern towhee, prairie warbler, and other migratory birds preferring more open canopy and denser understory, will potentially increase refuge-wide (locally), but is not expected to be measurable at regional or continental population scales. Eastern wood-pewee are also likely to thrive refugewide. Variability in fire intensity during individual burns, combined with rotating multiple small burn treatments across the refuge landscape over several years will provide the heterogeneity in stand structure preferred by the wood pewee. Patches of intermediate age forest with more closed canopy left where lower intensity fire spread occurs, will be in close proximity to open, park-like patches, and the entire gradient of conditions between these.

Massasoit Refuge Resource	Type of Impact	Alternative A Current Management	Alternative B Expanded Management (Service-preferred Alternative)
Biological Resources (cont.)	**Beneficial (cont.)** ***Migratory birds (cont.)***	Juvenile ovenbirds use regenerating cleared areas that have a denser understory for foraging and predator protection near ovenbird breeding habitat, and will be able to find that on the 50 acres treated with prescribed burning and mechanical thinning. The refuge will remain largely closed to public use year-round, minimizing human disturbance of migratory birds from authorized public use.	Juvenile ovenbirds that use regenerating cleared areas with a denser understory for foraging and predator protection near adult ovenbird breeding habitat, will find that on up to 200 acres treated with prescribed burning and mechanical thinning. Also, the HMP will identify patches to be reserved for migratory birds needing a more closed canopy habitat. This ensures that dense shrub juvenile ovenbird foraging and escape habitat is provided proximally to forest interior ovenbird nesting habitat, that is expected to remain available through the planning period and beyond on adjoining public and private lands. Providing wildlife observation, photography, interpretation and environmental education through staff or partner-led activities, and opening most of the Crooked Pond parcel to hunting, with an emphasis on deer and turkey hunting, are unlikely to provide more than minimal (not significant) benefit to migratory birds from the increased stewardship ethic and awareness of refuge resources, including migratory birds, they will foster. Some decrease in unauthorized (illegal) use that can damage or destroy eggs and nests on or near the ground, or disturb incubating or brooding adults on nests with the greater staff presence and enforcement is expected.
	Mammals	Silver-haired bats that forage in fairly open habitat in mixed wood forest areas near ponds may benefit, if present, from clearing vegetation on ¼ acre near the Crooked Pond shoreline for northern red-bellied cooter nesting habitat. Prescribed burning and mechanical thinning on 50 acres will create several patches with more open canopies and dense shrub understory, potentially suitable for future occupancy by New England cottontail.	Controlling invasive plants benefits mammals by maintaining the balance of food resources and native vegetative communities to which they are adapted for cover, nesting, and quality food resources. Early detection and control of invasive plants will help prevent non-native plant monocultures displacing native plant and insect diversity which provide critical year round food resources for herbivorous and insectivorous mammals. Silver-haired bats that forage in fairly open habitat in mixed wood forests near ponds may benefit, if present, from clearing vegetation on 1 acre near refuge pond shorelines for northern red-bellied cooter nesting habitat.

Massasoit Refuge Resource	Type of Impact	Alternative A Current Management	Alternative B Expanded Management (Service-preferred Alternative)
Biological Resources (cont.)	**Beneficial (cont.)** ***Mammals (cont)***	Bats will likely benefit somewhat from the creation of forest canopy openings on 50 acres where active vegetation management occurs. Canopy gaps created by thinning and prescribed burns may allow bats such as eastern red bat and big brown bat to forage more easily. Decreased tree density and increased openings, may also improve travel corridors for bats, as more light reaches and warms roost trees, and increases insect prey diversity and abundance through increased herbaceous and shrub growth. Fire may create new bat roost trees and snags by direct or indirect fire mortality, although it may take one or more seasons to develop after burning. Given the relatively small total and treated refuge acreage impacted, none of the above local (refuge-level) changes in bat species abundance are expected to be significant at the larger landscape or population levels. Other mammals preferring more open canopy conditions and a denser understory layer such as mice and voles would also indirectly benefit from the prescribed fire regime and thinning treatments on 50 acres. Denser understory often allows for better protection from predators along with more food resources for small mammals, such as mice and voles. The refuge will remain largely closed to public use year-round minimizing human disturbance of mammals from authorized public use.	Prescribed burning and mechanical thinning on up to 200 acres will create many patches with more open canopies and dense shrub understory, potentially suitable for future occupancy by New England cottontail. By working collaboratively with utility right-of-way managers, the future potential for additional improved habitat connectivity and conditions for New England cottontail with the larger landscape surrounding the refuge increases. Bats will likely benefit from the creation of forest canopy openings on up to 200 acres where active vegetation management occurs. Canopy gaps created by thinning and prescribed burns may allow bats such as eastern red bat and big brown bat to forage more easily. Decreased tree density and increased openings, may also improve travel corridors for bats, as more light reaches and warms roost trees, and increases insect prey diversity and abundance through increased herbaceous and shrub growth. Fire may create new bat roost trees and snags by direct or indirect fire mortality, although it may take one or more seasons to develop after burning. Given the relatively small total refuge acreage impacted, none of the above local (refuge-level) changes in bat species abundance are expected to be significant at the larger landscape or population levels. Other mammals preferring more open canopy conditions and a denser understory layer such as mice and voles would also indirectly benefit from the prescribed fire regime and thinning treatments on up to 200 acres (refugewide). Denser understory often allows for better protection from predators along with more food resources for small mammals such as mice and voles. With deer density currently well above the 6 to 8 deer per square mile MassWildlife target range for Wildlife Management Zone 11, and given normal fecundity rates, opening most of the Crooked Pond parcel to deer hunting will not significantly impact local deer density or achievement of state deer management goals. Offering refuge and partner-led wildlife observation, photography, interpretation and environmental education, as well as opening most of the Crooked Pond parcel seasonally to hunting are unlikely to provide more than minimal (not significant) benefit to mammals from the increased stewardship ethic and awareness of refuge resources, including mammals, they will foster.

Massasoit Refuge Resource	Type of Impact	Alternative A Current Management	Alternative B Expanded Management (Service-preferred Alternative)
Biological Resources (cont.)	**Beneficial (cont.)** ***Reptiles and amphibians***	Best management practices for amphibians and reptiles in pine forests such as those on the refuge include maintaining and creating canopy gaps that allow species that need sunlight such as American toad, Fowler's toad, and eastern hognose snake to thrive. The approximately 150 acres that will maintain a more closed canopy are likely to benefit such species as spotted salamander, spring peeper, wood frog, and milk snake. The refuge will remain largely closed to public use minimizing human disturbance of amphibians and reptiles from authorized public use.	Controlling invasive species would benefit amphibians and reptiles by contributing to the restoration and propagation of native plants and associated insects that are essential food resources. Additional inventories will further inform the Service and our partners about the extent and population of various amphibians and reptiles, increasing certainty about management impacts on them. Reptiles, and amphibians favored by open canopy conditions with a dense shrub understory, such as American toad, Fowler's toad, and eastern hognose snake are expected to benefit to an even greater (up to fourfold) from prescribed burning and thinning on up to 200 acres.
	Fish	There currently is no active management for fish in Crooked Pond, and only the shorelines of the other ponds are within Service jurisdiction. Therefore no impacts to fish species on the refuge are likely. Crooked Pond will remain closed to public use minimizing human disturbance to fish from authorized public use.	If surveys proposed indicate a need for aquatic invasive plant control, fish favored by native aquatic plants would benefit indirectly from that control, but the benefit is limited and not expected to be significant.
	Invertebrates, including pollinators	Rare butterfly and moth species that depend on sandplain heathland community or pitch pine –scrub oak shrubland, woodland, or forest association habitats, such as the Pine Barrens buckmoth, Gerhard's Underwing moth, and others, would benefit slightly from prescribed burning and thinning on 50 acres. Many caterpillars (larvae) of these species eat only pitch pine, scrub oak, or other specific plant hosts found only or mostly in pitch pine –scrub oak shrubland association or sandplain heathland communities. Prescribed burning and overstory thinning will allow more light to penetrate to the understory, favoring the host plants which attract these pollinators.	Rare butterfly and moth species that depend on sandplain heathland community or pitch pine-oak shrubland habitats, such as the Pine Barrens buckmoth and Gerhard's Underwing moth and others, will benefit refugewide from prescribed burning and thinning on up to 200 acres. Many caterpillars (larvae) of these species eat only pitch pine, scrub oak, or other specific plant hosts found only or mostly in pitch pine-scrub oak shrubland association or sandplain heathland communities. Prescribed burning and overstory thinning will allow more light to penetrate to the understory, favoring the host plants which attract these pollinators. Expansion of moth and butterfly inventory and monitoring also gives Service staff and partners better information about lepidopteran species occurrence, allowing for more strategic, targeted, and proactive application of refuge vegetation treatments. Collaboration with the utility company to manage for shrubland habitat along the power line would also benefit pollinators including some moths and butterflies. Sunlight is particularly important for basking behaviors that warm the body for flight.

Massasoit Refuge Resource	Type of Impact	Alternative A Current Management	Alternative B Expanded Management (Service-preferred Alternative)
Biological Resources (cont.)	**Adverse** ***Northern red-bellied cooter***	Locating and protecting existing cooter nests on the refuge and clearing ¼ acre of vegetation along Crooked Pond may disturb individual northern red-bellied cooters infrequently for brief periods, but no significant adverse impacts on the northern red-bellied cooter are expected.	Locating and protecting existing cooter nests on the refuge and clearing 1 acre of vegetation along refuge ponds may disturb individual northern red-bellied cooters infrequently for brief periods, but no significant adverse impacts on the northern red-bellied cooter are expected. Some potential for increased disturbance or harassment of northern red-bellied cooters from unauthorized users is expected, but is not deemed significant. It is possible that some disturbance from hunters could occur, but this is expected to be negligible as the area around Crooked Pond will be closed to hunting. Once hunters get into place, there will be no interaction with northern red-bellied cooters.
	Migratory birds	Migratory birds associated with closed canopy, forest interior conditions such as breeding ovenbirds and scarlet tanagers, will likely decline initially in the 50 acres treated with prescribed burning and mechanical thinning. Forest interior breeding birds breeding in sub-optimal conditions, may experience lower nest productivity or fledgling survival. The refuge will remain closed year round to public use, and therefore no adverse impact to migratory birds from human disturbance by refuge visitors is expected. Unauthorized use could potentially disturb and harm migratory birds if the limited enforcement capacity leads to further increases in illegal use during nesting and young rearing periods within closed areas.	Migratory birds associated with closed canopy, forest interior conditions such as breeding ovenbirds and scarlet tanagers will decline, but likely persist in lower numbers and density on up to 200 acres treated with prescribed burning and mechanical thinning. Suitable habitat will remain within the refuge, and on adjoining ownerships. Increased disturbance to individual migratory birds from authorized public uses will occur. Temporary disturbance to birds from wildlife observation and photography, environmental education and interpretation might occur. There should be no impact to migratory birds from hunting. Because of the diversity of habitats on the refuge directly connected to other large tracts of protected lands, population level effects to migratory birds from refuge public use would be minimized.
	Mammals	There will be no significant adverse impacts to mammals, including bats. The approximately 150 acres of refuge uplands remaining untreated will continue maturing to mature, degrading dense understory structure required by New England cottontails. Management activities such as prescribed burns on 50 acres naturally present a low direct mortality risk to small mammals. The impact is minor at the population level and generally of short (weeks to months) duration. Most mammals scurry out of the way, go underground or burrow under the duff and escape injury as low to moderate intensity flaming fronts move across an area. Direct mortality of some mammals, such as rabbits and raccoons, may occur during prescribed burns but is rare.	Potential direct mortality risk to small mammals such as rabbits, mice, and voles during prescribed burns on up to 200 acres is expected to be low (rare) and not significant, but may occur. A slightly increased predation or winter cold exposure risk during immediate post-burn periods for mammals displaced by prescribed burn units is expected. But this increase is more than offset by improved protective cover for 5 to 7 years after burning. Prescribed burning and mechanical thinning on up to 200 acres can have short term detrimental impacts on bats by eliminating snags and stumps.

Massasoit Refuge Resource	Type of Impact	Alternative A Current Management	Alternative B Expanded Management (Service-preferred Alternative)
Biological Resources (cont.)	**Adverse (cont.)** ***Mammals (cont.)***	Prescribed fire removes some protective cover, potentially exposing small rodents and rabbits to predation and cold. The extent of exposure largely depends on the proximity of available cover and predator (raptors, foxes, and feral cats) in the area. Prescribed burning will be performed on a (5 to 7 years) rotational basis, with no more than 50 acres burned on any given day or in any one year. Prescribed burns on the refuge will therefore be small (50 acres or less), which means alternate escape cover is never more than 700 feet away for small mammals temporarily displaced by a prescribed fire or other habitat treatment. Prescribed burning and mechanical thinning on 50 acres can have short-term detrimental effects on bats by eliminating some snags and stumps used for roosting. Roosting bats may also be killed under intense fire conditions. Firebreaks can be raked around snags, or the bases can be sprayed with retardant to protect the snags. Prescribed burns on 50 acres and fires occurring when bats are rearing young (April-July) or in deep hibernation (mid-winter) can therefore have negative impacts on local populations. To minimize losses, prescribed fires should be set during warmer days (above 50° F). This impact will most likely be minimal because refuge growing season prescribed burns are unlikely during the times when neonatal bats are still in their roost or during mid-winter deep hibernation periods. The approximately 150 acres of refuge uplands remaining untreated will continue maturing without natural disturbance. Bats now present in these areas that prefer more open canopy conditions such as big brown bats, will likely decrease locally. Unauthorized use will continue to disturb mammals on the refuge to a limited (not significant) extent.	Prescribed burns on up to 200 acres and fires occurring when bats are rearing young (April-July) or in deep hibernation (mid-winter) can therefore have negative impacts on local populations. To minimize losses, prescribed fires should be set during warmer days (above 50° F). This impact will most likely be minimal because refuge growing season prescribed burns are unlikely during the times when neonatal bats are still in their roost or during mid-winter deep hibernation periods. Increased disturbance to individual small mammals from visitors engaged in staff and partner led wildlife observation, photography, interpretation, and environmental education and hunters will occur but will be temporary and minimal. Unauthorized use will continue to disturb mammals on the refuge to a limited (not significant) extent. Opening portions of the refuge to hunting in accordance with state regulations would result in direct mortality of the individuals harvested.
	Reptiles and amphibians	Prescribed burning will be performed on 50 acres on a (5 to 7 years) rotational basis, with no more than 50 acres burned on any given day or in any one year. We anticipate short-term impacts on amphibian species from refuge prescribed fire activities. However, given the low-intensity and short flame-front residence time (duration), and relatively small burn area, we do not consider this to be a significant impact. The Crooked Pond and other micro-site features within and surrounding burn units may provide protective refugia from fire for refuge reptiles and amphibians, and breeding by aquatic species is expected to continue uninterrupted by fire.	Herbicide use for invasive species control could negatively impact amphibian eggs, larval stages, and tadpoles to a limited extent, but are largely expected to be mitigated by precautions during application.

Massasoit Refuge Resource	Type of Impact	Alternative A Current Management	Alternative B Expanded Management (Service-preferred Alternative)
Biological Resources (cont.)	**Adverse (cont.)** ***Reptiles and amphibians (cont.)***	Since the refuge will remain closed year-round to public use, so no adverse impacts from authorized public use on amphibians and reptiles are expected. Unauthorized use will continue to affect reptiles and amphibians on the refuge to a limited (not significant) extent. Utility rights-of-way, unpaved roads, and trails in pitch pine-oak upland forest systems often attract sensitive species for nesting (e.g., Eastern Box Turtle), basking (e.g., Eastern Hog-nosed Snake), or foraging where ORV traffic may result in direct mortality.	Short term impacts on amphibian species from prescribed burning and mechanical thinning up to 200 acres are expected. There is increased direct mortality risk. There is also increased indirect impact potential through increased risk of losing forest floor amphibian refugia to consumption by fire. Spotted salamander, spring peeper, wood frog, and milk snake are species that could be adversely impacted, but mitigation and adaptation may be possible. Refuge ponds and other micro-site features within and surrounding burn units may provide protective refugia from fire for refuge reptiles and amphibians, and breeding by aquatic species is expected to continue uninterrupted by fire. No adverse impacts from authorized public use on amphibians and reptiles are expected from opening the refuge to guided public use, or from hunting. Unauthorized use will continue to affect reptiles and amphibians on the refuge, but to a lesser extent
	Fish	Unauthorized use will continue to affect fish in refuge ponds to a limited (not significant) extent.	Herbicide use for invasive species control could negatively impact developing fish eggs and juvenile fish to a limited extent, but can be largely mitigated by precautions during application. Unauthorized (illegal) use will likely continue to affect fish in refuge ponds to a limited (not significant) but lesser extent, due to increased presence by Service personnel, including law enforcement.
	Invertebrates, including pollinators	Herbicide use along the utility right-of-way may negatively impact invertebrate species to a limited extent, which will largely be mitigated by precautions during application. The approximately 150 acres of refuge uplands remaining untreated will be increasingly dominated by more mature tree species such as the already common white pine. On these untreated acres, a further decline in the rarer butterfly and moth species, including Pine Barrens buckmoth and Gerhard's underwing moth is expected. Other pollinators and invertebrate species may be present or may immigrate that thrive on more closed canopy conditions that will remain largely undetected in the absence of monitoring and inventory.	Herbicide use for invasive species control could negatively impact pollinators and other invertebrates to a limited extent, but can be largely mitigated by precautions during application. Herbicide use along the utility right-of-way could negatively impact invertebrate species to a limited extent, but can be largely mitigated by precautions during application and collaboration with the State and utility company to minimize herbicide use along the utility line.

Massasoit Refuge Resource	Type of Impact	Alternative A Current Management	Alternative B Expanded Management (Service-preferred Alternative)
Climate Change	**Common to Both Alternatives**	With the potential for increased temperatures due to climate change, warmer conditions may shorten the hibernation period and lengthen the non-hibernation period, thereby increasing survival rates among northern red-bellied cooter populations. Carbon "sequestration" is essentially the process by which plants take up carbon dioxide through photosynthesis, and then store (sequester) it in plant biomass (wood, roots) and in the soil. Succession to forest stores the most carbon although the sequestration rate declines as trees mature. Some carbon sequestered on or above the soil surface is however released back to the atmosphere whenever vegetation burns during wildfire or prescribed burn surface fire, partially reversing vegetation and soil carbon sequestering, as with forest decomposition. Pine barren (pitch pine-scrub oak shrubland, pitch pine-oak woodland or forest associations, or sandplain heathland community) habitats are the least vulnerable (most resistant) to climate change forest types in the region. These naturally resilient forest types can withstand wildfire (with proper fuel load management), pest and invasive species outbreaks often associated with climate change. Although these forests are vulnerable to non-climate stressors, with the reduction of fuel hazards, the risk of severe wildfires brought on by alternating cycles of increased precipitation and drought is reduced.	
	Beneficial	Continued use of prescribed burns to manage fuel loads on 50 acres combined with expected climate change induced drought and other weather extremes, may create more favorable conditions for pitch pine-scrub oak persistence and expansion. Continuing hazardous fuel reduction will also reduce the high intensity wildfire threat, often exacerbated by the alternating cycles of extremes in precipitation and severe drought expected with changing climate.	Coastal ponds have a medium vulnerability to climate change as a result of the potential increase in invasive plants associated with climate change. Surveys of aquatic invasive plants with an evaluation of the need for management would potentially benefit refuge pond climate change resilience if control efforts were implemented sooner. Expanding prescribed burning and mechanical thinning for hazardous fuel reduction and habitat management to as much as 200 acres should increase resiliency of the refuge forests to climate change. Episodic greenhouse gas emissions from high intensity wildfires are less likely with fuel reduction on up to 200 acres. Invasive species monitoring and control would also increase to maintain less than 10 percent cover in invasive species refuge-wide. Carbon sequestration would differ based on the change in vegetation type, structure, and forest canopy closure, by extending mechanical thinning and prescribed burning to as much as 150 additional acres of what is now relatively mature, closed-canopy eastern white pine dominated forest, a less climate change resilient type. The net offset effect of carbon sequestration from forest succession to periodically carbon release back into the atmosphere during prescribed burning is however uncertain.

Massasoit Refuge Resource	Type of Impact	Alternative A Current Management	Alternative B Expanded Management (Service-preferred Alternative)
Climate Change (cont.)	**Adverse**	There is the potential for slight, short-term increases in atmospheric carbon emissions during prescribed burning and from motorized equipment use during mechanized thinning. Prescribed burning 50 acres will be performed on a (5 to 7 years) rotational basis, with no more than 50 acres burned on any given day or in any one year. The level of carbon emissions from habitat management under alternative A will be insignificant compared to the emissions from a single large, high severity wildfire due to high fuel load accumulations without fuel treatments. Atmospheric carbon emissions will result from round-trip motor vehicle travel by complex headquarters staff to work on the refuge. The staff increasingly utilizes lower emission vehicles to reduce atmospheric carbon emission contributions to global climate change. Because of the limited level of management, the carbon emissions from administrative activity expected are minimal, and not significant.	Increasing prescribed burning by up to 150 additional acres is expected to increase atmospheric carbon emissions by up to four times over the planning period. Prescribed burning up to 200 acres will be performed on a (5 to 7 years) rotational basis, with no more than 50 acres burned on any given day or in any one year. Rapid post-burn vegetative recovery and resumption of biological carbon sequestration following low to moderate intensity, small scale prescribed fires is expected. This increased level of atmospheric carbon emissions would still be insignificant compared with those from a single large, severe wildfire fueled by heavy fuel loads, as experienced in past decades. The use of power tools and equipment on the refuge would also produce small amounts of carbon emissions. Additional impacts on atmospheric carbon emissions may occur with the slight potential increase in visitation to walk on the trail, to deer and turkey hunt, and to participate in environmental education and interpretation. Atmospheric carbon emissions from increases in refuge visitor use will be negligible (insignificant) since most visits to the refuge would come from nearby residents or visitors already using the adjacent MSSF. Additional atmospheric carbon emissions will result from more round-trip motor vehicle travel by complex headquarters staff to the refuge. The shift toward lower emission vehicles to reduce atmospheric carbon emission contributions to global climate change will offset emissions from increased refuge staff administrative vehicle use. Atmospheric carbon emissions would still be minimal (insignificant) compared with emissions from sources originating outside the refuge.
Refuge Access and Public Uses	**Common to Both Alternatives**	No beneficial or adverse impacts to refuge access and public uses are common to both alternatives.	
	Beneficial	With continued closure of the refuge to public use, there will be no significant beneficial impact to refuge access and public use. The Service will have capability for limited oversight of vehicular and pedestrian traffic. The Service would continue providing limited programming, delivered primarily through refuge partners, as staffing, funding, and the interest and availability of Service partners allow.	Allowing visitors on the refuge for staff and partner-led wildlife observation, photography, interpretation and environmental education on the Crooked Pond parcel, and opening most of the Crooked Pond parcel seasonally to hunting, increases public access and public use. Staff and partner-led programs and the development of more interpretive materials should increase public awareness of the refuge. We expect increased public awareness of the presence of a refuge in the Plymouth region, about the importance of natural resources, human impacts on wildlife, and refuge policies.

Massasoit Refuge Resource	Type of Impact	Alternative A Current Management	Alternative B Expanded Management (Service-preferred Alternative)
Refuge Access and Public Uses (cont.)	**Adverse**	Continued closure of the refuge effectively precludes most refuge public use and access opportunities throughout the planning period. Limited outreach, interpretation, and enforcement by the Service will not ensure compliance with Federal, State, and local endangered species or wetland protection laws on the refuge. A lack of awareness of the refuge boundaries and refuge policies, and improper and unauthorized use and access to sensitive areas of the refuge is expected to remain unchanged, and continue through the planning period. The minimal level of interpretation that has occurred off the refuge related to the refuge's natural resources has been delivered principally through refuge partners. The Service would remain entirely dependent on the interest and availability of Service partners to deliver limited interpretive programming and outreach.	Continued closure to public access of ecologically sensitive areas such as refuge pond shoreline nesting sites of the northern red-bellied cooter will limit public access to pond shorelines. Even with the presence of wildlife observation and photography, environmental education and interpretation, and hunting, refuge staff would continue to limit activities that may impact the cooter. Additional authorized access to the refuge and its resources may also draw increased unauthorized use. It is unknown to what extent unauthorized use would occur with improved outreach efforts. Onsite and offsite programs require expenditures and committing resources that could be available for other refuge programs.
Archaeological, Historical, or Cultural Resources	**Common to Both Alternatives**	We will comply with all appropriate legal mandates to protect and manage refuge cultural resources. Any management actions with the potential to affect cultural resources require refuge manager review, as well as review by the Service's Regional Historic Preservation Officer), in consultation with the Commonwealth of Massachusetts SHPO and the THPO, as appropriate. Determining if particular actions within an alternative have the potential to affect cultural resources is an ongoing, well-established, and closely regulated process that will continue during the planning stages of any proposed projects under either alternative. It is probable that unrecorded archaeological or cultural sites exist on current refuge lands. Many of these are likely to include Native American artifacts. The likelihood of locating other prehistoric or historic sites on the refuge is also high given the human settlement and land use history in the refuge vicinity. Regardless of alternative, the Service is responsible for managing and protecting archaeological and historic sites found on national wildlife refuges.	
	Beneficial	Minimal beneficial impacts to any archaeological, historical, or national resources are expected. The refuge will remain largely closed to public use.	There may be an increased opportunity to discover and protect sites and artifacts those items and further evaluate the cultural significance of the discovery site during project planning or implementation. There would be little or no beneficial impact to cultural resources from increased public access and use under this alternative.

Massasoit Refuge Resource	Type of Impact	Alternative A Current Management	Alternative B Expanded Management (Service-preferred Alternative)
Archaeological, Historical, or Cultural Resources (cont.)	**Adverse**	Minimal adverse impacts to any archaeological, historical, or national resources are expected given precautions taken to protect any cultural, historical, or archaeological resources. Northern red-bellied cooter habitat management actions along the shoreline of Crooked Pond will be limited. Thinning and prescribed burning will be limited to 25 percent (or 50 acres) of the refuge within the northeastern corner of the Crooked Pond parcel. The limited law enforcement staff is not expected to prevent or detect many violations resulting from unauthorized public uses.	Minimal impacts to cultural resources on the refuge from disturbance related to habitat management are expected. Although mechanical thinning and prescribed burning would potentially increase across the refuge, the Service makes every effort to minimize new soil disturbance, identify and protect any sites or artifacts beforehand, or discovered during habitat management. Disturbance can occur through disturbing the top layer of soil that may serve as a protective layer for undiscovered artifacts. These areas would be limited to those small, localized areas disturbed through fire break creation, thinning and tree removal, or invasive species removal. A slight increase for potential disturbance to as yet undiscovered artifacts results from periodic maintenance of the new public use trail, installation of signs and interpretive panels, and the general increase in visitation. The likelihood of any destructive impacts from guided public use and hunting is minimal.
Socioeconomic	**Common to Both Alternatives**	Under both alternatives, the Service would continue somewhat offsetting tax revenue losses from refuge lands being removed from the property tax base by making annual "revenue sharing" payments to the town in lieu of taxes, as provided by Congress. No major changes in the level of revenue sharing payments unless Congress changes its annual revenue sharing appropriation. We expect these annual $4,000-$5,000 payments will have negligible effect on the $32.89 million (2015) town of Plymouth annual operating budget. Any increase in nearby home values also increases property tax revenues for those. In addition, people may be more likely to move to an area that values the protection of natural resources for public enjoyment.	
	Beneficial	The refuge will remain largely closed to the public. No additional beneficial impacts to the socioeconomic resources from visitors and staff expenditures are anticipated. No staff are stationed are permanently stationed at the refuge. Refuge Complex biological and law enforcement staff conduct site visits several times yearly. The slight (not significant) benefit to the local economy from small purchases of goods and services in the local area during staff visits should remain little changed.	Improved visitor access to the Crooked Pond parcel for interpretation, environmental education, wildlife observation and photography, and deer and turkey hunting will result. A slight increase in refuge visitation is expected, resulting in a corresponding slight increase in expenditures in the local community by refuge visitors. New net increases in expenditures by refuge visitors captured by the local economy will not be significant, since many of these new refuge visitors are expected to be local residents.
	Adverse	None	None.

Chapter 5


Stephanie Koch

Rototilling to prepare northern red-bellied cooter habitat

Planning to Protect Land and Resources

- **Introduction**
- **Planning to Protect Land and Resources**
- **Partners Involved in Refuge Planning**

Introduction

This chapter describes how we engaged others in developing this draft CCP/EA. In chronological order it details our efforts to encourage the involvement of the public and conservation partners, including other Federal and State agencies, county officials, civic groups, non-government conservation education organizations, and user groups. It also identifies who contributed to the writing of the plan.

This chapter does not detail the dozens of informal discussions the refuge staff have had over the last six years where the CCP was a topic of conversation. Those discussions involved a wide range of audiences, including congressional representatives or their staffs, local community leaders and other residents, refuge neighbors, refuge visitors, and other interested individuals. During those discussions, the refuge manager and staff often provided an update on our progress and encouraged comments and other participation.

A 60-day period for public review follows our release of this draft CCP/EA. We encourage all to respond with ideas about the plan. During that period, we will host open public meetings at locations near the refuge to gather comments and answer questions about our draft proposals. We will consider these responses carefully before we write the final CCP.

According to Service policy, we must review and update our final CCP at least once every 15 years, or sooner in response to important new information that would markedly change management direction, or when our Regional Director deems it necessary. If so, we will once again announce our revised planning and encourage your participation.

Planning to Protect Land and Resources

Our refuge planning began in 1999 when we initiated a CCP that would encompass all of the refuges in the Refuge Complex. We published an NOI in the *Federal Register* and began public scoping. By 2001, we determined that writing a plan for eight refuges was too cumbersome and instead focused on CCPs for the other refuges in the complex. The efforts in CCP completion for Massasoit NWR were halted at that time.

In 2011, we resumed our refuge planning for Massasoit NWR with an NOI published in the *Federal Register* on January 10, 2012. The planning process began informally in November 2011 at an initial strategy meeting between the refuge staff and the consultants. One major outcome of that first meeting was a timetable for accomplishing the major steps in the planning process and determining when and how we should involve others.

January 2012: Letters were sent to invite representatives from the Mashpee Wampanoag Tribe, Wampanoag Tribe of Gay Head (Aquinnah), Department of Conservation and Recreation and MSSF, NHESP, and MassWildlife to participate on the planning team. Invitations to participate on the planning team were also extended to Service staff from the Division of Migratory Birds and Ecological Services.

March 2, 2012: The pre-planning team, consisting of refuge and Regional Service staff, met at the complex headquarters in Sudbury, Massachusetts, to draft a preliminary vision statement and goals, identify issues and concerns, determine what additional resource information was needed to be collected and summarized, and discussed what other experts should be consulted to help address planning issues. We also scheduled our partner and public scoping meetings.

March 2, 2012: The core planning team, consisting of refuge staff, Regional staff from the Service's Ecological Services, MassWildlife, NHESP, and the Service's Coastal Program met to finalize the draft vision statement and goals to present to the public.

April 2012: We distributed a 1-page newsletter to approximately 90 people, organizations, and agencies to formally announce the beginning of the planning process and the upcoming public meeting, and sent out press releases to the local media to announce the public meeting. Invitation letters were sent to 15 people representing 20 local, State, and national agencies and organizations of potential interest to the upcoming public scoping meeting on April 9, 2012.

April 9, 2012: We hosted both the stakeholders and public meetings at Plymouth Library, having published notices in local newspapers, the newsletter, and partner's Websites. Nine people representing seven organizations were in attendance at the stakeholder meeting, and nine people signed in at the public meeting.

At each meeting the draft vision, goals, and objectives were posted, as well as the preliminary issues identified by the core planning team. A summary of the planning process was presented, and attendees were encouraged to provide feedback on any of the presented items, or general concerns and issues they had about the refuge. Comment forms were provided and staff recorded comments on flip charts. Members of the public were notified that there was an open comment period with no closing date.

June 4, 2012: The core planning team met again at the Refuge Complex headquarters in Sudbury, Massachusetts, to identify key issues and develop the strategies and alternatives for the document. Tom French from NHESP was in attendance along with Service staff.

August 8, 2012: The core planning team met at the Refuge Complex headquarters in Sudbury, Massachusetts, to review the alternative matrix.

June 26, 2012 & September 27, 2012: The Service staff met with town of Plymouth Board Member, Malcolm MacGregor, to walk through the refuge and abutting northern property to review the town's concept of potential trails to connect MSSF through the refuge as part of a larger regional trail connection system. Staff discussed potential issues regarding impacts to wildlife, costs, and feasibility of potential trails. No decision was determined at this gathering.

November 5, 2012: The core planning team met at the Refuge Complex headquarters in Sudbury, Massachusetts, to update the alternative matrix and finalize the public use options for the refuge including potential trail openings and hunting on the currently closed refuge. Tom French from NHESP program was present in addition to Service staff.

June 2012 to May 2016. Developed the first six chapters, acronyms/glossary, bibliography, and eight appendices of the CCP and prepared them for internal review.

Partners Involved in Refuge Planning

Refuge programs enjoy a great deal of support from outside the Service in many areas: conducting biological surveys, enhancing public use and refuge programs, restoring habitat, and protecting land. Our partnerships will continue to expand with the increasing interest in conserving refuge resources. During the past year, we contacted the following organizations to apprise them of the planning process and encourage their involvement.

Massachusetts Department of Fish and Game, Division of Fisheries and Wildlife (MassWildlife):
Jason Zimmer, Steve Hurley

Massachusetts Department of Conservation and Recreation:
Dave Celino, District Fire Chief

Massachusetts Natural Heritage and Endangered Species Program:
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Kristen Hare

Measuring the size of a red bellied-cooter

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Kourtnie Bouley/USFWS

Crooked Pond at Massasoit National Wildlife Refuge

Glossary and Acronyms

- Glossary
- Acronyms and Abbreviations

Glossary

– A –

abate to reduce in amount, degree, intensity, to lessen or diminish.

abiotic relating to the non-living chemical and physical factors of the environment (e.g. temperature, water, soil, atmosphere, etc.).

abut to be adjacent, or to touch or join at the edge or border.

approved acquisition boundary A project boundary which the Regional Director of the U.S. Fish and Wildlife Service approves upon completion of the planning and environmental compliance process. An approved refuge boundary only designates those lands which the Fish and Wildlife Service has authority to acquire and/or manage through various agreements. Approval of a refuge boundary does not grant the Fish and Wildlife Service jurisdiction or control over lands within the boundary, and it does not make lands within the refuge boundary part of the National Wildlife Refuge System. Lands do not become part of the National Wildlife Refuge System unless they are purchased or are placed under an agreement that provides for management as part of the refuge system.

acrolein a yellow, volatile and flammable liquid (C_3H_4O), having a pungent odor, usually produced during the decomposition of glycerol or distillation of fats. Acrolein is also known as acraldehyde, acryl-aldehyde, or acrylic aldehyde.

adaptation adjustment to environmental conditions.

adaptive management focuses on learning and adapting, through partnerships of managers, scientists, and other stakeholders who learn together how to create and maintain sustainable ecosystems. Adaptive management helps science managers maintain flexibility in their decisions, knowing that uncertainties exist and provides managers the latitude to change direction will improve understanding of ecological systems to achieve management objectives is about taking action to improve progress towards desired outcomes.

adhesion the union of adjacent normally separate biological parts or tissues; or the molecular force of attraction in the area of contact between unlike bodies that acts to hold them together.

aeolian of or caused by the wind; wind-blown.

alternative a reasonable way to fix an identified problem or satisfy a stated need (40 CFR 1500.2).

ambient of the surrounding area or environment.

anthropogenic caused or produced by humans or human activity.

appropriate use a proposed or existing use on a refuge that meets at least one of the following three conditions: (1) the use is a wildlife-dependent one; (2) the use contributes to fulfilling the refuge purpose(s), the System mission, or goals or objectives described in a refuge management plan approved after October 9, 1997, the date the National Wildlife Refuge System Improvement Act was signed into law; or (3) the use has been determined appropriate as specified in section 1.11 of that Act.

aquatic growing in, living in, or dependent upon water.

aquifer A water bearing stratum (layer) of permeable rock, sand, or gravel.

assemblage a grouping or aggregate of persons, things, or species; the collection of species making up any co-occurring community of organisms in a given habitat or area.

At-Risk Community defined in Title I of the Healthy Forests Restoration Act as: 1) an area comprised of an interface community as defined in the notice *Wildland Urban Interface Communities Within the Vicinity of Federal Lands That Are at High Risk From Wildfire* issued by the Secretary of Agriculture and the Secretary of the Interior in accordance with Title IV of the U.S. Department of the Interior and Related Agencies Appropriations Act, 2001 (114 Stat. 1009) (66 FR 753, January 4, 2001), or; 2) a group of homes and other structures with basic infrastructure and services (such as utilities and collectively maintained transportation routes) within or adjacent to Federal land, in which conditions are conducive to a large-scale wildland fire disturbance event, and for which a significant threat to human life or property exists as a result of a wildland fire disturbance event.

Atlantic Flyway a bird migration route that generally follows the Atlantic coast of North America and the Appalachian Mountains.

atmospheric deposition atmospheric deposition is the pollution of water caused by air pollution.

atmospheric subsidence a descending motion of air in the atmosphere occurring over a rather broad area.

avian of or relating to birds.

– B –

barrens usually, level or slightly rolling land, usually with a sandy soil and few trees, and relatively infertile.

basin the land surrounding and draining into a water body; see “watershed.”

best management practices land management practices that produce desired results; 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.

biochemical cycling any of the natural pathways by which essential elements of living matter are circulated. The term biogeochemical is a contraction that refers to the consideration of the biological, geological, and chemical aspects of each cycle.

biodiversity conservation the goal of conservation biology, to retain indefinitely as much of the earth’s biotic diversity as possible, with emphasis on those biotic elements most vulnerable to human impacts.

biological diversity or biodiversity The variety of life, including the variety of living organisms, the genetic differences among them, and the communities in which they occur.

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

biomass the amount of living matter in a given habitat, expressed either as the weight of organisms per unit area or as the volume of organisms per unit volume of habitat, or; organic matter, especially plant matter, that can be converted to fuel and is therefore regarded as a potential energy source.

biota the plant and animal life of a region.

biotic relating to the living components of the environment (e.g., plants, animals, fungi, bacteria).

bird conservation region regions that encompass landscapes having similar bird communities, habitats, and resource issues; used as an administrative tool to aid in the conservation of birds and their habitats.

breeding habitat habitat used by migratory birds or other animals during the breeding season.

– C –

candidate species plants and animals for which the U.S. Fish and Wildlife Service has sufficient information on their biological status and threats to propose them as endangered or threatened under the Endangered Species Act, but for which development of a proposed listing regulation is precluded by other higher priority listing activities.

canid any animal of the dog family Canidae, including the wolves, jackals, hyenas, coyotes, foxes, and domestic dogs.

canopy the layer of foliage formed by the crowns of trees in a stand. For stands with trees of different heights, foresters often distinguish among the upper, middle and lower canopy layers. These represent foliage on tall, medium, and short trees.

carapace a bony or chitinous shield, test, or shell covering some or all of the dorsal part of an animal, as of a turtle.

carbon footprint the amount of carbon dioxide (CO_2) emitted from the consumption of fossil fuels by a particular person, group, organization, agency, etc.

carbon sequestration the process of capture and long-term storage of atmospheric carbon dioxide (CO_2).

categorical exclusion 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); also known as CE, CX, CATEX, or CATX.

cation any positively charged atom or group of atoms; a positively charged ion that is attracted to the cathode in electrolysis.

cation exchange	the ability of a substance such as soil, to attract, retain, and release positively charged ions (cations).
cation release	the loss or release of positively charged ions (cations) from a substance, such as soil.
chiefdom	the territory or people over which a Tribal chief rules.
chironomid	a family of nematoceran (suborder of elongated flies with thin, segmented antennae and mostly aquatic larvae) flies with global distribution.
coastal plain pond	Shallow, highly acidic groundwater ponds in glacial outwash, usually with no inlet or outlet. Water rises and falls with changes in the water table, typically leaving an exposed shoreline in late summer. In wet years, the pondshore may remain inundated. Substrate varies from sand - cobble to muck.
community	the locality in which a group of people resides and shares the same government community type; a particular assemblage of plants and animals.
combustion	the act or process of burning, commonly rapid oxidation accompanied by heat and, usually, light but also may be slow oxidation not accompanied by high temperature and light.
compaction	The process by which the porosity of a given form of sediment is decreased as a result of its mineral grains being squeezed together by the weight of overlying sediment or by mechanical means.
compatible use	"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 Law105-57; 111 Stat. 1253]
compatibility determination	a required determination for wildlife-dependent recreational uses or any other public uses of a refuge.
Comprehensive Conservation Plan	(CCP) mandated by the 1997 Refuge Improvement Act, a document that provides a description of the desired future conditions and long-range guidance for the project leader to accomplish purposes of the refuge system and the refuge. CCPs establish management direction to achieve refuge purposes. [P.L. 105-57; Service Manual 602 FW 1.4]
concern	see "issue."
conifer	a tree or shrub in the phylum Gymnospermae; a tree or shrub that bears cones and has evergreen needlelike or scale-like leaves. Examples include pines and firs (family Pinaceae).
conservation	managing natural resources to prevent loss or waste; management actions may include preservation, restoration, and enhancement.
conservation easement	a non-possessory interest in real property owned by another imposing limitations or affirmative obligations with the purpose of returning or protecting the property's conservation values.

conservation status assessment of the status of ecological processes and of the viability of species or populations in an ecoregion.

contiguous touching, in contact with or in close proximity to and nearby.

cooperative agreement a usually long-term habitat protection action, which can be modified by either party, in which no property rights are acquired. Lands under a cooperative agreement do not necessarily become part of the National Wildlife Refuge System.

cover-type characteristic dominant plant species, or a common aspect of the assemblage, such as an elevation range or environmental commonality.

critical habitat according to U.S. Federal law, the ecosystems upon which endangered and threatened species depend.

crowning potential the relative susceptibility of a forest stand to a crown fire, the likelihood that a fire spreading through forest fuels on the ground surface will move vertically into and begin spreading through the crowns of overtopping trees.

cultural resource inventory a professional study to locate and evaluate evidence of cultural resources within a defined geographic area [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. Service Manual 614 FW 1.7).].

cutin an insoluble mixture containing waxes, fatty acids, soaps, and resinous material that forms a continuous layer on the outer epidermal layer of a plant.

– D –

database a collection of data arranged for ease and speed of analysis and retrieval.

defoliation a condition of when the leaves of (a plant, tree, or forest) to fall off.

degradation the loss of native species and processes due to human activities such that only certain components of the original biodiversity persist, often including significantly altered natural communities.

deliverable something that is or can be delivered, such as merchandise, especially to fulfill a contract.

demographer a scientist who studies the growth and density of populations and their vital statistics.

demographic a single vital or social statistic of a human population, as the number of births or deaths, or a specific segment of a population having shared characteristics.

deposition the act or process of depositing something, such as eroded soil sediment, or contaminants or pollutants.

depot fat	body fat stored as tissue in which the tissue cells are distended by droplets of fat, also known as adipose tissue.
depredate	to prey upon; to plunder.
desired future condition	the future qualities of the refuge that the Service hopes to develop through management actions and decisions (i.e. What will the refuge look like in the future?).
detritus	any decomposed and disintegrated organic material; debris.
devolve	to roll or flow downward.
disjunct	marked by separation from usually contiguous parts or individuals.
disseminate	to scatter or spread widely, as though sowing seed; promulgate extensively; broadcast; disperse.
disturbance	any relatively discrete event in time that disrupts ecosystem, community, or population structure and changes resources, habitat availability, or the physical environment.
disturbance dependent	species associated with a wide variety of naturally open habitats including grasslands, prairies, savannas, glades and barrens, bogs, beaver meadows (floodplains), xeric scrublands, open pine or oak woodlands.
disturbance regime	the pattern of disturbances that shape an ecosystem over a long time scale; it describes a spatial disturbance pattern, a frequency and intensity of disturbances, and a resulting ecological pattern over space and time; includes disturbance distribution, frequency, rotation period, predictability, area disturbed, and magnitude intensity (or severity).
division	an administrative unit of the refuge defined by a geographic feature, usually a river or other body of water (see biological integrity).
donation	a citizen or group may wish to give land or interests in land to the Service for the benefit of wildlife. Gifts and donations have the same planning requirements as purchases.
drawdown	a lowering of water surface level, as in a well; a reduction or depletion.
duff	a layer of organic matter in various stages of decomposition on a forest floor.
dwarf shrub	a perennial, multi-stemmed low-growing woody plant that is usually under 0.5 m (1.5 feet) tall, never exceeding 1 meter (3 feet) tall at maturity, typically have several stems arising from or near the ground.

– E –

early successional species, assemblages, structures, and processes associated with pioneering natural communities that have recently experienced significant disturbance

easement a non-possessory interest in real property that permits the holder to use another's land for a specified purpose. It may also impose limitations or affirmative obligations on the holder of the land subject to the 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 (see "conservation easement").

ecological integrity The integration of biological integrity, natural biological diversity, and environmental health; the replication of natural conditions. For communities, integrity is governed by demographics of component species, intactness of landscape-level processes (e.g., natural fire regime), and intactness of internal community processes (e.g., pollination).

ecological processes a complex mix of interactions among animals, plants, and their environment that ensures maintenance of an ecosystem's full range of biodiversity. Examples include population and predator-prey dynamics, pollination and seed dispersal, nutrient cycling, migration, and dispersal.

ecoregion a territory defined by a combination of biological, social, and geographic criteria, rather than geopolitical considerations. Generally, a system of related interconnected ecosystems.

ecosystem a natural community of organisms interacting with its physical environment, regarded as a unit.

ecosystem service a benefit or service provided free by an ecosystem or by the environment, such as clean water, flood mitigation, or groundwater recharge.

emergence when an adult insect emerges (or excloses) from the pupal stage by splitting the pupal case.

emergent wetland wetlands dominated by erect, rooted, herbaceous plants.

endangered species a federally listed or State-listed protected species in danger of extinction throughout all or a significant portion of its range.

endemic natural to or characteristic of a specific people or place; native; indigenous; belonging exclusively or confined to a particular place.

environment the sum total of all biological, chemical, and physical factors to which organisms are exposed.

Environmental Assessment (EA) a public document that discusses the purpose and need for an action, its alternatives, and provides sufficient evidence and analysis of its impacts to determine whether to prepare an environmental impact statement or a finding of no significant impact (q.v.) [cf. 40 CFR 1508.9].

environmental education curriculum-based education aimed at producing a citizenry that is knowledgeable about the biophysical environment and its associated problems, aware of how to help solve those problems, and motivated to work toward solving them.

environmental health the composition, structure, and functioning of soil, water, air, and other abiotic features comparable with historic conditions, including the natural abiotic processes that shape the environment. (see “abiotic”).

environmental justice the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies.

ephemeral lasting a very short time; short-lived; transitory; anything short-lived, as certain insects.

ericaceous belonging to the heath family of plants (Ericaceae).

erosion the process by which the surface of the earth is worn away by the action of water, glaciers, winds, waves, etc.

evaluation examination of how an organization’s plans and actions have turned out — and adjusting them for the future.

evapotranspiration the combination of evaporation from the ground and transpiration from plants.

exacerbate to make more severe or harsh.

exceedance above the limit or the standard.

exclosure A non-lethal method for decreasing predation uses protective cages; an area protected against intruders such as predators, as by fences.

exotic species a species that is not native to an area and has been introduced intentionally or unintentionally by humans; not all exotics become successfully established (see “invasive species”).

extinction the termination of any lineage of organisms, from subspecies to species and higher taxonomic categories from genera to phyla. Extinction can be local, in which one or more populations of a species or other unit vanish but others survive elsewhere, or total (global), in which all the populations vanish.

extirpated status of a species or population that has completely vanished from a given area but that continues to exist in some other location.

extrapolate to estimate to values outside or beyond the known or observed range of those values; to infer an unknown from something that is known.

– F –

fauna all animal life associated with a given habitat, country, area or period.

fecundity the capacity of abundant production; capacity, especially in female animals, of producing young in great numbers.

Federal land public land owned by the Federal Government, including national forests, national parks, and national wildlife refuges.

Federal-Recognized Native American Tribe
A group of Native American Indians recognized by the United States as an Indian Tribe. This recognition establishes a Tribe as an entity with the capacity to engage in government-to-government relations with the United States, or individual states, and also as one eligible to receive Federal services. Federal recognition is established as a result of historical and continued existence of a Tribal government; by Executive Order or legislation; and through the Federal recognition process established by Congress.

Federal trust resource
a resource that the Federal Government holds in trust for the people through law or administrative act. 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.

Federal trust responsibility
In the Federal government, a special duty required of agencies to hold and manage lands, resources, and funds on behalf of Native American Tribes.

federally listed species
a species listed either as endangered, threatened, or a species at risk under the Endangered Species Act of 1973, as amended.

fee-title acquisition
the acquisition of most or all of the rights to a tract of land; a total transfer of property rights with the formal conveyance of a title. While a fee-title acquisition involves most rights to a property, certain rights may be reserved or not purchased, including water rights, mineral rights, or use reservation (e.g., the ability to continue using the land for a specified time period, such as the remainder of the owner's life).

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].

fire behavior
the manner in which fuel ignites, flame develops, and fire spread and exhibits other related phenomena as determined by the interaction of fuels, weather, and topography.

fire intensity
A general term relating to the heat energy released by a fire.

fire management
all activities related to the management of wildfires.

fire regime
the characteristic frequency, intensity, and spatial distribution of natural fires within a given ecoregion or habitat.

flora
all the plants found in a particular place.

flowage
an overflowing onto adjacent land; a body of water formed by overflowing or damming; floodwater especially of a stream; flowing or overflowing water, or other liquid.

flyway
any one of several established migration routes of birds.

focal species	a species that is indicative of particular conditions in a system (ranging from natural to degraded) and used as a surrogate measure for other species of particular conditions. An element of biodiversity selected as a focus for conservation planning or action.
focus areas	see “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.
forest	land dominated by trees.
forest maturation	the point in the life cycle of a stand of trees or forest at which there is no net biomass accumulation; the stage before decline when annual growth is offset by breakage and decay.
formaldehyde	a colorless, toxic, potentially carcinogenic, water-soluble gas, CH_2O, having a suffocating odor, usually derived from methyl alcohol by oxidation, also known as methanal.
fragmentation	the disruption of extensive habitats into isolated and small patches. Fragmentation has two negative components for biota: the loss of total habitat area, and the creation of smaller, more isolated patches of habitat.
fuel break	A strip or block of land on which the vegetation, debris and detritus have been reduced and/or modified to control or diminish the risk of the spread of fire crossing the strip or block of land.
fuel load	The amount of fuel present expressed quantitatively in terms of weight of fuel per unit area, for example tons per acre.
fyke nets	a long bag net kept open by hoops used to trap animals like fish and turtles.

– G –

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).
geomorphic region	an area or landform shaped by a similar set of geologic forces and processes, exhibiting similar physical topographic and natural features.
girdling	killing a tree by removing a strip of bark from around its trunk.
glacial maximum	period in climate history when ice sheets reach their greatest areal extent, last reached in North America approximately 26,500 years ago.
glacial till	unsorted sediments directly deposited by a glacier, typically containing a mixture of clay, sand, gravel and boulders.
glaciofluvial	material moved by glaciers and subsequently sorted and deposited by streams flowing from the melting ice. The deposits are stratified and may occur in the form of outwash plains, deltas, kames, eskers, and kame terraces.

glyphosate a water soluble organophosphate compound of glycine and phosphate, $C_3H_8NO_5P$, used as a broad-spectrum systemic herbicide.

graminoid grasses (family Gramineae or Poaceae) and grasslike plants such as sedges (family Cyperaceae) and rushes (family Juncaceae).

grassland a habitat type with landscapes dominated by grasses.

groundwater water in the ground that is in the zone of saturation, from which wells and springs and groundwater runoff are supplied.

– H –

habitat fragmentation the breaking up of a specific habitat into smaller, unconnected areas. 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 a habitat to ensure that the use of that habitat wildlife and plants is not changed or reduced.

habitat is a combination of environmental factors that provides food, water, cover and space that a living thing needs to survive and reproduce.

headstarting hatching turtle eggs in controlled conditions and releasing these turtles in their natural environment when they reach an age and size that would have a better chance of survival against predators.

herbaceous a plant that has a non-woody stem and which dies back at the end of the growing season; having the texture, color, etc., of an ordinary foliage leaf.

herpetofauna the species of reptiles and amphibians in a particular area.

heterogeneity the quality or state of being heterogeneous (diverse in character or content).

hibernacula protective sites, especially for winter; winter quarters, used by hibernating animals.

historic conditions the composition, structure, and functioning of ecosystems resulting from natural processes that we believe, based on sound professional judgement, were present prior to substantial human-related changes to the landscape.

historic range of variability the maximum and minimum extremes in ecosystem or landscape structure, composition, and function during a prior time period. Departure of an ecosystem/landscape from the past range of variability is an important metric for sustaining biotic diversity and ecosystem integrity used by land managers.

hydrocarbons any of a class of compounds containing only hydrogen and carbon, as: an alkane, methane (CH_4); an alkene, ethylene (C_2H_4); an alkyne, acetylene, (C_2H_2); or an aromatic compound, benzene, (C_6H_6).

hydrology — the science of waters of the earth, their occurrences, distributions, and circulations; their physical and chemical properties; and their reactions with the environment.

hydrophobic — having little or no affinity for water.

hyperendemic — exhibiting a high and continued incidence—used chiefly of human diseases.

– I –

imazapyr — an imidazolinone herbicide used to control grasses, broadleaves, vines, brambles, brush, and trees. It disrupts an enzyme (found only in plants) necessary for protein synthesis, and interferes with cell growth and DNA synthesis in plants.

impact — influence; effect; to have an effect on; influence; alter.

incubation — sitting on or brooding the eggs of birds and other egg-laying animals to hatch them.

indigenous — native to an area; a species that historically occurred or currently occurs in a particular ecosystem.

infiltration — the seepage of water into soil or rock.

integrated pest management — (IPM) sustainable approach to managing pests by combining biological, cultural, physical, and chemical tools in a way that minimizes economic, health, and environmental risks.

interjurisdictional — a resource that occurs in an area under the jurisdiction of two or more states or countries; legislation arising from one level of jurisdiction may be applicable to matters covered at another level.

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).

intradepartmental — involving or existing within the same or a single organizational department.

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.

invasive species — an alien species whose introduction causes or is likely to cause economic or environmental harm or harm to human health.

invertebrate — any animal lacking a backbone or bony segment that encloses the central nerve cord.

irretrievable — the use or consumption of a specified resource that is neither renewable nor recoverable for later use by future generations.

irreversible — a commitment of resources whose primary or secondary impacts limit the future option for using a specified resource.

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. [A CCP should document, describe, and analyze issues even if they cannot be resolved during the planning process (Service Manual 602 FW 1.4).]

iterative — a process for calculating a desired result by means of a repeated cycle of operations. An iterative process should be convergent, i.e., it should come closer to the desired result as the number of iterations increases.

– K –

kame — a hill or hummock composed of stratified sand and gravel laid down by glacial meltwater.

kettle hole — a generally circular hollow or depression in an outwash plain or moraine, believed to have formed where a large block of subsurface ice has melted.

kiosk — a small open structure with one or more sides used to display information.

– L –

landscape — a heterogeneous land area composed of a cluster of interacting ecosystems that are repeated in similar form throughout.

landform — the physical shape of the land reflecting geologic structure and processes of geomorphology that have sculpted the structure.

late-successional — species, assemblages, structures, and processes associated with mature natural communities that have not experienced significant disturbance for a long time.

LD-50 — the amount of a material, given all at once, which causes the death of 50 percent (one half) of a group of test animals.

lentic — pertaining to or inhabiting still water.

lepidopteran — insects comprising the butterflies, moths, and skippers that as adults have four broad or lanceolate wings usually covered with minute overlapping and often brightly colored scales and that as larvae are caterpillars.

leptospiral — an infection or disease condition caused by any of several spirally shaped, aerobic bacteria of the genus *Leptospira*.

limiting factor — an environmental limitation that prevents further population growth.

littoral — the near shore region of freshwater lake beds from the sublittoral zone up to and including damp areas on shore; of or relating to the shore of a lake, sea, or ocean.

local agencies — generally municipal governments, regional planning commissions, or conservation groups.

logging slash — In forestry, slash are coarse and fine woody debris generated during logging operations or through wind, snow or other natural forest disturbances.

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 (see “fee-title acquisition”).

lotic — pertaining to or inhabiting flowing water.

– M –

macrofauna — animals of soil or benthic sediments that are greater than about 1 or 2 millimeters in size, generally large enough to be visible with the naked eye, such as earthworms or polychaetes.

macroinvertebrates — invertebrates large enough to be seen with the naked eye (e.g., most aquatic insects, snails, and amphipods).

malady — any undesirable or disordered condition; any disorder or disease, especially if a chronic or deepseated disorder.

management alternative — a set of objectives and the strategies needed to accomplish each objective [Service Manual 602 FW 1.4].

management concern — see “issue.”

management opportunity — see “issue.”

management plan — a plan that guides future land management practices on a tract. [In the context of an environmental impact statement, management plans may be designed to produce additional wildlife habitat along with primary products like timber or agricultural crops (see “cooperative agreement”).]

management strategy — a general approach to meeting unit objectives. [A strategy may be broad, or it may be detailed enough to guide implementation through specific actions, tasks, and projects (Service Manual 602 FW 1.4).]

mastadons — an extinct group of mammal species related to elephants, that inhabited North and Central America during the late Miocene or late Pliocene up to their extinction at the end of the Pleistocene 10,000 to 11,000 years ago.

masticate — to reduce to a pulp by crushing or grinding, as rubber; to chew.

Memorandum of Understanding — (MOU) a document that describes an agreement between partners where a set of expectations, actions or commitments are agreed upon.

mesic of, relating to, or adapted to an environment having a balanced supply of moisture.

metapopulation a group of spatially separated populations of the same species which interact at some level.

microbial nitrogen fixation a process in which nitrogen (N_2) in the atmosphere is converted into ammonium (NH_4^+) or nitrogen dioxide (NO_2) by microorganisms.

microburst a very localized column of rapidly sinking air.

microclimate climate of a small, specific place within a larger area. A small yard or park can have several microclimates differing by how much sunlight, shade, or exposure to the wind there is at a particular spot.

microfauna animals that cannot be seen with the naked eye, normally observed with the aid of a microscope; small, often microscopic animals, especially those inhabiting the soil, an organ, or other localized habitat; the animals of a microhabitat.

microhabitat the local habitat of a particular organism or microorganism. There are normally a number of different microhabitats within a large habitat (*macrohabitat*), each with its distinct set of environmental conditions.

mid-seral an intermediate stage of secondary forest succession in which plant species typical of the potential natural community are increasing in the forest composition as a result of their active colonization of the site, and are approaching equal proportions with the seral species.

migratory birds species that generally migrate south each fall from breeding grounds to their wintering grounds and vice versa in the spring

milfoil a widely distributed aquatic plant with whorls of fine submerged leaves and wind-pollinated flowers from the Genus *Myriophyllum*, family *Haloragaceae,* often considered a highly invasive aquatic plant.

mineralization mineralization is a decomposition process in which complex organic substances are converted to simpler inorganic substances by heat, sunlight, water, chemicals, or biological metabolism such as by soil microorganisms.

mission statement a succinct statement of the purpose for which the refuge was established; its reason for being.

mitigation actions 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).

monitoring the process of collecting information to track changes of selected parameters over time.

monoculture a land management strategy in which large areas are planted with a single crop, over many years.

monotype the plant species dominating an area to the near exclusion of all other potential plant species suited to the area.

moraine a mass or ridge of earth scraped up by ice and deposited at the edge or end of a glacier.

mosaic an interconnected patchwork of distinct vegetation types.

motile moving or capable of moving spontaneously.

– N –

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 (refuge complex) an internal Service administrative linking of refuge units closely related by their purposes, goals, ecosystem, or geopolitical boundaries.

National Wildlife Refuge System (Refuge System) all lands and waters and interests therein administered by the U.S. Fish and Wildlife Service as wildlife refuges, wildlife ranges, wildlife management areas, waterfowl production areas, and other areas managed to preserve a national network for the conservation and management of fish, wildlife, and plant resources of the United States, for the benefit of present and future generations (National Wildlife Refuge System Improvement Act, 16 USC 668dd).

native a species that historically occurred or currently occurs in a particular ecosystem.

native plant a plant that has grown in the region since the last glaciations and occurred before European settlement.

natural disturbance event any natural event that significantly alters the structure, composition, or dynamics of a natural community: e.g., floods, fires, and storms.

natural processes a complex mix of interactions among animals, plants, and their environment that ensures maintenance of an ecosystem's full range of biodiversity. Examples include population and predator-prey dynamics, pollination and seed dispersal, nutrient cycling, and migration.

neotropical migrant birds, bats, or invertebrates that seasonally migrate between the Neoarctic region (North America as far south as northern Mexico) and the neotropical region (South America as far north as northern Mexico).

nitrification	the chemical process in which a nitro group is added to or substituted for an organic compound; the oxidation of ammonium compounds in dead organic material into nitrates and nitrites by soil bacteria (making nitrogen available to plants); conversion of nitrogen from inorganic to organic by nitrate bacteria, into a form that it can be taken up through plant roots and used again for plant growth.
nitrogen oxides	the mono-nitrogen oxides NO and NO_2 (nitric oxide and nitrogen dioxide). Nitrogen oxides (NO_x) are produced during combustion in the presence of nitrogen from the reaction among nitrogen, oxygen and/or hydrocarbons, especially at high temperatures, as in air-breathing engines or by lightning. In atmospheric chemistry, the term means the total concentration of NO and NO_2. NO_x gases react to form smog and acid rain and are central to ground level ozone formation.
nonattainment	to have air quality worse than the National Ambient Air Quality Standards as defined in the Clean Air Act Amendments of 1970.
non-consumptive, wildlife-oriented recreation	wildlife observation and photography and environmental education and interpretation (see “wildlife-oriented recreation”).
non-native species	see “exotic species” or “invasive species.”
non-point source	pollution originating from multiple, diffuse locations, generally resulting from land runoff, precipitation, atmospheric emissions and deposition, drainage, seepage or hydrologic modification. As the runoff or polluted air mass moves, it picks up and carries away natural and human-made pollutants, finally depositing them into lakes, rivers, wetlands, coastal waters and ground waters.
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].

– O –

objective	a concise statement of what a refuge wants to achieve, how much a refuge wants to achieve, when and where the refuge wants to achieve it, and who is responsible for the work. Objectives derive from refuge goals and provide the basis for determining strategies, monitoring refuge accomplishments, and evaluating the success of strategies.
odonate	a predatory insect of the order *Odonata*; a dragonfly or damselfly.
open canopy	the condition when individual plants forming the upper layer or habitat zone, formed by mature tree crowns and including other biological organisms (epiphytes, lianas, arboreal animals, etc.) are widely spaced, allowing unfiltered sunlight to reach the ground surface. The term is most commonly used when forest canopy closure falls within the range of 25 to 70 percent.
organo-chlorine	an organic compound containing at least one covalently bonded chlorine atom as the dominant functionality, of which chloroalkane and chlorinated solvent as examples are major members. Their wide structural variety and divergent chemical properties lead to a broad range of names and applications, many of which are controversial because of their effects on the environment, human and animal health.

outwash plain the plain formed by deposits from a stream or river originating from the melting of glacial ice that are distributed over a considerable area; generally coarser, heavier material is deposited nearer the ice and finer material carried further away.

overstory the uppermost layer of foliage that forms a forest canopy.

– P –

pandemic a disease epidemic over a large area, such as an entire country, continent, or the whole world.

parameter characteristic or factor; aspect; element; limits or boundaries; guidelines a variable entering into the mathematical form of any distribution such that the possible values of the variable correspond to different distributions. A variable that must be given a specific value during the execution of a program or of a procedure within a program.

particulate matter microscopic solid or liquid matter suspended in the atmosphere; a complex mixture of extremely small particles and liquid droplets. Particle pollution is made up of a number of components, including acids (such as nitrates and sulfates), organic chemicals, metals, and soil or dust particles.

partnership any time that a Federal or non-Federal individual or entity work together with the U.S. Fish and Wildlife Service to achieve a mutual goal.

patch-mosaic a means of visualizing spatially heterogeneous ecosystems or natural landscapes as a larger matrix (mosaic) smaller areas or patches, the patches differing from the larger matrix and each other in size, shape, composition, natural history, duration in the landscape, and/or boundary characteristics.

payment in lieu of taxes see Revenue Sharing Act of 1935, Chapter One, Legal Context.

phenology the study of cyclical and seasonal natural phenomena, especially in relationship to climate and plant and animal life cycle events.

physiographic relating to physical geography.

plant community a distinct assemblage of plants that develops on sites characterized by particular climates and soils.

plume something (such as smoke, steam, or water) that moves into the air, water, or ground as it disperses in a long or tall, thin or conical shape , such as sewage outflow from a sewage treatment plant, or smokestack emissions from a factory.

population an interbreeding group of plants or animals. The entire group of individuals of one species.

population monitoring assessing the characteristics of populations to ascertain their status and establish trends on their abundance, condition, distribution, or other characteristics.

population persistence when a given interbreeding group of individuals of a single species, generally living in the same geographic area, (a population) continues to exist (avoid extinction), over a specified time period, usually expressed as a probability of persistence over a specified number of years or generations. Commonly used by conservation biologists as a relative index of extinction risk.

preferred alternative The alternative determined by the decision-maker that best achieves the refuge's purpose, vision, and goals; contributes to the Refuge System mission; addresses the significant issues; and is consistent with principles of sound fish and wildlife management.

prescribed fire the application of fire to wildland fuels, either by natural or intentional ignition, to achieve identified land use objectives [Service Manual 621 FW 1.7] Also referred to as prescribed burn and controlled burn.

presence-absence data results (data) from biological survey methods recording when one or more species of interest was detected as present within the area surveyed. A species is inferred as absent from the area if it was not detected by the survey method(s) used.

priority public use a compatible wildlife-dependent recreational use of a refuge involving hunting, fishing, wildlife observation and photography, or environmental education and interpretation.

private land land owned by a private individual or group or non-government organization.

private organization any non-government organization.

proposed wilderness an area of the Refuge System that the Secretary of the Interior has recommended to the President for inclusion in the National Wilderness Preservation System.

protection mechanisms that ensure land use and land management practices will remain compatible with maintaining species populations at a site.

public individuals, organizations, and non-government groups; officials of Federal, state, and local government agencies; Native American Tribes, and foreign nations—includes anyone outside the core planning team, those who may or may not have indicated an interest in the issues, and those who do or do not realize that our decisions may affect them.

public involvement offering an opportunity to interested individuals and organizations whom our actions or policies may affect to become informed; soliciting their opinions. We thoroughly study public input, and give it thoughtful consideration in shaping decisions about managing refuges.

public land land owned by the local, state, or Federal government.

public use when individuals utilize the property or lands possessed by another (e.g. the government) who holds them for the benefit of others.

– R –

rare species species identified for special management emphasis because of their uncommon occurrence within a given region.

rate of spread the linear rate of advance of a wildland fire into unburned fuel in the direction perpendicular to the fire front, expressed as distance spread during a specified period of time (e.g. feet per minute).

Record of Decision (ROD) a concise public record of a decision by a Federal agency pursuant to NEPA. 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 (see "desired future conditions").

refuge purposes 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.

refuge lands lands in which the Service holds full interest in fee-title or partial interest, such as an easement.

refugia areas where special environmental circumstances enable individuals of a species or a community to survive when otherwise fatal conditions or events affect the surrounding areas.

residual smoldering the long-duration combustion that may persist for several hours or several days following the passage of the flame front.

resiliency an ability to recover from or adjust easily to change.

restoration management of a disturbed or degraded habitat that results in the recovery of its original state (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).

retention cut a silvicultural system that retains individual trees or groups of trees to: 1) maintain structural diversity over the area of the cutblock for at least one rotation, or 2) leave more than half the total area of the cutblock within one tree height from the base of a tree or group of trees, whether or not the tree or group of trees is inside the cutblock.

revegetate to grow plants again; to cause vegetation to grow again on a given area.

riparian of, relating to, or situated or dwelling on the bank of a river or other body of water.

riverine within the active channel of a river or stream.

riverine wetlands all the wetlands and deepwater habitats occurring within a freshwater river channel not dominated by trees, shrubs, or persistent emergents.

ruderal a plant growing in waste places, along roadsides or in rubbish; a weedy plant.

runoff water from rain, melted snow, or agricultural or landscape irrigation that flows over a land surface into a water body (see “urban runoff”).

– S –

sachemship the domain or area ruled by the chief of an American Indian Tribe.

scale the magnitude of a region or process. Refers to both spatial size—for example, a (relatively small-scale) patch or a (relatively large-scale) landscape; and temporal rate—for example, (relatively rapid) ecological succession or (relatively slow) evolutionary speciation.

sedge any plant of the sedge family; any rushlike or grasslike plant of the genus *Carex,* growing in wet places.

sediment core a sample of 2-5 inch diameter of undisturbed soil deposits in the bottom of a lake or wetland which reflect changes over time, typically extracted using a long narrow metal (generally aluminum) tube. The soil samples are removed, dried, and analyzed in a laboratory.

sequestration the trapping of a chemical in the atmosphere or environment and its isolation in a natural or artificial storage area.

seral stage an intermediate phase found in ecological succession in an ecosystem advancing towards its climax community.

Service U.S. Fish and Wildlife Service.

Service presence public awareness of the Service; programs and facilities directed by the Service or that the Service shares with other organizations.

shrublands habitats dominated by various species of shrubs, often with many grasses and forbs.

siltation to fill, cover, or obstruct with silt or mud.

silvicultural the cultivation of forest trees; forestry.

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 on-native with native plants, refurbishing footbridges and trails, and renovating or expanding exhibits).

small patch communities that form small, discrete areas of vegetation cover. Individual occurrences of this community type typically range in size from 1 to 50 hectares. Small patch communities occur in very specific ecological settings, such as on specialized landform types or in unusual microhabitats. The specialized conditions of small patch communities, however, are often dependent on the maintenance of ecological processes in the surrounding matrix and large patch communities. In many ecoregions, small patch communities contain a is proportionately large percentage of the total flora, and also support a specific and restricted set of associated fauna (e.g., invertebrates or herpetofauna) dependent on specialized conditions.

snag a standing dead tree.

socioeconomic social and economic conditions and their interplay.

soil aeration the ability of the soil to have air that makes it favorable for plant growth.

soil porosity the ratio, expressed as a percentage, of the volume of the pores, voids or interstices of a soil, to the total volume of the soil mass.

spatial analysis a set of techniques for analyzing the attributes of data or objects that are dependent on the locations of the objects being analyzed.

species the basic category of biological classification intended to designate a single kind of animal or plant. Any variation among the individuals may be regarded as not affecting the essential sameness which distinguishes them from all other organisms.

species of concern an informal term referring to a species that might be in need of conservation action. This may range from a need for periodic monitoring of populations and threats to the species and its habitat, to the necessity for listing as threatened or endangered under the Endangered Species Act. Such species receive no legal protection and use of the term does not necessarily imply that a species will eventually be proposed for listing.

species richness a simple measure of species diversity calculated as the total number of species in a habitat or community.

stakeholder individuals, groups, organizations or agencies representing a broad spectrum of interests offering business, tourism, conservation, recreation, and historical perspectives.

stand an area of trees (or other vegetation) with a common set of conditions (e.g., based on age, density, species composition, or other features) that allow a single management treatment throughout.

state agencies agencies of state governments.

state land state-owned public land.

state-listed species a species listed as endangered, threatened, or a species of conservation concern by a state.

status assessment	a compilation of biological data and a description of past, present and likely future threats to a species.
stepdown management plan	a plan for dealing with specific refuge management subjects, strategies, and schedules (e.g., Habitat Management Plan, Fire Management Plan, Inventorying and Monitoring Plan) [Service Manual 602 FW 1.4].
stormwater	water runoff generated when precipitation from rain and snowmelt events flows over land or impervious surfaces.
strategy	a specific action, tool, technique, or combination of actions, tools, and techniques for meeting refuge objectives.
strategic management	the continual process of inventorying, choosing, implementing, and evaluating what an organization should be doing.
stratified	to lie in beds or layers.
structure	the horizontal and vertical arrangement of trees and other vegetation having different sizes, resulting in different degrees of canopy layering, tree heights, and diameters within a stand.
subclimax species	a species associated with the stage in the ecological succession of a plant or animal community immediately preceding a climax, often persisting because of the repeated effects of fire, flood, or other conditions.
submerged aquatic vegetation	(SAV) plants that live under water, such as sea grasses like eelgrass.
subpopulation	a part or subdivision of a population, especially one originating from some other population.
substrate	the base or material on which a non-motile organism lives or grows; something that underlies or serves as a basis or foundation.
succession	the natural, sequential change of species composition of a community in a given area.
successional habitat	the plants and animals typically occurring together in a given seral stage of ecological following a disturbance event such as from a lava flow or a severe landslide, or by some form of disturbance of a community, such as from a fire, severe windthrow, or logging.
sulfate aerosol	a suspension of fine solid particles of a sulfate or tiny droplets of a solution of a sulfate or of sulfuric acid (not technically a sulfate).
supraglacial	of, relating to, or situated or occurring at the surface of a glacier.
surface water	all waters whose surface is naturally exposed to the atmosphere, or wells or other collectors directly influenced by surface water.

surrogate species a species that serves as an indicator of landscape habitat and system conditions.

suspended solids small solid particles which remain in suspension in water as a colloid or due to the motion of the water. It is used as one indicator of water quality.

– T –

taxonomic status the unique nomenclature and categories assigned to a given biological organism through the scientific classification process known as taxonomy.

terminal moraine a mass of rocks and sediment carried down and deposited by a glacier at the point of furthest advance of a glacier.

terrace a step-like landform, consisting of a flat or gently sloping geomorphic surface, called a tread, that is typically bounded one side by a steeper ascending slope, which is called a "riser" or "scarp." The tread and the steeper descending slope (riser or scarp) together constitute the terrace.

terrestrial living on land.

territory an area over which an animal or group of animals establishes jurisdiction.

thermal stratification the vertical temperature stratification of a lake or reservoir which consists of: (a) the upper layer, or epilimnion, in which the water temperature is virtually uniform; (b) the middle layer, or thermocline, in which there is a marked drop in temperature per unit of depth; and (c) the lowest stratum, or hypolimnion, in which the temperature is again nearly uniform.

thinning reducing the density of trees in a stand primarily to improve the growth and condition of the remaining trees and prevent mortality.

threatened species a federally listed, protected species that is likely to become an endangered species in all or a significant portion of its range.

torpor a diurnal hibernation-like state.

total maximum daily load (TMDL) a calculation of maximum amount of a pollutant that a waterbody can receive and still meet water quality standards.

transect a path along which one counts and records occurrences of the phenomena of study (e.g. plants).

trust resource a resource that the Government holds in trust for the people through law or administrative act. 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.

tryclopyr a systemic foliar pyridine herbicide, used to control broadleaf weeds while leaving grasses and conifers unaffected.

turbidity refers to the extent to which light penetrates a body of water.

tussock a tuft or clump of growing grass or the like.

– U –

unconsolidated loose materials, ranging from clay to sand to gravel. Ground water flows through spaces between the grains. Geologic processes can likewise erode and metamorphose unconsolidated sediments.

understory the lower layer of vegetation in a stand, which may include short trees, shrubs, and herbaceous plants.

upland dry ground (i.e., other than wetlands).

– V –

vernal pool a type of seasonal wetland formed by isolated depressions in the landscape that hold water in the winter and spring and are usually dry by midsummer or fall. There are no permanent surface connections to flowing water. Water sources include rainfall, snowmelt and elevated water tables. Although fish are usually absent, vernal pools in riparian floodplains may contain fish periodically. Vernal pools are important breeding sites for amphibians. The woody debris and emergent grasses provide attachment sites for egg masses.

vision statement a concise statement of what a refuge hopes to achieve over the next 15 years.

volatile organic compound (VOC) hydrocarbon compounds that have low boiling points, usually less than 100°C, and therefore evaporate readily. Some are gases at room temperature. Propane, benzene, and other components of gasoline are all volatile organic compounds; when released into the atmosphere by anthropogenic and natural emissions they are important because of their involvement in photochemical pollution.

volatilization passing off in vapor.

– W –

waterbody Any significant accumulation of water forming a physiographic feature, such as a river, lake, bay, a sea or a reservoir.

watershed the geographic area within which water drains into a particular river, stream, or body of water. A watershed includes both the land and the body of water into which the land drains.

water supply the supply of purified, drinkable or potable water available to a community.

water withdrawal freshwater taken from ground or surface water sources, either permanently or temporarily, and conveyed to a place of use.

wetlands lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water. These areas are inundated or saturated by surface water or groundwater at a frequency and duration sufficient to support a prevalence of vegetation typically adapted to life in saturated soil conditions.

White-nose syndrome a fungal disease of bats caused by the fungus *Pseudogymnoascus destructans* (formerly known as *Geomyces destructans*).

wilderness area an area designated by Congress as part of the National Wilderness Preservation System [Service Manual 610 FW 1.5 (draft)].

wilderness study area lands and waters identified by inventory as meeting the definition of wilderness and being evaluated for a recommendation they be included in the Wilderness System. A wilderness study area must meet these criteria: generally appears to have been affected primarily by the forces of nature, with the imprint of human substantially unnoticeable; has outstanding opportunities for solitude or a primitive and unconfined type of recreation; has at least 5,000 contiguous, roadless acres, or sufficient size to make practicable its preservation and use in an unimpaired condition (Service Manual 610 FW 1.5 (draft)).

wildfire a free-burning fire requiring a suppression response; all fire other than prescribed fire that occurs on wildlands [Service Manual 621 FW 1.7]. An unplanned ignition caused by lightning, volcanoes, unauthorized, and accidental human-caused actions and escaped prescribed fires.

wildland urban interface The line, area, or zone where structures and other human development meet or intermingle with undeveloped wildland or vegetative fuels.

wildlife-dependent recreational use use of a national wildlife refuge involving hunting, fishing, wildlife observation and photography, or environmental education and interpretation (National Wildlife Refuge System Administration Act of 1966).

wildlife management manipulating wildlife populations, either directly by regulating the numbers, ages, and sex ratios harvested, or indirectly by providing favorable habitat conditions and alleviating limiting factors.

wildlife-oriented recreation recreational activities in which wildlife is the focus of the experience. ["The terms 'wildlife-dependent recreation' and 'wildlife-dependent recreational use' mean a use of a refuge involving hunting, fishing, wildlife observation and photography, or environmental education and interpretation."—National Wildlife Refuge System Improvement Act of 1997]

wind throw trees uprooted or broken by wind.

xeric of an environment (or habitat) containing little moisture; very dry.

Acronyms and Abbreviations

Acronym	Full Name
ACJV	Atlantic Coast Joint Venture
AHWP	Annual Habitat Work Plan
ARPA	Archaeological Resources Protection Act
ATV	All-terrain Vehicle
BCC	Birds of Conservation Concern
BCR	Bird Conservation Region
BMP	Best Management Practices
BP	Before Present
CAA	Clean Air Act
CCP	Comprehensive Conservation Plan
CCSP	U.S. Climate Change Science Program
CD	Compatibility Determination
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
CO	Carbon Monoxide
EA	Environmental Assessment
EEE	Eastern Equine Encephalitis
EO	Executive Order
ESA	Endangered Species Act
FMP	Fire Management Plan
FOA	Findings of Appropriate Use
FONSI	Finding of No Significant Impact
Gd	*Geomyces destructans*
GIS	Geographic Information System
HMP	Habitat Management Plan
IMP	Inventory and Monitoring Plan
IPCC	Intergovernmental Panel on Climate Change
IPMP	Integrated Pest Management Plan
LCC	Landscape Conservation Cooperative
MA	Massachusetts
MADCR	Massachusetts Department of Conservation and Recreation

Acronym	Full Name
MADEP	Massachusetts Department of Environmental Protection
MANEM	Mid-Atlantic/New England/Maritime
MassWildlife	Massachusetts Division of Fisheries and Wildlife
MHC	Massachusetts Historical Commission
MOU	Memorandum of Understanding
MSSF	Myles Standish State Forest
NAAQS	National Ambient Air Quality Standards
NABCI	North American Bird Conservation Initiative
NAGRPA	Native American Graves Protection and Repatriation Act
NAWCP	North American Waterbird Conservation Plan
NAWMP	North American Waterfowl Management Plan
NEAFWA	Northeast Association of Fish and Wildlife Agencies
NEPA	National Environmental Policy Act
NHESP	(Massachusetts) Natural Heritage and Endangered Species Program
NHPA	National Historic Preservation Act
NOA	Notice of Availability
NOI	Notice of Intent
NO_x	Nitrous Oxides
NPS	National Park Service
NRCS	Natural Resources Conservation Service
NVCS	National Vegetation Classification System
NWPS	National Wilderness Preservation System
NWR	National Wildlife Refuge
NWRS	National Wildlife Refuge System
ORV	Off-Road Vehicle
PARC	Partners in Amphibian and Reptile Conservation
Pd	*Pseudogymnoascus destructans*
PIF	Partners in Flight
PL	Public Law
PM	Particulate Matter
PPM	Parts per Million

Acronym	Full Name
RCN	Regional Conservation Need
RHPO	Regional Historic Preservation Officer
RM	Refuge Manual
ROW	Right-of-Way
SGCN	Species of Greatest Conservation Need
SHC	Strategic Habitat Conservation
SHPO	State Historic Preservation Office
SMART	Specific, Measurable, Achievable, Results-oriented, and Time-fixed
SO_2	Sulfur Dioxide
SUP	Special Use Permit
SSURGO	Soil Survey Geographic Database
SWAP	State Wildlife Action Plan
SWG	State Wildlife Grant
THPO	Tribal Historic Preservation Officer
TMDL	Total Maximum Daily Load
TNC	The Nature Conservancy
TWA	Time-weighted Average
USC	United States Code
USCB	United States Census Bureau
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency
USFS	United States Forest Service
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
UV	Ultraviolet
WNV	West Nile Virus
WSA	Wilderness Study Area

Appendix A


Bill Thompson

Prairie warbler

Species Known or Suspected on Massasoit National Wildlife Refuge

Table A-1. Fish Species in Crooked Pond on Massasoit NWR

No formal fish surveys have been conducted by Service on refuge property, but several fish have been observed by staff and partners during other ongoing work in Crooked Pond (U.S. Fish and Wildlife Service unpublished data). Therefore, this does not represent a comprehensive list of fish in Crooked Pond or other ponds on the refuge.

Common Name	Scientific Name	Federal Legal Status[1]	MA Legal Status[2]	Global Rarity Rank[3]	MA Rarity Rank[4]	North Atlantic LCC Representative Species[5]
Centrarchidae Family						
Black Crappie	*Pomoxis nigromaculatus*	-	-	G5	-	-
Largemouth Bass	*Micropterus salmoides*	-	-	G5	-	-
Smallmouth Bass	*Micropterus dolomieu*	-	-	G5	-	-
Pumpkinseed	*Lepomis gibbosus*	-	-	G5	-	-
Redbreast Sunfish	*Lepomis auritus*	-	-	G5	-	-
Ictaluridae Family						
Brown Bullheads	*Ameiurus nebulosus*	-	-	G5	-	-
Esocidae Family						
Chain Pickerel	*Esox niger*	-	-	G5	-	-
Moronidae Family						
White Perch	*Morone americana*	-	-	G5	-	-
Percidae Family						
Yellow Perch	*Perca flavescens*	-	-	G5	-	-

Source: Graham Annual Reports, 1987-2000, Massaoit NWR Master Plan 1985 and per conversation Graham 2000

[1] Federal Legal Status Codes (under Federal Endangered Species List): E=endangered; T=threatened; C=candidate; "-"=no status.

[2] State Legal Status Codes (under Massachusetts Endangered Species Lists): E=endangered; T=threatened; SC= special concern; WL=watch list; "-"=no status.

[3] Global Rarity Rank: NatureServe Global Conservation Status Ranks from *http://explorer.natureserve.org/* where the conservation status of a species is designated by a number from 1 to 5 (1=critically imperiled, 2=imperiled, 3=vulnerable, 4=apparently secure, 5=secure), preceded by a letter reflecting the appropriate geographic scale of the assessment (G = Global, N = National, and S = Subnational). Additionally, GNR=unranked (global rank not yet assessed) and "?"=inexact numeric rank.

[4] Massachusetts Rarity Rank from 2005 Massachusetts Comprehensive Wildlife Conservation Strategy, Revised 2006: S1 =critically imperiled; S2=imperiled; S3=either very rare or uncommon, vulnerable; S4=widespread, abundant, apparently secure; S5=secure; SNA=not applicable; "-"=no rank given. State rarity ranks were only provided for "species in greatest need of conservation", therefore although some species were assigned a rank of S5, they are still of conservation concern in Massachusetts.

[5] North Atlantic Landscape Conservation Cooperative Representative Species: NNE=northern New England; SNE = southern New England; MAt=mid Atlantic; "-"=not listed. (*http://www.fws.gov/northeast/science/pdf/nalcc_terrestrial_rep_species_table.pdf*)

Table A-2. Amphibians and Reptiles Confirmed on Massasoit NWR

Few standardized surveys for amphibians and reptiles have been conducted on Massasoit NWR, but several species have been confirmed during anuran calling surveys (2001 and 2002) and/or observed by staff and partners during other ongoing work (U.S. Fish and Wildlife Service unpublished data). Therefore, this does not represent a comprehensive list of amphibians and reptiles on the Refuge.

Common Name	Scientific Name	Federal Legal Status[1]	MA Legal Status[2]	Global Rarity Rank[3]	MA Rarity Rank[4]	North Atlantic LCC Representative Species[5]
Plethodontidae Family						
Red-backed Salamander	*Plethodon cinereus cinereus*	-	-	G5	-	-
Salamandridae Family						
Red-spotted Newt	*Notophthalmus viridescens*	-	-	G5	-	-
Ranidae Family						
American Bullfrog	*Lithobates catesbeianus*	-	-	G5	-	-
Green Frog	*Lithobates clamitans*	-	-	G5	-	-
Northern Leopard Frog	*Lithobates pipiens*	-	-	G5	S4	-
Wood Frog	*Lithobates sylvaticus*	-	-	G5	-	NNE, SNE, MAt
Bufonidae Family						
American Toad	*Anaxyrus americanus*	-	-	G5	-	-
Fowler's Toad	*Anaxyrus fowleri*	-	-	G5	-	-
Hylidae Family						
Northern Spring Peeper	*Pseudacris crucifer*	-	-	G5	-	-
Gray Treefrog	*Hyla versicolor*	-	-	G5	-	-
Colubridae Family						
Eastern Hognose Snake	*Heterodon platirhinos*	-	-	G5	S4	SNE, MAt
Eastern Ribbon Snake	*Thamnophis sauritus*	-	-	G5	S5	-
Milk Snake	*Lampropeltis triangulum*	-	-	G5	-	-
Emydidae Family						
Painted Turtle	*Chrysemys picta*	-	-	G5	-	MAt
Northern Red-Bellied Cooter	*Pseudemys rubriventris*	E	E	G5T2Q	S1	-
Chelydridae Family						
Snapping Turtle	*Chelydra serpentina*	-	-	G5	-	-
Kinosternidae Family						
Common Musk Turtle	*Sternotherus odoratus*	-	-	G5	-	-

[1] Federal Legal Status Codes (under Federal Endangered Species List): E=endangered; T=threatened; C=candidate; "-"=no status.

[2] State Legal Status Codes (under Massachusetts Endangered Species Lists): E=endangered; T=threatened; SC= special concern; WL=watch list; "-"=no status.

[3] Global Rarity Rank: NatureServe Global Conservation Status Ranks from *http://explorer.natureserve.org/* where the conservation status of a species is designated by a number from 1 to 5 (1=critically imperiled, 2=imperiled, 3=vulnerable, 4=apparently secure, 5=secure), preceded by a letter reflecting the appropriate geographic scale of the assessment (G = Global, N = National, and S = Subnational). Additionally, GNR=unranked (global rank not yet assessed) and "?"=inexact numeric rank.

[4] Massachusetts Rarity Rank from 2005 Massachusetts Comprehensive Wildlife Conservation Strategy, Revised 2006: S1 =critically imperiled; S2=imperiled; S3=either very rare or uncommon, vulnerable; S4=widespread, abundant, apparently secure; S5=secure; SNA=not applicable; "-"=no rank given. State rarity ranks were only provided for "species in greatest need of conservation", therefore although some species were assigned a rank of S5, they are still of conservation concern in Massachusetts.

[5] North Atlantic Landscape Conservation Cooperative Representative Species: NNE=northern New England; SNE = southern New England; MAt=mid Atlantic; "-"=not listed. (*http://www.fws.gov/northeast/science/pdf/nalcc_terrestrial_rep_species_table.pdf*)

Table A-3. Birds Confirmed on Massasoit NWR

Standardized breeding bird surveys (for land birds) were conducted at the Crooked Pond parcel of Massasoit NWR twice each year (generally in May and June) from 2001 through 2010 and then once each year in 2014 and 2015. Additionally, bird species were recorded opportunistically by staff and partners during other ongoing work (U.S. Fish and Wildlife Service unpublished data). However, because staff presence at Massasoit NWR has not been consistent, this list is certainly not inclusive of all species that are present throughout the calendar year.

Common Name	Scientific Name	Federal Legal Status[1]	MA Legal Status[2]	Global Rarity Rank[3]	MA Rarity Rank[4]	North Atlantic LCC Representative Species[5]	BCC Region 5[6]	BCR 30[7]	PIF Area 9[8]
Gaviidae Family (Loons)									
Common Loon	*Gavia immer*	-	SC	G5	S1	NNE, SNE	-	-	-
Ardeidae Family (Wading Birds)									
Great Blue Heron	*Ardea herodias*	-	-	G5	-	-	-	-	V
Black-crowned Night Heron	*Nycticorax nycticorax*	-	-	G5	S2	-	-	M	V
Anatidae Family (Swans, Geese, Ducks)									
Mute Swan	*Cygnus olor*	-	-	G5	-	-	-	-	-
Canada Goose	*Branta canadensis*	-	-	G5	-	-	-	HH	-
Wood Duck	*Aix sponsa*	-	-	G5	-	MAt	-	-	-
Mallard	*Anas platyrhynchos*	-	-	G5	-	-	-	H	-
American Black Duck	*Anas rubripes*	-	-	G5	S4	NNE, SNE, MAt	-	HH	IIC
Blue-winged Teal	*Anas discors*	-	-	G5	-	-	-	-	-
Green-winged Teal	*Anas crecca*	-	-	G5	-	-	-	M	-
Cathartidae, Accipitridae, and Pandionidae Families (Diurnal Raptors and Osprey)									
Turkey Vulture	*Cathartes aura*	-	-	G5	-	-	-	-	-
Red-shouldered Hawk	*Buteo lineatus*	-	-	G5	-	MAt	-	-	V
Red-tailed Hawk	*Buteo jamaicensis*	-	-	G5	-	-	-	-	-
Bald Eagle	*Haliaeetus leucocephalus*	-	T	G5	S1	-	Y	M	-
Osprey	*Pandion haliaetus*	-	-	G5	-	-	-	-	V
Phasianidae and Odontophoridae Families (Upland Game Birds)									
Northern Bobwhite	*Colinus virginianus*	-	-	G5	S5	-	-	H	-
Ruffed Grouse	*Bonasa umbellus*	-	-	G5	S5	NNE	-	-	-
Wild Turkey	*Meleagris gallopavo*	-	-	G5	-	-	-	-	-

Common Name	Scientific Name	Federal Legal Status[1]	MA Legal Status[2]	Global Rarity Rank[3]	MA Rarity Rank[4]	North Atlantic LCC Representative Species[5]	BCC Region 5[6]	BCR 30[7]	PIF Area 9[8]
Columbidae Family (Pigeons and Doves)									
Mourning Dove	*Zenaida macroura*	-	-	G5	-	-	-	-	-
Cuculidae Family (Cuckoos and Allies)									
Yellow-billed Cuckoo	*Coccyzus americanus*	-	-	G5	-	-	-	-	-
Black-billed Cuckoo	*Coccyzus erythropthalmus*	-	-	G5	-	-	-	-	IA
Caprimulgidae Family (Goatsuckers)									
Whip-poor-will	*Caprimulgus vociferous*	-	SC	G5	S4	MAt	Y	H	-
Alcedinidae Family (Kingfishers)									
Belted Kingfisher	*Megaceryle alcyon*	-	-	G5	-	-	-	-	-
Picidae Family (Woodpeckers)									
Red-bellied Woodpecker	*Melanerpes carolinus*	-	-	G5	-	-	-	-	-
Yellow-bellied Sapsucker	*Sphyrapicus varius*	-	-	G5	-	-	-	-	-
Downy Woodpecker	*Picoides pubescens*	-	-	G5	-	-	-	-	-
Hairy Woodpecker	*Picoides villosus*	-	-	G5	-	-	-	-	IIA
Northern Flicker	*Colaptes auratus*	-	-	G5	-	-	-	H	-
Tyrannidae Family (Tyrant Flycatchers)									
Eastern Wood-Pewee	*Contopus virens*	-	-	G5	-	MAt	-	-	IIA
Eastern Phoebe	*Sayornis phoebe*	-	-	G5	-	-	-	-	-
Great Crested Flycatcher	*Myiarchus crinitus*	-	-	G5	-	-	-	H	-
Eastern Kingbird	*Tyrannus tyrannus*	-	-	G5	-	-	-	H	-
Vireonidae Family (Vireos)									
Red-eyed Vireo	*Vireo olivaceus*	-	-	G5	-	-	-	-	-
Corvidae Family (Crows and Jays)									
Blue Jay	*Cyanocitta cristata*	-	-	G5	-	-	-	-	-
American Crow	*Corvus brachyrhynchos*	-	-	G5	-	-	-	-	-
Fish Crow	*Corvus ossifragus*	-	-	G5	-	-	-	-	-

Common Name	Scientific Name	Federal Legal Status[1]	MA Legal Status[2]	Global Rarity Rank[3]	MA Rarity Rank[4]	North Atlantic LCC Representative Species[5]	BCC Region 5[6]	BCR 30[7]	PIF Area 9[8]
Hirundinidae Family (Swallows)									
Barn Swallow	*Hirundo rustica*	-	-	G5	-	-	-	-	-
Tree Swallow	*Tachycineta bicolor*	-	-	G5	-	-	-	-	-
Paridae Family (Chickadees and Titmice)									
Tufted Titmouse	*Baeolophus bicolor*	-	-	G5	-	-	-	-	-
Black-capped Chickadee	*Poecile atricapillus*	-	-	G5	-	-	-	-	-
Sittidae Family (Nuthatches)									
Red-breasted Nuthatch	*Sitta canadensis*	-	-	G5	-	-	-	-	-
White-breasted Nuthatch	*Sitta carolinensis*	-	-	G5	-	-	-	-	-
Troglodytidae Family (Wrens)									
Carolina Wren	*Thryothorus ludovicianus*	-	-	G5	-	-	-	-	-
Sylviidae Family (Gnatcatchers)									
Blue-gray Gnatcatcher	*Polioptila caerulea*	-	-	G5	-	-	-	-	-
Turdidae Family (Thrushes)									
Eastern Bluebird	*Sialia sialis*	-	-	-	-	-	-	-	-
American Robin	*Turdus migratorius*	-	-	G5	-	-	-	-	-
Wood Thrush	*Hylocichla mustelina*	-	-	G5	S5	NNE, SNE, MAt	Y	HH	IA
Hermit Thrush	*Catharus guttatus*	-	-	G5	-	-	-	-	-
Mimidae Family (Mimids)									
Gray Catbird	*Dumetella carolinensis*	-	-	G5	-	-	-	M	-
Northern Mockingbird	*Mimus polyglottos*	-	-	G5	-	-	-	-	-
Brown Thrasher	*Toxostoma rufum*	-	-	G5	S5	MAt	-	H	-
Bombycillidae Family (Waxwings)									
Cedar Waxwing	*Bombycilla cedrorum*	-	-	G5	-	-	-	-	-

Common Name	Scientific Name	Federal Legal Status[1]	MA Legal Status[2]	Global Rarity Rank[3]	MA Rarity Rank[4]	North Atlantic LCC Representative Species[5]	BCC Region 5[6]	BCR 30[7]	PIF Area 9[8]
Parulidae Family (Wood Warblers)									
Yellow Warbler	*Dendroica petechia*	-	-	G5	-	-	-	-	-
Prairie Warbler	*Dendroica discolor*	-	-	G5	S5	SNE, MAt	Y	HH	IA
Palm Warbler	*Dendroica palmarum*	-	-	G5	-	NNE	-	-	-
Pine Warbler	*Dendroica pinus*	-	-	G5	-	-	-	-	-
Blackpoll Warbler	*Dendroica striata*	-	SC	G5	S1	NNE	-	-	-
Black-and-white Warbler	*Mniotilta varia*	-	-	G5	-	MAt	-	H	IIA
Ovenbird	*Seiurus aurocapilla*	-	-	G5	-	NNE, SNE, MAt	-	-	-
Common Yellowthroat	*Geothlypis trichas*	-	-	G5	-	-	-	-	-
Thraupidae Family (Tanagers)									
Scarlet Tanager	*Piranga olivacea*	-	-	G5	-	-	-	H	IA
Cardinalidae Family (Cardinals and Grosbeaks)									
Northern Cardinal	*Cardinalis cardinalis*	-	-	G5	-	-	-	-	-
Rose-breasted Grosbeak	*Pheucticus ludovicianus*	-	-			-	-	-	IIA
Emberizidae Family (Emberizine Sparrows and Allies)									
Eastern Towhee	*Pipilo erythrophthalmus*	-	-	G5	S5	NNE, MAt	-	H	IIA
Field Sparrow	*Spizella pusilla*	-	-	G5	S5	-	-	H	-
Chipping Sparrow	*Spizella passerina*	-	-	G5	-	-	-	-	-
Song Sparrow	*Melospiza melodia*	-	-	G5	-	-	-	-	-
Icteridae Family (Icterids)									
Brown-headed Cowbird	*Molothrus ater*	-	-	G5	-	-	-	-	-
Red-winged Blackbird	*Agelaius phoeniceus*	-	-	G5	-	-	-	-	-
Common Grackle	*Quiscalus quiscula*	-	-	G5	-	-	-	-	-
Baltimore Oriole	*Icterus galbula*	-	-	G5	-	-	-	H	IA

Common Name	Scientific Name	Federal Legal Status[1]	MA Legal Status[2]	Global Rarity Rank[3]	MA Rarity Rank[4]	North Atlantic LCC Representative Species[5]	BCC Region 5[6]	BCR 30[7]	PIF Area 9[8]
Fringillidae Family (Finches)									
Purple Finch	*Carpodacus purpureus*	-	-	G5	-	-	-	-	IIA
House Finch	*Carpodacus mexicanus*	-	-	G5	-	-	-	-	-
American Goldfinch	*Carduelis tristis*	-	-	G5	-	-	-	-	-

[1] Federal Legal Status Codes (under Federal Endangered Species List): E=endangered; T=threatened; C=candidate; "-"=no status.

[2] State Legal Status Codes (under Massachusetts Endangered Species Lists): E=endangered; T=threatened; SC= special concern; WL=watch list; "-"=no status.

[3] Global Rarity Rank: NatureServe Global Conservation Status Ranks from *http://explorer.natureserve.org/* where the conservation status of a species is designated by a number from 1 to 5 (1=critically imperiled, 2=imperiled, 3=vulnerable, 4=apparently secure, 5=secure), preceded by a letter reflecting the appropriate geographic scale of the assessment (G = Global, N = National, and S = Subnational). Additionally, GNR=unranked (global rank not yet assessed) and "?"=inexact numeric rank.

[4] Massachusetts Rarity Rank from 2005 Massachusetts Comprehensive Wildlife Conservation Strategy, Revised 2006: S1 =critically imperiled; S2=imperiled; S3=either very rare or uncommon, vulnerable; S4=widespread, abundant, apparently secure; S5=secure; SNA=not applicable; "-"=no rank given. State rarity ranks were only provided for "species in greatest need of conservation", therefore although some species were assigned a rank of S5, they are still of conservation concern in Massachusetts.

[5] North Atlantic Landscape Conservation Cooperative Representative Species: NNE=northern New England; SNE = southern New England; MAt=mid Atlantic; "-"=not listed. (*http://www.fws.gov/northeast/science/pdf/nalcc_terrestrial_rep_species_table.pdf*)

[6] U.S. Fish and Wildlife Service Division of Migratory Birds, Birds of Conservation Concern for Region 5 (Northeast) (USFWS 2008). Y=species identified as a species of conservation concern in Region 5; "-"=species not identified.

[7] Bird Conservation Region 30: New England/Mid-Atlantic Coast Conservation Priority Category: HH=highest priority; H=high priority; M=moderate priority (*http://www.acjv.org/BCR_30/BCR30_June_23_2008_final.pdf*).

[8] Partners in Flight Bird Conservation Plan for Southern New England: Physiographic Area 09 (Dettmers and Rosenberg 2000). IA=high continental priority and high regional responsibility; IB=high continental priority and low regional responsibility; IIA=high regional concern; IIC=high regional threats; V=additional state listed.

[9] Not detected during refuge surveys/monitoring, but listed in chapter or appendix text in this CCP/EA.

Table A-4. Mammals Confirmed on Massasoit NWR

Few standardized surveys for mammals have been conducted on Massasoit NWR, but several species have been confirmed during acoustic bat surveys (2012 and 2013) and/or observed by staff and partners during other ongoing work (U.S. Fish and Wildlife Service unpublished data). Therefore, this does not represent a comprehensive list of mammals on the Refuge.

Common Name	Scientific Name	Federal Legal Status[1]	MA Legal Status[2]	Global Rarity Rank[3]	MA Rarity Rank[4]	North Atlantic LCC Representative Species[5]
Canidae Family						
Coyote	*Canis latrans*	-	-	G5	-	-
Gray Fox	*Urocyon cinereoargenteus*	-	-	G5	-	-
Red Fox	*Vulpes vulpes*	-	-	G5	-	-
Procyonidae Family						
Raccoon	*Procyon lotor*	-	-	G5	-	-
Mephitidae Family						
Striped Skunk	*Mephitis mephitis*	-	-	G5	-	-
Mustelidae Family						
Fisher	*Martes pennanti*	-	-	G5	-	-
Cervidae Family						
White-tailed Deer	*Odocoileus virginianus*	-	-	G5	-	-
Sciuridae Family						
Red Squirrel	*Tamiasciurus hudsonicus*	-	-	G5	-	-
Vespertilionidae Family						
Big Brown Bat	*Eptesicus fuscus*	-	-	G5	-	-
Silver-haired Bat	*Lasionycteris noctivagans*	-	-	G5	SU	-
Eastern Red Bat	*Lasiurus borealis*	-	-	G5	S4	NNE, SNE, MAt
Tri-colored Bat	*Pipistrellus subflavus*	-	-	G3	-	MAt
Eastern Small-footed Myotis	*Myotis leibii*	-	SC	G1G3	S1	-

[1] Federal Legal Status Codes (under Federal Endangered Species List): E=endangered; T=threatened; C=candidate; "-"=no status.

[2] State Legal Status Codes (under Massachusetts Endangered Species Lists): E=endangered; T=threatened; SC= special concern; WL=watch list; "-"=no status.

[3] Global Rarity Rank: NatureServe Global Conservation Status Ranks from *http://explorer.natureserve.org/* where the conservation status of a species is designated by a number from 1 to 5 (1=critically imperiled, 2=imperiled, 3=vulnerable, 4=apparently secure, 5=secure), preceded by a letter reflecting the appropriate geographic scale of the assessment (G = Global, N = National, and S = Subnational). Additionally, GNR=unranked (global rank not yet assessed) and "?"=inexact numeric rank.

[4] Massachusetts Rarity Rank from 2005 Massachusetts Comprehensive Wildlife Conservation Strategy, Revised 2006: S1 =critically imperiled; S2=imperiled; S3=either very rare or uncommon, vulnerable; S4=widespread, abundant, apparently secure; S5=secure; SNA=not applicable; "-"=no rank given. State rarity ranks were only provided for "species in greatest need of conservation", therefore although some species were assigned a rank of S5, they are still of conservation concern in Massachusetts.

[5] North Atlantic Landscape Conservation Cooperative Representative Species: NNE=northern New England; SNE = southern New England; MAt=mid Atlantic; "-"=not listed. (*http://www.fws.gov/northeast/science/pdf/nalcc_terrestrial_rep_species_table.pdf*)

[6] Not detected during refuge surveys/monitoring, but listed in chapter or appendix text in this CCP/EA.

Table A-5. Invertebrates Recorded at Massasoit NWR

No formal invertebrate surveys have been conducted by refuge staff on Massasoit NWR, but several invertebrates have been observed by staff and partners during other ongoing work at the refuge (U.S. Fish and Wildlife Service unpublished data). Therefore, this does not represent a comprehensive list of invertebrates on the refuge.

Common Name	Scientific Name	Federal Legal Status[1]	MA Legal Status[2]	Global Rarity Rank[3]	MA Rarity Rank[4]
Libellulidae Family					
Blue Dasher	*Pachydiplax longipennis*	-	-	G5	-
Calico Pennant	*Celithemis elisa*	-	-	G5	-
Common Whitetail	*Libellula lydia*	-	-	G5	-
Eastern Pondhawk	*Erythemis simplicicollis*	-	-	G5	-
Golden-Winged Skimmer	*Libella auripennis*	-	-	G5	-
Slaty Skimmer	*Libellula incesta*	-	-	G5	-
White Corporal	*Libellula exusta*	-	-	G4	-
Nymphalidae Family					
Eastern Comma	*Polygonia comma*	-	-	G5	-
Great Spangled Fritillary	*Speyeria cybele*	-	-	G5	-
Mourning Cloak	*Nymphalis antiopa*	-	-	G5	-
Red Admiral	*Vanessa atalanta*	-	-	G5	-
Red-spotted Purple	*Limenitis artemis astyanax*	-	-	G5T5	-
Lycaenidae Family					
Striped Hairstreak	*Satyrium liparops*	-	-	G5	-
Hesperiidae Family					
True Skipper sp. (tauny-orange or brown)	*Hesperia spp.*	-	-	G5	-
Saturniidae Family					
Polyphemus moth	*Antheraea polyphemus*	-	-	G5	-
Carabidae Family					
Six-spotted Green Tiger Beetle	*Cicindela sexguttata*	-	-	G5	-
Erebidae Family					
Gypsy moth	*Lymantria dispar*	-	-	GNR	-
Ixodidae Family					
Deer (Blacklegged) tick	*Ixodes scapularis*	-	-	GNR	-

Source: U.S. Fish and Wildlife Service Unpublished

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[2] State Legal Status Codes (under Massachusetts Endangered Species Lists): E=endangered; T=threatened; SC= special concern; WL=watch list; "-"=no status.

[3] Global Rarity Rank: NatureServe Global Conservation Status Ranks from *http://explorer.natureserve.org/* where the conservation status of a species is designated by a number from 1 to 5 (1=critically imperiled, 2=imperiled, 3=vulnerable, 4=apparently secure, 5=secure), preceded by a letter reflecting the appropriate geographic scale of the assessment (G = Global, N = National, and S = Subnational). Additionally, GNR=unranked (global rank not yet assessed) and "?"=inexact numeric rank.

[4] Massachusetts Rarity Rank from 2005 Massachusetts Comprehensive Wildlife Conservation Strategy, Revised 2006: S1 =critically imperiled; S2=imperiled; S3=either very rare or uncommon, vulnerable; S4=widespread, abundant, apparently secure; S5=secure; SNA=not applicable; "-"=no rank given. State rarity ranks were only provided for "species in greatest need of conservation", therefore although some species were assigned a rank of S5, they are still of conservation concern in Massachusetts.

Table A-6. State-Listed Moths and Butterflies Documented in Myles Standish State Forest

Several State-listed moths and butterflies have been documented in Myles Standish State Forest (Massachusetts Department of Conservation and Recreation (MADCR) 2011). These species have not been confirmed on Massasoit NWR but are listed below because of their dependence on habitat that is found on Massasoit NWR.

Common Name	Scientific Name	Federal Legal Status[1]	MA Legal Status Status[2]	Global Rarity Rank[3]	MA Rarity Rank[4]	Habitat
Saturnidae Family						
Barrens Buckmoth	*Hemileuca maia*	-	SC	G5	S3	Shrubland
Geometridae Family						
Buckholz's Grey Moth	*Hypomecis buchholzaria*	-	E	G3G4	S1	Shrubland
Coastal Swamp Metarranthis	*Metarranthis pilosaria*	-	SC	G3G4	S1	Pine Barrens Wetland
Lycaenidae Family						
Frostin Elfin Butterfly	*Callophrys irus*	-	SC	G3	S2S3	Sandplain Grassland
Noctuidae Family						
Gerhard's Underwing Moth	*Catocala herodias gerhardi*	-	SC	G3T3	S3	Shrubland
Pine Barrens Zale	*Zale lunifera*	-	SC	G3G4	S2S3	Shrubland
Water-willow Stem Borer	*Papaipema cataphracta*	-	T	G5	S2	Pond Shore Wetland
Barrens Daggermoth	*Acronicta albarufa*	-	T	G3G4	S2S3	Shrubland
Coastal Heathland Cutworm	*Abagrotis nefascia*	-	SC	G4	S3	Shrubland
Pale Green Pinion Moth	*Lithophane viridipallens*	-	SC	G5	S1S3	Pine Barrens Wetland
Pine Barrens Speranza Moth	*Speranza exonerata*	-	SC	G3G4	-	Shrubland
Pine Barrens Zanclognatha	*Zanclognatha martha*	-	T	G4	S2	Shrubland
Pink Sallow Moth	*Psectraglaea carnosa*	-	SC	G3	S2S3	Shrubland
Waxed Sallow Moth	*Chaetaglaea cerata*	-	SC	G3G4	S2S3	Pine Barrens
Mimallodinae Family						
Melsheimer's Sack Bearer	*Cicinnus melsheimeri*	-	T	G4	S2S3	Shrubland
Sphingidae Family						
Slender Clearwing Sphinx Moth	*Hemiris gracilis*	-	SC	G3G4	S2S3	Shrubland

Source: MADCR Resource Management Plan Myles Standish State Forest Planning Unit-December, 2011

[1] Federal Legal Status Codes (under Federal Endangered Species List): E=endangered; T=threatened; C=candidate; "-"=no status.

[2] State Legal Status Codes (under Massachusetts Endangered Species Lists): E=endangered; T=threatened; SC= special concern; WL=watch list; "-"=no status.

[3] Global Rarity Rank: NatureServe Global Conservation Status Ranks from *http://explorer.natureserve.org/* where the conservation status of a species is designated by a number from 1 to 5 (1=critically imperiled, 2=imperiled, 3=vulnerable, 4=apparently secure, 5=secure), preceded by a letter reflecting the appropriate geographic scale of the assessment (G = Global, N = National, and S = Subnational). Additionally, GNR=unranked (global rank not yet assessed) and "?"=inexact numeric rank.

[4] Massachusetts Rarity Rank from 2005 Massachusetts Comprehensive Wildlife Conservation Strategy, Revised 2006: S1 =critically imperiled; S2=imperiled; S3=either very rare or uncommon, vulnerable; S4=widespread, abundant, apparently secure; S5=secure; SNA=not applicable; "-"=no rank given. State rarity ranks were only provided for "species in greatest need of conservation", therefore although some species were assigned a rank of S5, they are still of conservation concern in Massachusetts.

Table A-7. Plant Species Confirmed on Massasoit NWR

An inventory of plants was conducted in 2012 by volunteer botanists (Zinovjev and Kadis, unpublished report) and the results are included in table A-7.

Common Name	Scientific Name	Federal Legal Status[1]	MA Legal Status[2]	Global Rarity Rank[3]	MA Rarity Rank[4]	Native or Introduced/ Invasive Status[5]	Location[6]
Aceraceae Family (Maple)							
Red Maple	*Acer rubrum*	-	-	G5	S5	N / -	NE, GEP, NW
Anacardiaceae Family (Sumac)							
Winged Sumac	*Rhus copallinum*	-	-	G5	S4S5	N / -	IP
Poison Ivy	*Toxicodendron radicans*	-	-	G5	S5	N / -	NE
Apocynaceae Family (Dogbane)							
Spreading Dogbane	*Apocynum androsaemifolium*	-	-	G5	S5	N / -	NE
Araliaceae Family (Ivy)							
Wild Sarsaparilla	*Aralia nudicaulis*	-	-	G5	S5	N / -	Main
Asclepiadaceae Family (Milkweed)							
Common Milkweed	*Asclepias syriaca*	-	-	G5	S5	N / -	NE
Asteraceae (Daisy or Aster)							
Annual Ragweed	*Ambrosia artemisiifolia*	-	-	G5	S5	N / -	NE
Bushy Aster (Rice Button Aster)	*Symphyotrichum dumosum*	-	-	G5	S5	N / -	IP, CP
Calico Aster	*Symphyotrichum lateriflorum*	-	-	G5	S5	N / -	IP
New York Aster	*Symphyotrichum novi-belgii Nesom var. novi-belgii*	-	-	G5T5	S5	N / -	CP, GEP
Aster species	*Symphyotrichum sp.*	-	-	-	-	NA	NE
Swamp Beggar-ticks (Purple-stem Beggarticks)	*Bidens connata*	-	-	G5	S5	N / -	IP, CP, HP
Bull Thistle	*Cirsium vulgare*	-	-	GNR	-	NN / -	Main
Horseweed, Hogweed, Butterweed (Canada Horseweed)	*Erigeron Canadensis (Conyza canadensis)*	-	-	G5	S5	N / -	NE, CP
Pink Tickseed (Rose coreopsis)	*Coreopsis rosea*	-	WL	G3	S3	N / -	IP, CP, GEP

Common Name	Scientific Name	Federal Legal Status[1]	MA Legal Status[2]	Global Rarity Rank[3]	MA Rarity Rank[4]	Native or Introduced/ Invasive Status[5]	Location[6]
Fireweed, Pilewort (American Burnweed)	*Erechtites hieraciifolius var. hieraciifolius*	-	-	G5	S5	N / -	CP, GEP
Fireweed, Seaside Pilewort (American Burnweed)	*Erechtites hieraciifolius var. megalocarpus*	-	WL	G5T3	S2S3	N / -	CP
Showy Aster	*Eurybia spectabilis*	-	-	G5	S4	N / -	ROW
Atlantic Joe-Pye-weed (Coastal Plain Joepyeweed)	*Eutrochium dubium*	-	-	G5	S5	N / -	IP
Boneset (Common Boneset)	*Eupatorium perfoliatum*	-	-	G5	S5	N / -	IP, CP
Rough Boneset	*Eupatorium pilosum*	-	-	G5	S5	N / -	IP
Slender-leaved Flat-topped Goldenrod	*Euthamia caroliniana*	-	-	G5	S5	N / -	NE, IP, GEP
Sweet Everlasting (Rabbit-tobacco)	*Pseudognaphalium obtusifolium*	-	-	G5	S5	N / -	CP, GEP
Hairy Hawkweed (Gronovis Hawkweed)	*Hieracium gronovii*	-	-	G5	S4	N / -	NE
Smooth Hawkweed (Tall Hawkweed)	*Hieracium piloselloides*	-	-	GNR	SNA	NN / -	Main, CP
King-devil (Meadow Hawkweed)	*Hieracium caespitosum*	-	-	GNR	SNA	* / IP	GEP
Spotted Cat's Ear (Hairy Cat's Ear)	*Hypochaeris radicata*	-	-	GNR	SNA	NN / IP	NE, GEP
Yellow Wild Lettuce (Canada Lettuce, Wild Lettuce)	*Lactuca canadensis*	-	-	G5	S5	N / -	IP
Toothed White-topped Aster (Toothed Whitetop Aster)	*Sericocarpus asteroides*	-	-	G5	S5	N / -	NE, Main
Narrow-leaved White-topped Aster (Narrowleaf Whitetop Aster)	*Sericocarpus linifolius*	-	-	G5	S4	N / -	NE
Pearly Everlasting	*Anaphalis margaritaceae*	-	-	G5	S5	N / -	ROW
Spotted Knapweed	*Centaurea biebersteinii*	-	-	GNR	SNA	NN / LI	ROW
Grass-leaf Goldenrod	*Euthamia graminifolia*	-	-	G5T5	S5	N	POND

Common Name	Scientific Name	Federal Legal Status[1]	MA Legal Status[2]	Global Rarity Rank[3]	MA Rarity Rank[4]	Native or Introduced/ Invasive Status[5]	Location[6]
Narrow-leaf Goldenrod	*Euthamia tenuifolia (galetorum)*	-	-	G3	S5	NN /	POND
Rough (-leafed) Goldenrod	*Solidago rugosa*	-	-	G5	S5	N	ROW
Betulaceae Family (Birch)							
Smooth Alder (Brook-side Alder)	*Alnus serrulata*	-	-	G5	S5	N / -	GEP
Buddlejaceae Family (Butterfly Bush)							
Butterfly-bush (Orange Eye Butterflybush)	*Buddleja davidii*	-	-	G4G5	SNA	* / IP	Main
Cabombaceae Family (Water-Shield)							
Water-shield (Watershield)	*Brasenia schreberi*	-	-	G5	S5	N / -	CP, HP
Campanulaceae Family (Bellflower / Bellwort)							
Water-lobelia (Dortmann's Cardinalflower)	*Lobelia dortmanna*	-	-	G4G5	S4	N / -	GEP
Caprifoliaceae Family (Honeysuckle)							
Morrow Honeysuckle (Morrow's Honeysuckle)	*Lonicera morrowii*	-	-	GNR	SNA	NN / I	Main
Wild Raisin (Withe-rod)	*Viburnum nudum var. cassinoides*	-	-	G5T5	S5	N / -	NE
Caryophyllaceae Family (Pink)							
Mouse-ear Chickweed (Common Mouse-ear Chickweed)	*Cerastium fontanum ssp. vulgare*	-	-	GNRTNR	SNA	NN / -	Main
Celastraceae Family (Bittersweet)							
Oriental Bittersweet	*Celastrus orbiculatus*	-	-	GNR	SNA	NN / I	IP
Cistaceae Family (Rockrose)							
Canadian Frostweed (Longbranch Frostweed)	*Crocanthemum canadense* *(Helianthemum canadense)*	-	-	G5	S4S5	N / -	NE, Main, CP
Low Frostweed	*Crocanthemum propinquum* *(Helianthemum propinquum)*	-	-	G4	S4	N / -	NE
Large-podded Pinweed (Largepod Pinweed)	*Lechea intermedia*	-	-	G5	S4	N / -	CP

Common Name	Scientific Name	Federal Legal Status[1]	MA Legal Status[2]	Global Rarity Rank[3]	MA Rarity Rank[4]	Native or Introduced/ Invasive Status[5]	Location[6]
Beach-pinweed (Beach Pinweed)	*Lechea maritima*	-	-	G5	S5	N / -	NE, CP
Clethraceae Family (White Alder / Sweet Pepperbush)							
Sweet Pepper-bush (Coastal Sweet Pepperbush)	*Clethra alnifolia*		-	G4G5	S5	N / -	NE, CP, GEP, NW
Clusiaceae Family (St. John's Wort)							
Canadian St. John's-wort (Lesser Canadian St. Johnswort)	*Hypericum canadense*	-	-	G5	S5	N / -	IP, CP, GEP, HP
Pale St. John's-wort (Pale St. Johnswort)	*Hypericum ellipticum*	-	-	G5	S5	N / -	IP, HP
Orange Grass (Orangegrass)	*Hypericum gentianoides*	-	-	G5	S5	N / -	CP
Dwarf St. John's-wort (Dwarf St. Johnswort)	*Hypericum mutilum*	-	-	G5	S5	N / -	IP
Spotted St. John's-wort (Spotted St. Johnswort)	*Hypericum punctatum*	-	-	G5	S5	N / -	NE
Marsh St. John's-wort (Marsh St. John's Wort)	*Triadenum virginicum*	-	-	G5	S5	N / -	IP, HP
Cupressaceae Family							
Eastern Red Cedar	*Juniperus virginiana*	-	-	G5	S5	N / -	-
Droseraceae Family (Sundew)							
Spatulate-leaved Sundew (Spoonleaf Sundew)	*Drosera intermedia*	-	-	G5	S4S5	N / -	CP
Round-leaved Sundew (Roundleaf Sundew)	*Drosera rotundifolia*	-	-	G5	S4S5	N / -	Main, CP
Ericaceae Family (Heath)							
Leatherleaf	*Chamaedaphne calyculata*	-	-	G5	S5	N / -	IP, NW
Bearberry	*Arctostaphylos uva-ursi*	-	-	G5	S5	N / -	ROW
Mayflower (Trailing Arbutus, Ground-laurel)	*Epigaea repens*	-	-	G5	S5	N / -	NE, Main, CP
Wintergreen (Eastern Wintergreen, Eastern Teaberry)	*Gaultheria procumbens*	-	-	G5	S5	N / -	NE

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Black Huckleberry	*Gaylussacia baccata*	-	-	G5	S5	N / -	NE, Main
Dangleberry (Blue Huckleberry)	*Gaylussacia frondosa*	-	-	G5	S4S5	N / -	O
Sheep-laurel (Sheep Laurel)	*Kalmia angustifolia*	-	-	G5	S5	N / -	NE, Main, CP
Swamp-sweetbells (Coastal Fetterbush, Swamp Doghobble)	*Eubotrys racemosa*	-	-	G5	S4	N / -	CP, GEP, NW
Maleberry	*Lyonia ligustrina*	-	-	G5	S5	N / -	IP, CP, GEP
Low Sweet Blueberry, Late Sweet Blueberry, Lowbush (Lowbush Blueberry)	*Vaccinium angustifolium*	-	-	G5	S5	N / -	NE
Highbush-blueberry (Highbush Blueberry)	*Vaccinium corymbosum*	-	-	G5	S5	N / -	NE, Main, CP, GEP, NW
Early Sweet Blueberry (Hillside Blueberry)	*Vaccinium pallidum*	-	-	G5	S5	N / -	NE, Main
Fabaceae Family (Bean)							
Yellow Wild Indigo	*Baptisia tinctoria*	-	-	G5	S5	N / -	NE
Hairy Bush-clover (Hairy Lespedeza)	*Lespedeza hirta*	-	-	G5	S5	N / -	NE
Wand Bush-clover (Violet Lespedeza)	*Lespedeza violacea*	-	-	G5	S5	N / -	NE
Round Headed Bush-clover	*Lespedeza capitata*			G5		N / -	ROW
Black Locust	*Robinia pseudoacacia*	-	-	G5	SNA	NN / I	NE
Rabbit-foot Clover	*Trifolium arvense*	-	-	GNR	SNA	NN	ROW
Palmate Hop-clover (Golden Clover)	*Trifolium aureum*	-	-	GNR	SNA	N / -	Main
Fagaceae Family (Beech or Oak)							
American Beech	*Fagus grandifolia*	-	-	G5	S5	N / -	Main
White Oak	*Quercus alba*	-	-	G5	S5	N / -	NE, Main, CP
Scarlet Oak	*Quercus coccinea*	-	-	G5	S5	N / -	NE
Scrub-oak (Bear Oak)	*Quercus ilicifolia*	-	-	G5	S5	N / -	NE, Main

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Dwarf Chinquapin-oak (Dwarf Chinquapin Oak)	*Quercus prinoides*	-	-	G5	S5	N / -	Main
Red Oak (Northern Red Oak)	*Quercus rubra*	-	-	G5	S5	N / -	NE
Black Oak	*Quercus velutina*	-	-	G5	S5	N / -	NE
Gentianaceae Family (Gentian)							
Screw-stem (Yellow Screwstem)	*Bartonia virginica*	-	-	G5	S4	N / -	O
Plymouth Gentian (Plymouth Rose Gentian)	*Sabatia kennedyana*	-	SC	G3	S3	N / -	IP
Haloragaceae Family (Watermilfoil)							
Lowly Water-milfoil (Low Water-milfoil)	*Myriophyllum humile*	-	-	G5	S5	N / -	IP, CP, GEP, HP
Lamiaceae Family (Mint)							
Sessile Water-horehound (Clasping Water Horehound)	*Lycopus amplectens*	-	WL	G5	S2S3	N / -	IP
Northern Water-horehound	*Lycopus uniflorus*	-	-	G5	S5	N / -	IP, CP, HP
Short-toothed Mountain-mint (Clustered Mountainmint)	*Pycnanthemum muticum*	-	-	G5	S4	N / -	Main
Lauraceae Family (Laurel)							
Sassafras	*Sassafras albidum*	-	-	G5	S5	N / -	IP, Main
Lentibulariaceae Family (Bladderwort)							
Horned Bladderwort	*Utricularia cornuta*	-	-	G5	S5	N / -	HP
Purple Bladderwort	*Utricularia purpurea*	-	-	G5	S5	N / -	HP
Small Floating Bladderwort (Little Floating Bladderwort)	*Utricularia radiata*	-	-	G4	S5	N / -	CP
Lythraceae Family (Loosestrife)							
Water-willow (Swamp Loosestrife)	*Decodon verticillatus*	-	-	G5	S5	N / -	HP

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Melastomataceae Family (Melastome)							
Northern Meadow-beauty, (Common Meadowbeauty, Handsome Harry)	*Rhexia virginica*	-	-	G5	S4	N / -	IP, CP
Molluginaceae Family (Mollugo / Carpetweed)							
Carpetweed	*Mollugo verticillata*	-	-	GNR	SNA	NN / -	IP, CP
Monotropaceae Family (Indian Pipe)							
Indian Pipe	*Monotropa uniflora*	-	-	G5	S5	N / -	IP
Moraceae Family (Mulberry)							
White Mulberry	*Morus alba*	-	-	GNR	SNA	NN / -	IP
Myricaceae Family (Bayberry)							
Sweet-fern (Sweet Fern)	*Comptonia peregrina*	-	-	G5	S5	N / -	NE, Main
Sweet Gale (Sweetgale)	*Myrica gale*	-	-	G5	S5	N / -	HP
Bayberry (Northern Bayberry)	*Morella pensylvanica*	-	-	G5	S5	N / -	NE, CP
Nymphaeaceae Family (Waterlily)							
Yellow Water-lily, Cow-lily (Varigated Yellow Pond-Lily)	*Nuphar variegata*	-	-	G5T5	S5	N / -	CP, HP
White Water-lily, Fragrant Water-lily (American White Waterlily)	*Nymphaea odorata*	-	-	G5	S5	N / -	CP
Onagraceae Family (Evening Primrose)							
American Willow-herb (Fringed Willowherb, Hairy Willowherb)	*Epilobium ciliatum*	-	-	G5	S5	N / -	IP
Water Purslane (Marsh Primrose-willow, Marsh Seedbox)	*Ludwigia palustris*	-	-	G5	S5	N / -	IP, HP
Oxalidaceae Family (Wood-Sorrel)							
Common Yellow Wood-sorrel (Sheep Sorrel)	*Oxalis stricta*	-	-	G5	S5	N / -	Main
Phytolaccaceae Family (Pokeweed)							
Pokeweed	*Phytolacca americana*	-	-	G5T5	S5	N / -	IP

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Poaceae Family							
Bent-grass	*Agrostis sp.*	-	-	G5	S5	N / -	ROW
Poverty Grass (Poverty Oatgrass)	*Danthonia spicata*	-	-	G5	S5	N / -	ROW
Polygonaceae Family (Buckwheat / Smartweed)							
Carey's Smartweed	*Persicaria careyi*	-	-	G4	S?	N / -	IP, CP, GEP
Lady's Thumb (Spotted Ladysthumb)	*Persicaria maculosa*	-	-	G3G5	SNA	NN / -	IP, CP
Perrenial Water-smartweed, Dotted Smartweed	*Persicaria punctata*	-	-	G5	S5	N / -	IP, GEP
Bitter Dock	*Rumex obtusifolius*	-	-	GNR	SNA	NN / -	IP
Primulaceae Family (Primrose)							
Whorled Loosestrife	*Lysimachia quadrifolia*	-	-	G5	S5	N / -	NE
Swamp Candles	*Lysimachia terrestris*	-	-	G5	S5	N / -	CP, GEP
American Starflower (Northern Starflower)	*Lysimachia borealis (Trientalis borealis)*	-	-	G5	S5	N / -	NE, Main
Pyrolaceae Family (Shinleaf)							
Striped Pipsissewa (Striped Prince's Pine)	*Chimaphila maculata*	-	-	G5	S5	N / -	NE
Glossy Shinleaf (American Wintergreen)	*Pyrola americana*	-	-	G5	S5	N / -	NE
Ranunculaceae Family (Buttercup / Crowfoot)							
Wood Anemone	*Anemone quinquefolia*	-	-	G5	S5	N / -	Main
Tall Meadow-rue (King of the Meadow)	*Thalictrum pubescen*	-	-	G5	S5	N / -	Main
Rhamnaceae Family (Buckthorn)							
Glossy Alder-buckthorn	*Frangula alnus (Rhamnus frangula)*	-	-	GNR	SNA	NN / I	NE, Main, CP
Rosaceae Family (Rose)							
Thicket Shadbush (Canadian Serviceberry)	*Amelanchier canadensis*	-	-	G5	S5	N / -	Main, CP
Black Chokeberry	*Aronia melanocarpa*	-	-	G5	S5	N / -	Main

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Northern Wild Strawberry (Wild Strawberry)	*Fragaria virginiana Duchesne ssp. glauca*	-	-	G5	S4?	* / -	Main
Dwarf Cinquefoil	*Potentilla canadensis*	-	-	G5	S5	N / -	NE, Main
Three-finger (Norwegian Cinquefoil)	*Potentilla norvegica*	-	-	G5	S5	N / -	IP
Black Cherry (Black Chokecherry)	*Prunus serotina*	-	-	G5	S5	N / -	NE, Main
Swamp-rose	*Rosa palustris*	-	-	G5	S5	N / -	IP
Northern Dewberry	*Rubus flagellaris*	-	-	G5	S5	N / -	Main
Bristly Dewberry	*Rubus hispidus*	-	-	G5	S5	N / -	NE
Meadowsweet (White Meadowsweet)	*Spiraea alba var. latifolia*	-	-	G5T5	S5	N / -	IP, GEP, NW
Steeple-bush (Steeplebush)	*Spiraea tomentosa*	-	-	G5	S4	N / -	Main, CP
Rubiaceae Family (Bedstraw or Coffee)							
Buttonbush (Common Buttonbush)	*Cephalanthus occidentalis*	-	-	G5	S5	N / -	IP, HP
Clayton's Marsh-bedstraw (Dye Bedstraw)	*Galium tinctorium*	-	-	G5	S5	N / -	IP
Bluets, Innocence, Quaker Ladies (Azure Bluet)	*Houstonia caerulea*	-	-	G5	S5	N / -	OMNWR
Salicaceae Family (Willow)							
Big-toothed Aspen (Bigtooth Aspen)	*Populus grandidentata*	-	-	G5	S5	N / -	Main
Gray Willow (Large Gray Willow)	*Salix cinerea ssp. oleifolia*	-	-	G5TNR	SNA	* / I	NE, IP, Main, GEP, HP
Dwarf Prairie Willow (Prairie Willow)	*Salix occidentalis* (*Salix. humilis var tristis*)	-	-	G5T4T5	S5	N / -	Main
Scrophulariaceae Family (Figwort)							
Purple Gerardia (Purple False Foxglove)	*Agalinis purpurea*	-	-	G5	S4	N / -	CP
Golden Pert (Golden Hedge-hyssop)	*Gratiola aurea*	-	-	G5	S5	N / -	IP, CP, GEP, HP

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Mud Hedge-hyssop (Clammy Hedge-hyssop)	*Gratiola neglecta*	-	-	G5	S4	N / -	CP
False Pimpernel (Moistbank Pimpernel, Yellowseed False Pimpernel)	*Lindernia dubia*	-	-	G5	S5	N / -	IP, HP
Cow-wheat (Narrowleaf Cowwheat)	*Melampyrum lineare*	-	-	G5	S5	N / -	NE
Blue Toadflax (Oldfield Toadflax, Canada Toadflax)	*Nuttallanthus canadensis*	-	-	G5	S5	N / -	NE, CP, GEP
Common Mullein (Velvet Dock)	*Verbascum thapsus*	-	-	GNR	SNA	NN / -	Main
Fern-leaf False Foxglove	*Aureolaria pedicularia*			G5		N / -	-
Smilacaceae Family							
Saw-brier (Cat Greenbrier)	*Smilax glauca*	-	-	G5	S5	N / -	-
Bullbrier (Common Greenbrier)	*Smilax rotundifolia*	-	-	G5	S5	N / -	-
Violaceae Family (Violet)							
Lance-leaf Violet (Bog White Violet, Lanceleaf Violet)	*Viola lanceolata*	-	-	G5	S5	N / -	NE, IP, CP, HP
Bird's Foot Violet (Birdfoot Violet)	*Viola pedata*	-	-	G5	S5	N / -	NE
Arrow-leaf Violet (Arrow-leaved Violet, Arrowleaf Violet)	*Viola sagittata*	-	-	G5	S5	N / -	NE, Main
Primrose-leaf Violet	*Viola primulifolia*	-	-	GNA	S?	N / -	NE
Vitaceae Family (Grape)							
Virginia Creeper (American Ivy, Woodbine)	*Parthenocissus quinquefolia*	-	-	G5	S5	N / -	NE
Alismataceae Family (Water-Plantain or Arrowhead)							
Pondshore-arrowhead, Terete-Arrowhead (Slender Arrowhead)	*Sagittaria teres*	-	SC	G3	S3	N / -	IP, CP, GEP, HP

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Cyperaceae Family (Sedge)							
Howe's Prickly Sedge (Prickly Bog Sedge)	*Carex atlantica ssp. capillacea*	-	-	G5T5?	S5	N / -	OMNWR
Pennsylvania Sedge	*Carex pensylvanica*	-	-	G5	S5	N / -	Main
Broom Sedge	*Carex scoparia*	-	-	G5	S5	N / -	IP, Main, CP
Pondshore Flatsedge (Toothed Flatsedge)	*Cyperus dentatus*	-	-	G4	S5	N / -	IP, CP, GEP
Slender Sand-flatsedge, Button-flatsedge (Great Plains Flatsedge)	*Cyperus lupulinus*	-	-	G5	S4	N / -	NE, CP
Threeway Sedge	*Dulichium arundinaceum*	-	-	G5	S5	N / -	IP, Main, CP
Little Spike-rush (Needle Spikerush)	*Eleocharis acicularis*	-	-	G5	S5	N / -	GEP, HP
Black-fruited Spike-rush (Blackfruit Spikerush)	*Eleocharis melanocarpa*	-	WL	G4	S3	N / -	IP, CP, HP
Soft-stemmed Spike-rush (Blunt Spikerush)	*Eleocharis obtusa*	-	-	G5	S5	N / -	CP, HP
Robbins' Spike-rush (Robbins' spikerush)	*Eleocharis robbinsii*	-	-	G4G5	S5	N / -	GEP
Autumn Fimbry (Slender Fimbry)	*Fimbristylis autumnalis*	-	-	G5	S5	N / -	IP
Annual Umbrella-sedge (Dwarf Umbrella-sedge)	*Fuirena pumila*	-	WL	G4	S3	N / -	IP
Brown Beak-rush (Brownish Beakrush)	*Rhynchospora capitellata*	-	-	G5	S5	N / -	IP, CP
Wool-grass (Bulrush, Woolgrass)	*Scirpus cyperinus*	-	-	G5	S5	N / -	IP, CP, HP
Eriocaulaceae Family (Pipewort)							
Pipewort (Sevenangle Pipewort)	*Eriocaulon aquaticum*	-	-	G5	S5	N / -	CP, GEP, HP
Iridaceae Family (Iris)							
Northern Blue Flag (Harlequin Blueflag)	*Iris versicolor*	-	-	G5	S5	N / -	CP

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Juncaceae Family (Rush)							
Sharp-fruited Rush (Sharp-fruit Rush)	*Juncus acuminatus*	-	-	G5	S5	N / -	IP, HP
Marsh Rush, Canada Rush (Canadian Rush)	*Juncus canadensis*	-	-	G5	S5	N / -	CP
Soft Rush (Common Rush)	*Juncus effusus*	-	-	G5	S5	N / -	IP, CP
Greene's rush	*Juncus greenei*	-	-	G5	S5	N / -	CP, GEP
Bayonet-rush (Bayonet Rush)	*Juncus militaris*	-	-	G4	S5	N / -	GEP, HP
Pondshore-rush (Brownfruit Rush)	*Juncus pelocarpus*	-	-	G5	S5	N / -	IP
Common Wood-rush	*Luzula multiflora*	-	-	G5	S5	N / -	Main
Liliaceae Family (Lily)							
Yellow Star-grass (Common Goldstar)	*Hypoxis hirsuta*	-	-	G5	S4S5	N / -	OMNWR
Wood Lily	*Lilium philadelphicum*	-	-	G5	S4	N / -	Main
Orchidaceae Family (Orchid)							
Pink Lady's-slipper (Moccasin Flower)	*Cypripedium acaule*	-	-	G5	S5	N / -	NE, Main
Poaceae Family (Grass)							
Northern Ticklegrass (Rough Bentgrass, Ticklegrass)	*Agrostis scabra*	-	-	G5	S5	N / -	CP, GEP
Woodgrass	*Brachyelytrum aristosum*	-	-	G4G5	S5	N / -	NE
Canada Bluejoint, Reedgrass (Bluejoint Reedgrass)	*Calamagrostis canadensis*	-	-	G5	S5	N / -	GEP
Common Hairgrass	*Deschampsia flexuosa*	-	-	G5	S5	N / -	NE, Main, CP
Fascicled Panic-grass (Tapered Rosette Grass, Western Panicgrass)	*Dichanthelium acuminatum var. fasciculatum*	-	-	G5T5	S5	N / -	CP
Deer-tongue (Deertongue)	*Dichanthelium clandestinum*	-	-	G5?	S5	N / -	IP
Forked Panic-grass (Cypress Panicgrass)	*Dichanthelium dichotomum*	-	-	G5	S5	N / -	NE, CP

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Smooth Panic-grass	*Dichanthelium acuminatum var. spretum*	-	-	G5	S4	N / -	IP
Barnyard-grass (Barnyard Grass)	*Echinochloa crus-galli*	-	-	GNR	SNA	NN / -	IP
Purple Lovegrass (Petticoat-climber)	*Eragrostis spectabilis*	-	-	G5	S5	N / -	NE
Sheep Fescue	*Festuca ovina*	-	-	GNR	SNA	NN / -	NE, Main, CP
Mannagrass (Rattlesnake Mannagrass)	*Glyceria canadensis*	-	-	G5	S5	N / -	HP
Rice Cut-grass (Rice Cutgrass)	*Leersia oryzoides*	-	-	G5	S5	N / -	IP, CP, HP
Common Reed, Phragmites	*Phragmites australis*	-	-	G5	SNA	NN / I	IP
Black Oatgrass (Blackseed Needlegrass)	*Piptochaetium avenaceum*	-	WL	G5	SNR	N / -	Main
Little Bluestem	*Schizachyrium scoparium*	-	-	G5	S5	N / -	NE, CP
Xyridaceae Family (Yelloweyed-Grass)							
Yellow-eyed-grass (Bog Yelloweyed Grass)	*Xyris difformis*	-	-	G5	S5	N / -	CP
Pinaceae Family (Pine)							
Norway Spruce	*Picea abies*	-	-	G5	SNR	* / IP	Main
Pitch-pine (Pitch Pine)	*Pinus rigida*	-	-	G5	S5	N / -	NE, Main
White Pine	*Pinus strobus*	-	-	G5	S5	N / -	NE, Main
Dennstaedtiaceae Family (Hay-Scented Fern)							
Hay-scented Fern	*Dennstaedtia punctilobula*	-	-	G5	S5	N / -	OMNWR
Bracken (Bracken Fern)	*Pteridium aquilinum*	-	-	G5	S5	N / -	Main
Onocleaceae Family (Sensitive Fern)							
Sensitive Fern	*Onoclea sensibilis*	-	-	G5	S5	N / -	OMNWR
Dryopteridaceae Family (Wood Fern)							
Christmas-fern (Christmas Fern)	*Polystichum acrostichoides*	-	-	G5	S5	N / -	OMNWR

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Osmundaceae Family (Royal Fern)							
Cinnamon Fern	*Osmundastrum cinnamomeum* *(Osmundastrum cinnamomea)*	-	-	G5	S5	N / -	OMNWR
Interrupted Fern	*Osmunda claytoniana*	-	-	G5	S5	N / -	OMNWR
Thelypteridaceae Family (Marsh Fern)							
Marsh-fern (Marsh Fern, Meadow Fern)	*Thelypteris palustris*	-	-	G5	S5	N / -	IP

1 Federal Legal Status Codes (under Federal Endangered Species List): E=endangered; T=threatened; C=candidate; "-"=no status.

2 State Legal Status Codes (under Massachusetts Endangered Species Lists): E=endangered; T=threatened; SC= special concern; WL=watch list; "-"=no status.

3 Global Rarity Rank: NatureServe Global Conservation Status Ranks from *http://explorer.natureserve.org/* where the conservation status of a species is designated by a number from 1 to 5 (1=critically imperiled, 2=imperiled, 3=vulnerable, 4=apparently secure, 5=secure), preceded by a letter reflecting the appropriate geographic scale of the assessment (G = Global, N = National, and S = Subnational). Additionally, GNR=unranked (global rank not yet assessed) and "?"=inexact numeric rank.

4 Massachusetts Rarity Rank from Dow Cullina et al. (2011): S1 =critically imperiled; S2=imperiled; S3=either very rare or uncommon, vulnerable; S4=widespread, abundant, apparently secure; S5=secure; SNA=not applicable; "-"=no rank given. State rarity ranks were only provided for "species in greatest need of conservation", therefore although some species were assigned a rank of S5, they are still of conservation concern in Massachusetts.

5 Native or Introduced / Invasive Status information comes from Dow Cullina et al. (2011) for Plymouth Count, and also from the Massachusetts Invasive Plants Advisory Group (*http://www.massnrc.org/mipag/speciesreviewed_alpha.htm*). Codes: N=native; NN=nonnative, I=invasive, LI=likely invasive, IP=invasive status pending in MA, "-"=noninvasive, "*"=not on record as occurring in Plymouth County (at time of publication).

6 Location information comes from Zinovjev and Kadis 2012. The three land parcels are coded as: Main=Crooked Pond parcel, NE=Northeast (Island Pond parcel), NW=Northwest (Hoyt Pond parcel). Each of the four ponds area also recognized as separate locations and coded as: IP=Island Pond, CP=Crooked Pond, HP=Hoyt Pond, GEP=Gunners Exchange Pond. Additionally, OMNWR=outside Refuge boundaries. Location from AECOM 2010. ROW=transmission line corridor, Pond=along edge of Island Pond, "-"=not recorded.

Appendix B


USFWS

Northern red-bellied cooter

Findings of Appropriateness and Compatibility Determinations

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FWS Form 3-2319
02/06

FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Massasoit National Wildlife Refuge

Use: Research Conducted by Non-Service Personnel

This form is not required for wildlife-dependent recreational uses, take regulated by the State, or uses already described in a refuge CCP or stepdown management plan approved after October 9, 1997.

Decision criteria:	**YES**	**NO**
(a) Do we have jurisdiction over the use?	✔	
(b) Does the use comply with applicable laws and regulations (Federal, State, Tribal, and local)?	✔	
(c) Is the use consistent with applicable Executive orders and Department and Service policies?	✔	
(d) Is the use consistent with public safety?	✔	
(e) Is the use consistent with goals and objectives in an approved management plan or other document?	✔	
(f) Has an earlier documented analysis not denied the use or is this the first time the use has been proposed?	✔	
(g) Is the use manageable within available budget and staff?	✔	
(h) Will this be manageable in the future within existing resources?	✔	
(i) Does the use contribute to the public's understanding and appreciation of the refuge's natural or cultural resources, or is the use beneficial to the refuge's natural or cultural resources?	✔	
(j) Can the use be accommodated without impairing existing wildlife-dependent recreational uses or reducing the potential to provide quality (see section 1.6D, 603 FW 1, for description), compatible, wildlife-dependent recreation into the future?	✔	

Where we do not have jurisdiction over the use ("no" to (a)), there is no need to evaluate it further as we cannot control the use. Uses that are illegal, inconsistent with existing policy, or unsafe ("no" to (b), (c), or (d)) may not be found appropriate. If the answer is "no" to any of the other questions above, we will **generally** not allow the use.

If indicated, the refuge manager has consulted with State fish and wildlife agencies. Yes ✔ No______

When the refuge manager finds the use appropriate based on sound professional judgment, the refuge manager must justify the use in writing on an attached sheet and obtain the refuge supervisor's concurrence.

Based on an overall assessment of these factors, my summary conclusion is that the proposed use is:

Not Appropriate ________ **Appropriate** ✔

Refuge Manager: ___________________________ Date: ________________

If found to be **Not Appropriate**, the refuge supervisor does not need to sign concurrence if the use is a new use.

If an existing use is found **Not Appropriate** outside the CCP process, the refuge supervisor must sign concurrence.

If found to be **Appropriate**, the refuge supervisor must sign concurrence:

Refuge Supervisor:______________________________ Date:__________

A compatibility determination is required before the use may be allowed.

603 FW 1
Exhibit 1
Page 2

JUSTIFICATION FOR A FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Massasoit National Wildlife Refuge

Use: Research Conducted by Non-Service Personnel

NARRATIVE:

The Service encourages and supports research and management studies on refuge lands that will improve and strengthen natural resource management decisions. The refuge manager encourages and seeks research clearly relating to approved refuge objectives, improves habitat management, and promotes adaptive management at Massasoit National Wildlife Refuge (NWR). We will generally support research projects addressing important management issues or demonstrating species or habitat management techniques important to agencies of the Department of Interior, the National Wildlife Refuge System (Refuge System), and State fish and game agencies. Researchers will submit a final report to the refuge upon completing their work. For long-term studies, we may also require interim progress reports. Researchers are expected to publish in peer-reviewed publications. All reports, presentations, posters, articles, or other publications will acknowledge the refuge system and the Massasoit NWR as partners in the research. All posters will adhere to Service graphics standards. We will insert this requirement to ensure that the research community, partners, and the public understand that the research could not have been conducted without the refuge having been established, or without its operational support and that of the Refuge System.

COMPATIBILITY DETERMINATION

USE

Research Conducted by Non-Service Personnel

REFUGE NAME:

Massasoit National Wildlife Refuge

DATE ESTABLISHED:

1983

ESTABLISHING AND ACQUISITION AUTHORITY(IES):

Endangered Species Act of 1973 (16 USC § 1531-1543, as amended)

REFUGE PURPOSE(S):

". . . to conserve (A) fish or wildlife which are listed as endangered or threatened species. . . or (B) plants. . ." (16 U.S.C. § 1534).

NATIONAL WILDLIFE REFUGE SYSTEM MISSION:

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

DESCRIPTION OF USE:

(a) What is the use? Is the use a priority public use?
This determination covers low impact research projects; namely, those projects with methods that only have a minimal potential to adversely impact cultural resources and native wildlife and plants.

This is not an all-inclusive list, but examples of the types of research that would be allowed include: northern red-bellied cooter capture and tagging, radio-telemetry tracking, fish sampling, use of cameras and recorders, use of live or other passive traps, non-destructive searches of nests, dens, or burrows, habitat modifications for nesting, research on predator exclosures, landbird nesting and migration ecology, and habitat and vegetation changes.

Research activities allowed under this determination would not result in long-term, negative alterations to species' behavior (e.g. result in wildlife leaving previously occupied areas for long periods; modifying their habitat use; or, causing nest or young abandonment). No project would degrade wildlife habitat, including vegetation, soils, and water. Research associated activities that would not be allowed include, but are not limited to, those that would result in soil compaction or erosion, degrade water quality, destroy habitat, cause public health or safety concerns, or result in conflicts with other compatible refuge uses.

Research conducted by non-U.S Fish and Wildlife Service (Service) personnel is not a priority public use of the National Wildlife Refuge System (Refuge System) under the National Wildlife Refuge System Administration Act of 1966 (16 U.S.C. 668dd-668ee), and the Refuge System Improvement Act of 1997 (Public Law 105-57).

(b) Where would the use be conducted?
The location of the research will vary depending on the individual research project being conducted. The entire refuge is potentially available for scientific research. An individual research project is usually limited to a particular habitat type, plant, or wildlife species. On occasion, research projects will encompass an assemblage of habitat types, plants, or wildlife, or may span more than one refuge or include lands outside the refuge. The research location will be limited to those areas of the refuge necessary to conduct the research project. Because of the need to close parts of the refuge spatially or temporally to protect refuge wildlife, some research may not be able to be conducted on certain parts of the refuge during certain times.

(c) When would the use be conducted?
The timing of the research will depend entirely on the individual research project's approved design. Scientific research will be allowed to occur on the refuge throughout the year, unless it conflicts with the protection of northern red-bellied cooters, or with other resources of conservation concern. Individual research projects can be short-term, requiring one or two visits over the course of a few days, or multi-year studies requiring daily visits to the study site. The research project timing will be limited to the minimum (shortest duration) required to meet project objectives. The refuge manager would approve the timing (e.g., project length, seasonality, time of day) of the research prior to the start of the project to minimize impacts to wildlife and habitats, ensure safety, and reduce conflicts with other compatible refuge uses.

(d) How would the use be conducted?
Research methods will also depend on the individual research project. The methods and study design of each research project will be reviewed and scrutinized before the project will be allowed to occur on the refuge. All research project approvals will require individual proposals to demonstrate (1) an approved scientific method, (2) provisions for assuring public health and safety, and (3) no adverse effects on endangered species, migratory birds, or other priority resources of conservation concern. Only low impact research activities, such as those listed under section (a) above, are covered under this determination.

Access to Massasoit NWR is primarily facilitated by vehicle and pedestrian walking access. Both of these means of access are the same as those used by Service staff when conducting biological surveys and management.

Research projects must have a Service-approved study plan and protocol. A detailed research proposal that follows the refuge's study proposal guidelines (see attachment I) is required from parties interested in conducting research on the refuge. Each research proposal request will be considered, and if determined appropriate and compatible, will be issued a special use permit (SUP) by the refuge manager that includes the stipulations in this determination. The refuge manager will use sound professional judgment and ensure that the request will have no considerable negative impacts to natural or cultural resources, or impact visitors, and does not violate refuge regulations. Before initiating a research project that involves federally listed endangered or threatened species, an interagency Section 7 consultation process should be completed.

If approved, multi-year research projects will be reviewed annually to ensure that they are meeting their intended design purposes, that reporting and communicating with refuge staff is occurring, and that projects continue to be consistent with the mission of the Refuge System and purposes for which the Massasoit NWR was established.

If the refuge manager decides to deny, modify, or halt a specific research project, the refuge manager will explain the rationale and conclusions supporting their decision in writing. The denial or modification to an existing study will generally be based on evidence that the details of a particular research project may:

- Negatively impact native fish, wildlife, and habitats or cultural, archaeological, or historical resources.
- Detract from fulfilling the refuge's purposes or conflict with refuge goals and objectives.
- Raise public health or safety concerns.
- Conflict with other compatible refuge uses.

- Not be manageable within the refuge's available staff or budget time.
- Deviate from the approved study proposal such that impacts to refuge resources are more severe or extensive than originally anticipate.

(e) Why is this use being proposed?
Research by non-Service personnel is conducted by colleges, universities, Federal, state, local agencies, nongovernmental organizations, and qualified members of the public to further the understanding of the natural and physical refuge environments and improve management of refuge natural resources. Much of the information generated by the research is applicable to management on and near the refuge. Thorough research provides critical information for establishing baseline information on refuge resources and evaluating management effects on wildlife and habitat. Research projects may also include evaluating habitat management treatments and the associated wildlife community response, as well as, measures of impacts from public uses on refuge lands.

The Service will encourage and support research and management studies on refuge lands that improve and strengthen natural resource management decisions. The refuge manager will encourage and seek research related to approved refuge objectives, which clearly improves land management and promotes adaptive management. Priority research addresses information that is important to agencies of the Department of the Interior, the Service, Refuge System, State fish and game agencies and other agencies responsible for managing natural resources.

The refuge will also consider research for other purposes that may not be directly related to refuge-specific objectives, but will 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 comply with the Service's governing laws, regulations, and policies.

The refuge will maintain a list of research needs that will be provided to prospective researchers or organizations upon request.

AVAILABILITY OF RESOURCES:

Refuge support of research directly related to refuge goals and objectives may take the form of funding, in-kind services such as use of facilities, vehicles, boats, or equipment, direct staff assistance with the project for data collection, providing historical records, conducting management treatments, or other assistance as appropriate.

The cost for research is incurred in staff time to review research proposals, coordinate with researchers, write and administer special use permits, and in some instances vehicle support and fuel. At an hourly rate of approximately $45 for a GS-12 step 8, this totals about $6,000 annually spent on outside research. However, the costs could be much different depending on how many research projects are underway in any given year.

Research program administration	1 staff	120 hours	$5,400
Fuel and equipment			$600
Total annual costs:			**$6,000**

ANTICIPATED IMPACTS OF THE USE:

The Service encourages approved research to further our understanding of natural resources. Research by other than Service personnel adds to the best available information base supporting management decisions. Researchers may disturb wildlife (such as altering bird behavior as a result of human presence), or cause direct mortality or vegetation trampling while conducting their activities. Researchers may occasionally access the refuge using a four-wheel drive vehicle but most researcher activity will be on foot. Pedestrians have the potential to impact migratory birds when they are present in the same areas (Boyle and Samson 1985). Research has shown that recreation can alter the species composition, nest success, and even brood parasitism of nesting land birds (Miller et al. 1998, Fernández-Juricic 2000; see also Steven et al. 2011). However, we expect potential bird disturbances to be very light given that research is not often conducted on Massasoit

NWR. Researchers may also cause disturbance to nesting northern red-bellied cooters if research activities are occurring in nesting areas from June to September. Nesting sites are small however, and most research activities can be directed away from these areas during the nesting season. We also expect potential vegetation trampling from researchers to be light, and will encourage researchers to use existing access trails and fire breaks whenever possible.

It is possible that direct mortality could result incidental to research activities. Mist-netting for example, can cause stress or (rarely) physical injury, especially when birds are captured, banded and weighed. There may also be occasional mortalities to birds, if predators reach netted birds before researchers do. Similarly, mortality could occur to turtles or fish when fyke nets are used to capture pond fauna. However, all of these injuries and mortalities can be minimized and nearly eliminated when strict protocols for trapping and handling are required and followed, and research personnel are properly trained. Additionally, all research will be conducted according to the stipulations stated in the special use permit. Overall, allowing well-designed and properly reviewed research to be conducted by non-Service personnel is likely to have very little impact on refuge wildlife populations and habitat. If the research project is conducted with professionalism and integrity, potential minor adverse impacts are likely to be outweighed by the knowledge added to our understanding of refuge resources and our management effects on those resources, as well as the opportunity to inform, strengthen, and improve future refuge management decisions. In the event of persistent disturbance to habitat or to wildlife, the activity will be further restricted or discontinued. Because Service or partner staff will supervise this activity, impacts of research will likely be minimal when conducted in accordance with refuge regulations.

We anticipate research will have only negligible to minor impacts to refuge wildlife and habitats because it will only be carried out after the refuge approves a detailed project proposal and issues a Special Use Permit, or enters into a Cooperative Agreement or Research Work Order, including the stipulations in this determination to ensure compatibility. These stipulations are designed to help ensure each project minimizes impacts to refuge cultural resources, wildlife, vegetation, soils, and water.

PUBLIC REVIEW AND COMMENT:

As part of the comprehensive conservation planning (CCP) process for the Massasoit NWR, this compatibility determination will undergo a public comment period concurrent with the release of the draft Massasoit CCP/ Environmental Assessment.

DETERMINATION (CHECK ONE BELOW):

_____ Use is not compatible

__X__ Use is compatible with the following stipulations

STIPULATIONS NECESSARY TO ENSURE COMPATIBILITY:

- All researchers will be required to submit a detailed research proposal following Service Policy (Service Refuge Manual Chapter 4 Section 6, as may be amended), as well as a completed Refuge System Special Use Research and Monitoring Application and Permit. This can be found at . Applications can be submitted to the refuge manager via email or by fax. The refuge must be given at least 45 days to review and decide whether to approve proposals before initiation of research. If collection of wildlife is involved, the refuge must be given 60 days to review and decide whether to approve the proposal. The Service cannot guarantee that it will review or approve proposals not submitted within these timeframes.

- Only low impact projects are covered under this determination. Low impact projects, as indicated under (a) above, are those that would only have a minimal potential to impact cultural resources and native wildlife and plants. No project should result in long-term negative alterations to species' behavior (e.g. result in wildlife leaving previously occupied areas for a long term; modifying their habitat use within their range; or, causing nest or young abandonment). No project should degrade wildlife habitat, including vegetation, soils, and water. Nest, dens, and burrows must not be harmed. No research activities should result in soil compaction or erosion, degrade water quality, or destroy habitat.

- Research would only be conducted in Service-approved locations, using approved modes of access, and conducted only after the timing, season, duration, numbers of researchers, and areas open and closed are approved. Sensitive wildlife habitat areas will be avoided unless sufficient protection, approved by the Service, is implemented to limit the area and/or resources potentially impacted by the proposed research.

- Proposals will be prioritized and approved based on need, benefit to refuge resources, and the level of refuge funding or other support required. Service experts, State agencies, or academic experts may be asked to review and comment on proposals.

- SUPs or Cooperative Agreements will be issued for all research conducted by non-Service personnel. The permit will list all the conditions necessary to ensure compatibility and will identify a schedule for periodic progress reports and submittal of a final report or scientific paper.

- Any research project may be terminated at any time for non-compliance with the conditions of the special use permit, or modified, redesigned, relocated, or terminated upon a determination by the refuge manager that the project is causing unanticipated adverse impacts to wildlife, wildlife habitat, approved priority public uses, or refuge resources of staff time, equipment, or funding.

- All work with endangered species will require the proper permits from Federal or State government. Any research involving federally listed species may require Section 7 consultation under the ESA. Any research involving ground disturbance may require historic preservation consultation with the Regional Historic Preservation Officer and/or State Historic Preservation Officer. Researchers may also need State and Federal collection permits and may need to provide an assurance of animal care form or an institutional animal approval form, if applicable.

- Researchers will mark any survey routes, plots, and points in as visually unobtrusive a manner as practical. No permanent markers or infrastructure can be left on the refuge.

- Researchers will use every precaution and not conduct activities that would cause damage to refuge property or present hazards or significant annoyances to other refuge visitors. Any damage should be reported immediately to the refuge manager.

- Researchers must not litter, or start or use open fires on refuge lands.

- All research staff handling wildlife must be properly trained to minimize the potential for impacts to individual wildlife prior to initiating the project. In addition, a review of the U.S. Department of Agriculture's Animal Welfare Information Center Website must be documented by the researcher with identification of practices that will be followed to help further minimize stress, injury, and mortality of wildlife. The Website is reached at: accessed October 2015

- Researchers may not use any chemicals (e.g., herbicides to treat invasive plants) or hazardous materials without prior written consent of refuge manager (e.g., the type of chemical, timing of use, and rate of application). All activities will be consistent with Service policy and an approved refuge Pesticide Use Plan.

- Researchers will be required to take steps to ensure that invasive species and pathogens are not inadvertently introduced or transferred to the refuge and surrounding lands (e.g., cleaning and disinfecting equipment).

- Researchers must have the SUP in their possession when engaged in research activities and will present it to refuge officials and State and Federal law enforcement agents upon request.

- Researchers will submit a final report to the refuge upon completion of their work. For long-term studies, interim progress reports may also be required. The refuge also expects that research findings will be published in peer-reviewed publications. The contribution of the refuge and the Service should be acknowledged in any publications. The SUP (Cooperative Agreement or Research Work Order) will identify a schedule for annual progress reports and the submission of a final report or scientific paper.

JUSTIFICATION:

The Service encourages quality, scientific research because it provides critical baseline information on Federal trust and other refuge resources and helps evaluate the management effects on those resources. Research by non-Service personnel, guided by the stipulations listed above, adds greatly to the information base for refuge managers to make proper refuge management decisions. This use will potentially contribute to the refuge's concurrent purposes in carrying out endangered species and migratory bird management. While some research activities may cause minimal disturbance to wildlife or result in the loss of specific individuals, this impact will be offset by the value of the research to managers and future generations. Impacts, if they occur, would be confined in area, duration, and magnitude, with no long-term consequences predicted. Research conducted by non-Service personnel will not materially interfere with or detract from the mission of the Refuge System or the purposes for which the refuge was established.

SIGNATURE:

Refuge Manager: ______________________________ ______________________________
(Signature) (Date)

CONCURRENCE:

Regional Chief: ______________________________ ______________________________
(Signature) (Date)

MANDATORY 10 YEAR RE-EVALUATION DATE: ______________________________

LITERATURE CITED:

Boyle, S.A. and F.B. Samson. 1985. Effects of non-consumptive recreation on wildlife: A review. Wildlife Society Bulletin 13: 110-116.

Fernández-Juricic, E. 2000. Local and regional effects of pedestrians on forest birds in a fragmented landscape. Condor 102(2):247-255.

Miller, S.G., R.L. Knight, and C.K. Miller. 1998. Influence of recreational trails on breeding bird communities. Ecological Applications 8:162-169.

Steven, R., C. Pickering, and J.G. Castley. 2011. A review of the impacts of nature based recreation on birds. Journal of Environmental Management 92: 2287-2294.

Attachment 1. Massasoit National Wildlife Refuge Study Proposal Guidelines

A study proposal is a justification and description of the work to be done, and includes cost and time requirements. Proposals must be specific enough to serve as “blueprints” for the investigative efforts. Step-by-step plans for the actual investigations must be spelled out in advance, with the level of detail commensurate with the cost and scope of the project and the needs of management. Please submit proposals electronically as a Microsoft Word document or hardcopy to the refuge manager.

The following list provides a general outline of first order headings/sections for study proposals.

- Cover Page.
- Table of Contents (for longer proposals).
- Abstract.
- Statement of Issue.
- Literature Summary.
- Objectives/Hypotheses.
- Study Area.
- Methods and Procedures.
- Quality Assurance/Quality Control (QA/QC).
- Specimen Collections.
- Deliverables.
- Special Requirements, Concerns, Necessary Permits.
- Literature Cited.
- Peer Review.
- Budget.
- Personnel and Qualifications.

Cover Page

The cover page must contain the following information:

- Title of Proposal.
- Current Date.
- Investigator(s): name, title, organizational affiliation, address, telephone and fax numbers and e-mail address of all investigators or cooperators.
- Proposed starting date.
- Estimated completion date.
- Total Funding Support Requested from the U.S. Fish and Wildlife Service (Service).
- Signatures of Principal Investigator(s) and other appropriate institutional officials.

Abstract

The abstract should contain a short summary description of the proposed study, including reference to major points in the Statement of Issue, Objectives, and Methods and Procedures sections.

Statement of Issue

Provide a clear, precise summary of the problem to be addressed and the need for its solution. This section should include statements of the importance, justification, relevance, timeliness, generality, and contribution of the study. Describe how any products will be used, including any anticipated commercial use. What is the estimated probability of success of accomplishing the objective(s) within the proposed timeframe?

Literature Summary

This section should include a thorough but concise literature review of current and past research that pertains to the proposed research, especially any pertinent research conducted within southeastern Massachusetts or New England, and specifically, on refuge units. A discussion of relevant legislation, policies, and refuge planning and management history, goals, and objectives should also be included.

Objectives/Hypotheses

A very specific indication of the proposed outcomes of the project should be stated as objectives or hypotheses to be tested. Project objectives should be measurable. Provide a brief summary of what information will be provided at the end of the study and how it will be used in relation to the problem. These statements should flow logically from the statement of issue and directly address the management problem.

Establish data quality objectives in terms of precision, accuracy, representativeness, completeness, and comparability as a means of describing how good the data need to be to meet the project's objectives.

Study Area

Provide a detailed description of the geographic area(s) to be studied and include a clear map delineating the proposed study area(s) and showing specific locations where work will occur.

Methods and Procedures

This section should describe as precisely as possible how the objectives will be met or how the hypotheses will be tested. Include detailed descriptions and justifications of the field and laboratory methodology, protocols, and instrumentation. Explain how each variable to be measured directly addresses the research objective/hypothesis. Describe the experimental design, population, sample size, and sampling approach (including procedures for sub-sampling). Summarize the statistical and other data analysis procedures to be used. List the response variables and tentative independent variables or covariates. Describe the experimental unit(s) for statistical analysis. Also include a detailed project time schedule that includes initiation, fieldwork, analysis, reporting, and completion dates.

Quality Assurance/Quality Control

Adequate QA/QC procedures help ensure that data and results are: credible and not an artifact of sampling or recording errors; of known quality; able to stand up to external scientific scrutiny; and accompanied by detailed method documentation. Describe the procedures to be used to insure that data meet defined standards of quality and program requirements, errors are controlled in the field, laboratory, and office, and data are properly handled, documented, and archived. Describe the various steps (e.g., personnel training, calibration of equipment, data verification and validation) that will be used to identify and eliminate errors introduced during data collection (including observer bias), handling, and computer entry. Identify the percentage of data that will be checked at each step.

Specimen Collections

Clearly describe the kind (species), numbers, sizes, and locations of animals, plants, rocks, minerals, or other natural objects to be sampled, captured, or collected. Identify the reasons for collecting, the intended use of all the specimens to be collected, and the proposed disposition of collected specimens. For those specimens to be permanently retained as voucher specimens, identify the parties responsible for cataloging, preservation, and storage and the proposed repository.

Deliverables

The proposal must indicate the number and specific format of hard and/or electronic media copies to be submitted for each deliverable. The number and format will reflect the needs of the refuge and the Refuge manager. Indicate how many months after the project is initiated (or the actual anticipated date) that each deliverable will be submitted. Deliverables are to be submitted or presented to the refuge manager.

Deliverables that are required are as follows:

Reports and Publications
Describe what reports will be prepared and the timing of reports. Types of reports required in fulfillment of natural and social science study contracts or agreements include:

(1) Progress report(s) (usually quarterly, semiannually, or annually): may be required

(2) Draft final and final report(s): always required

A final report must be submitted in addition to a thesis or dissertation (if applicable) and all other identified deliverables. Final and draft final reports should follow refuge guidelines (Attachment 1a).

In addition, investigators are encouraged to publish the findings of their investigations in refereed professional, scientific publications and present findings at conferences and symposia. The Refuge manager appreciates opportunities to review manuscripts in advance of publication.

Data Files
Provide descriptions of any spatial (Geographic Information Systems; GIS) and non-spatial data files that will be generated and submitted as part of the research. Non-spatial data must be entered onto Windows CD-ROMs in Access or Excel. Spatial data, which includes GPS (Global Position System)-generated files, must be in a format compatible with the refuge's GIS system (ArcGIS 10). All GIS data must be in UTM Zone 19, NAD 83.

Metadata
For all non-spatial and spatial data sets or information products, documentation of information (metadata) describing the extent of data coverage and scale, the history of where, when, and why the data were collected, who collected the data, the methods used to collect, process, or modify/ transform the data, and a complete data dictionary must also be provided as final deliverables. Spatial metadata must conform to Service (Federal Geographic Data Committee; FDGC) metadata standards.

Oral Presentations
Three types of oral briefings should be included: pre-study, annual, and closeout.

These briefings will be presented to refuge staff and other appropriate individuals and cooperators. In addition, investigators should conduct periodic informal briefings with refuge staff throughout the study whenever an opportunity arises. During each refuge visit, researchers should provide verbal updates on project progress. Frequent dialogue between researchers and refuge staff is an essential element of a successful research project.

Specimens and Associated Project Documentation
A report on collection activities, specimen disposition, and the data derived from collections, must be submitted to the refuge following refuge guidelines.

Other:
Researchers must provide the refuge manager with all of the following:

(1) Copies (numbered) of field notes/ notebooks/ datasheets.

(2) Copies of raw data (in digital format), including GIS data, as well as analyzed data.

(3) Copies of all photos, slides (digital photos preferred), videos, and films.

(4) Copies of any reports, theses, dissertations, publications or other material (such as news articles) resulting from studies conducted on refuge.

(5) Detailed protocols used in study.

(6) Aerial photographs.

(7) Maps.

(8) Interpretive brochures and exhibits.

(9) Training sessions (where appropriate).

(10) Survey forms.

(11) Value-added software, software developed, and models.

Additional deliverables may be required of specific studies.

Special Requirements, Permits, and Concerns

Provide information on the following topics where applicable. Attach copies of any supporting documentation that will facilitate processing of your application.

Refuge Assistance
Describe any refuge assistance needed to complete the proposed study, such as use of equipment or facilities or assistance from refuge staff. It is important that all equipment, facilities, services, and logistical assistance expected to be provided by the Service be specifically identified in this section so all parties are in clear agreement before the study begins.

Ground Disturbance
Describe the type, location, area, depth, number, and distribution of expected ground- disturbing activities, such as soil pits, cores, or stakes. Describe plans for site restoration of affected areas.

Proposals that entail ground disturbance may require an archeological survey and special clearance prior to approval of the study. You can help reduce the extra time that may be required to process such a proposal by including identification of each ground disturbance area on a U.S. Geological Survey (USGS) 7.5-minute topographic map.

Site Marking and/or Animal Marking
Identify the type, amount, color, size, and placement of any flagging, tags, or other markers needed for site or individual resource (e.g., trees) identification and location. Identify the length of time it is needed and who will be responsible for removing it. Identify the type, color, placement of any tags placed on animals (see SUP or requirements on marking and handling of animals).

Access to Study Sites
Describe the proposed method and frequency of travel to and within the study site(s). Explain any need to enter restricted areas. Describe duration, location, and number of participants, and approximate dates of site visits.

Use of Mechanized and Other Equipment
Describe any vehicles, boats, field equipment, markers, or supply caches by type, number, and location. You should explain the need to use these materials and if or how long they are to be left in the field.

Safety
Describe any known potentially hazardous activities, such as electro-fishing, scuba diving, aircraft use, wildlife capture or handling, wildlife or immobilization.

Chemical Use
Identify chemicals and hazardous materials that you propose using within the refuge.

Indicate the purpose, method of application, and amount to be used. Describe plans for storage, transfer, and disposal of these materials and describe steps to remediate accidental releases into the environment. Attach copies of Material Safety Data Sheets.

Animal Welfare
If the study involves vertebrate animals, describe your protocol for any capture, holding, marking, tagging, tissue sampling, or other handling of these animals (including the training and qualifications of personnel relevant to animal handling and care). If your institutional animal welfare committee has reviewed your proposal, please include a photocopy of their recommendations. Describe alternatives considered, and outline procedures to be used to alleviate pain or distress. Include contingency plans to be implemented in the event of accidental injury to or death of the animal. Include state and Federal permits. Where appropriate, coordinate with and inform state natural resource agencies.

Literature Cited

List all reports and publications cited in the proposal.

Peer Review

Provide the names, titles, addresses, and telephone numbers of individuals with subject-area expertise who have reviewed the research proposal. If the reviewers are associated with the investigator's research institution or if the proposal was not reviewed, please provide the names, titles, addresses, and telephone numbers of three to five potential subject-area reviewers who are not associated with the investigator's institution. These individuals will be asked to provide reviews of the proposal, progress reports, and the draft final report.

Budget

The budget must reflect both funding and assistance that will be requested from the Fish and Wildlife Service and the cooperator's contributions on an identified periodic (usually annual) basis.

Personnel Costs
Identify salary charges for principal investigator(s), research assistant(s), technician(s), clerical support, and others. Indicate period of involvement (hours or months) and pay rate charged for services. Be sure to include adequate time for data analysis and report writing and editing.

Fringe Benefits
Itemize fringe benefit rates and costs.

Travel
Provide separate estimates for fieldwork and meetings. Indicate number of trips, destinations, estimated miles of travel, mileage rate, air fares, days on travel, and daily lodging and meals charges. Vehicle mileage rate cannot exceed standard government mileage rates. Charges for lodging and meals are not to exceed the maximum daily rates set for the locality by the Federal Government.

Equipment
Itemize all equipment to be purchased or rented and provide a brief justification for each item costing more than $1,000 that would be paid for using Federal funds. Be sure to include any computer-related costs. For proposals funded under Service agreement or contract, the refuge reserves the right to transfer the title of purchased equipment with unit cost of $1,000 or more to the Federal Government following completion of the study. These items should be included as deliverables.

Supplies and Materials
Purchases and rentals under $1,000 should be itemized as much as is reasonable.

Subcontract or Consultant Charges
All such work must be supported by a subcontractor's proposal also in accordance with these guidelines.

Specimen Collections
Identify funding requirements for the cataloging, preservation, storage, and analyses of any collected specimens that will be permanently retained.

Printing and Copying
Include costs for preparing and printing the required number of copies of progress reports, the draft final report, and the final report. In general, a minimum of two (2) copies of progress reports (usually due quarterly, semiannually, or as specified in agreement), the draft final report, and the final report are required.

Indirect Charges
Identify the indirect cost (overhead) rate and charges and the budget items to which the rate is applicable.

Cooperator's Contributions
Show any contributing share of direct or indirect costs, facilities, and equipment by the cooperating research institution.

Outside Funding
List any outside funding sources and amounts.

Personnel and Qualifications

List the personnel who will work on the project and indicate their qualifications, experience, and pertinent publications. Identify the responsibilities of each individual and the amount of time each will devote. A full vitae or resume for each principal investigator and any consultants should be included here.

Attachment 1a. Final Report Guidelines

Draft final and final reports should follow Journal of Wildlife Management format and should include the following sections:

- Title Page
- Abstract
- Introduction/Problem statement
- Study Area
- Methods (including statistical analyses)
- Results
- Discussion
- Management Implications
- Management Recommendations
- Literature Cited

COMPATIBILITY DETERMINATION

USE:

Wildlife Observation and Photography, Environmental Education and Interpretation

REFUGE NAME:

Massasoit National Wildlife Refuge

DATE ESTABLISHED:

1983

ESTABLISHING AND ACQUISITION AUTHORITY(IES):

Endangered Species Act of 1973 (16 U.S.C. § 1531-1543, as amended)

REFUGE PURPOSE(S):

“. . . to conserve (A) fish or wildlife which are listed as endangered species or threatened species… or (B) plants…” (16 U.S.C. § 1534).

NATIONAL WILDLIFE REFUGE SYSTEM MISSION:

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

DESCRIPTION OF USE:

(a) What is the use? Is the use a priority public use?
The uses are wildlife observation, wildlife photography, environmental education and interpretation. These are priority public uses of the National Wildlife Refuge System (Refuge System) under the National Wildlife Refuge System Administration Act of 1966 (16 U.S.C. 668dd-668ee), and the National Wildlife Refuge System Improvement Act (Improvement Act) of 1997 (Public Law 105-57).

(b) Where would the use be conducted?
These uses would occur on the Crooked Pond parcel of the refuge. Environmental education and interpretation programs could also occur offsite in classrooms, teacher workshops, and lectures.

(c) When would the use be conducted?
These activities could occur year-round during daylight hours (sunrise to sunset). Environmental education would likely occur primarily during the school season from September through June.

(d) How would the use be conducted?
Visitation to the refuge by the public will only occur as part of a scheduled refuge staff or partner-led activity. All partners would be issued a special use permit (SUP) by refuge staff. The SUP would identify the types of activities that can be held as well as restrictions to prevent and minimize disturbance to wildlife, particularly northern red-bellied cooters. Some parts of the refuge, particularly the shoreline of Crooked Pond, could remain closed to the public to protect the cooter and its habitat. Although wildlife observation and photography is usually self-guided on refuges, the presence of the northern red-bellied cooter and the lack of road frontage and parking on the refuge limits our ability to offer unrestricted access.

Refuge staff will work with local teachers, volunteers and conservation partners to conduct environmental education and interpretation on and off the refuge. Onsite refuge activities will primarily include teacher or staff-guided field trips exploring topics requested by teachers, “Teach-the Teacher” workshops, or more structured curriculum-based programs specifically designed for use on the refuge. Offsite activities would primarily include offering refuge staff assistance to local partners who are interested in working with the refuge staff to expand their efforts into local classrooms and the occasional refuge attendance at special events such as a career day.

Interpretation consists of guided natural or cultural history programs, interpretative signs, lectures, development and publication of brochures, management of a refuge Website, and use of social media such as Facebook and Twitter. Any of these may be used to provide information to the public and to provide a quality refuge experience.

(e) Why is this use being proposed?
The Improvement Act states that priority, wildlife-dependent public uses should receive enhanced consideration in planning and be facilitated on refuges to the extent they are compatible.

Wildlife observation and photography and environmental education and interpretation promote refuge purposes and management objectives through activities that increase public knowledge and understanding of wildlife and the importance of habitat protection and management. Refuge visitors that participate in these uses will gain an understanding of the missions of the Service and the Refuge System, and the contribution of the Massasoit NWR to this system.

AVAILABILITY OF RESOURCES:

These uses will occur with the availability of existing staff to lead or develop partnerships. Massasoit NWR has been closed to the public, so it is unknown what the actual demand for these uses will be.

New Costs:			
Develop a traveling “northern red-bellied cooter” trunk exhibit			$1,000
Total new costs:			**$1,000**
Recurring annual costs:			
Equipment and supplies			$1,000
GS-11 Visitor Services Manager	1 staff	40 hours	$1,800
GS-9 Park Ranger	1 staff	40 hours	$1,500
Total annual recurring costs:			**$4,300**

ANTICIPATED IMPACTS OF THE USE:

The majority of the impact from wildlife observation and photography will be disturbance caused to resting, feeding or nesting migratory birds and turtles, although this will be minimized due to the structured nature of the activities that will be allowed by SUP or conducted by refuge staff. There will be some trampling of vegetation and soil compaction.

Visitors engaged in wildlife observation and photography and/or environmental education and interpretation have a vested interest in minimizing disturbance to the wildlife they wish to observe, photograph, and learn about. However, people are known to disturb wildlife in an attempt to get closer looks at the objects of their attention. Pedestrians have the potential of impacting songbird and other migratory bird populations feeding and resting in the forested area. Pedestrians can also impact turtles if they happen to be in the same area and do not maintain appropriate distances from the turtles. Conflicts arise when migratory birds and humans are present in the same areas (Boyle and Samson 1985). Response of wildlife to human activities includes: departure from site (Owen 1973, Burger 1981, Kaiser and Fritzell 1984, Korschgen et al.1985, Henson and Grant 1991, Kahl 1991, Klein 1993), use of sub-optimal habitat (Erwin 1980, Williams and Forbes 1980), altered behavior (Burger 1981, Korschgen et al. 1985, Morton et al. 1989, Ward and Stehn 1989, Havera et al. 1992, Klein 1993), and increase in energy expenditure (Morton et al. 1989, Bélanger and Bédard 1990).

PUBLIC REVIEW AND COMMENT:

As part of the CCP process for the Massasoit NWR, this compatibility determination will undergo a public comment period concurrent with the release of the draft Massasoit CCP/Environmental Assessment.

DETERMINATION (CHECK ONE BELOW):

_____ Use is not compatible

__X__ Use is compatible with the following stipulations

STIPULATIONS NECESSARY TO ENSURE COMPATIBILITY:

- All wildlife observation and photography, environmental education and interpretation activities will be guided by refuge staff or led by partners who have been issued an SUP by refuge staff. Permittees must follow the conditions outlined in the SUP.

- Activities will avoid sensitive areas prone to disturbance (e.g., sensitive vegetation areas) or degradation (e.g., soil compaction), and will be designed to minimize impacts to turtles, nesting birds, or other breeding, feeding, or resting wildlife.

- Access for wildlife observation and photography, environmental education and interpretation activities will be on foot. No motorized vehicles, bicycles, dogs, or horses will be allowed on the refuge.

- Activities will be held in designated sites where only minimal direct and short term impacts are predicted, and adverse long term, cumulative impacts are not anticipated. Periodic evaluations will be done to insure that visitors are not causing unacceptable adverse impacts. If evidence of unacceptable impacts occurs, access would be modified or curtailed as deemed necessary by the refuge manager.

- The refuge is a leave-no-trace, carry in-carry out facility. All food containers, bottles, and other waste and refuse must be taken out. Littering, dumping, and abandoning property are prohibited by Federal regulation at 50 C.F.R. 27.93.94.

JUSTIFICATION:

Wildlife observation and photography and environmental education and interpretation are priority, wildlife-dependent public uses identified by the Improvement Act. By definition, these activities are determined appropriate by law and, when compatible, are to be facilitated on refuges. These programs support the mission of the Refuge System by promoting an understanding and appreciation of natural and cultural resources and their management within a national system of refuges. Our programs will reach out to all segments of the public to expand support for the refuge system. Individual refuge programs will be consistent with, and fully support, the goals and objectives in the Massasoit NWR CCP.

We do not expect for the offering and conduct of guided wildlife observation or photography, environmental education or interpretation to materially interfere with or detract from the mission of the Refuge System, nor diminish the purpose for which the refuge was established. It will not pose significant adverse effects on refuge resources, nor interfere with public use of the refuge, nor cause an undue administrative burden.

SIGNATURE:

Refuge Manager: ______________________ ______________________
(Signature) (Date)

CONCURRENCE:

Regional Chief: ______________________ ______________________
(Signature) (Date)

MANDATORY 15 YEAR RE-EVALUATION DATE: ______________________

LITERATURE CITED:

Bélanger, L., and J. Bédard. 1990. Energetic cost of man-induced disturbance to staging snow geese. Journal of Wildlife Management. 54:36.

Boyle, S.A., and F. B. Samson. 1985. Effects of non-consumptive recreation on wildlife: A review. Wildlife Society Bulletin. 13:110.

Burger, J. 1981. The effect of human activity on birds at a coastal bay. Biological Conservation. 21:231-241.

Erwin, R.M. 1980. Breeding habitat by colonially nesting water birds in 2 Mid-Atlantic U.S. regions under different regimes of human disturbance. Biological Conservation. 18:39-51.

Havera, S.P., L.R. Boens, M.M. Georgi, and R.T. Shealy. 1992. Human disturbance of waterfowl on Keokuk Pool, Mississippi River. Wildlife Society Bulletin. 20:290-298.

Henson, P.T., and A. Grant. 1991. The effects of human disturbance on trumpeter swan breeding behavior. Wildlife Society Bulletin 19:248-257.

Kaiser, M.S. and E.K. Fritzell. 1984. Effects of river recreationists on green-backed heron behavior. Journal of Wildlife Management. 48:561-567.

Kahl, R. 1991. Boating disturbance of canvasbacks during migration at Lake Poygan, Wisconsin. Wildlife Society Bulletin. 19:242-248.

Klein, M.L. 1993. Waterbird behavioral responses to human disturbance. Wildlife Society Bulletin. 21:31-39.

Korschgen, C.E., L.S. George, and W.L. Green. 1985. Disturbance of diving ducks by boaters on a Migrational staging area. Wildlife Society Bulletin. 13:290-296.

Morton, J.M., A.C. Fowler, and R.L. Kirkpatrick. 1989. Time and energy budgets of American black ducks in winter. Journal of Wildlife Management. 53:401-410 (also see corrigendum in Journal of Wildlife Management. 54:683).

Owen, M. 1973. The management of grassland areas for wintering geese. Wildfowl. 24:123-130.

Ward, D.H., and R.A. Stehn. 1989. Response of brant and other geese to aircraft disturbance at Izembek Lagoon, Alaska. U.S. Fish and Wildlife Service, Alaska Fish and Wildlife Research Center. Final report to the Minerals Management Service. Anchorage, Alaska. 193 pp.

Williams, G.J., and E. Forbes. 1980. The habitat and dietary preferences of dark-bellied Brant geese and widgeon in relation to agricultural management. Wildfowl. 31:151-157.

COMPATIBILITY DETERMINATION

USE:

Fishing

REFUGE NAME:

Massasoit National Wildlife Refuge

DATE ESTABLISHED:

1983

ESTABLISHING AND ACQUISITION AUTHORITY(IES):

Endangered Species Act of 1973 (16 U.S.C. § 1531-1543, as amended)

REFUGE PURPOSE(S):

". . . to conserve (A) fish or wildlife which are listed as endangered or threatened species. . . or (B) plants. . ." (16 U.S.C. § 1534).

NATIONAL WILDLIFE REFUGE SYSTEM MISSION:

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

DESCRIPTION OF USE:

(a) What is the use? Is the use a priority public use?
Fishing is a priority public use of the National Wildlife Refuge System (Refuge System) under the National Wildlife Refuge System Administration Act of 1966 (16 U.S.C. 668dd-668ee), and the National Wildlife Refuge System Improvement Act (Improvement Act) of 1997 (Public Law 105-57).

(b) Where would the use be conducted?
All of Crooked Pond is located within the Massasoit NWR. Sections of Hoyt Pond, Gunners Exchange Pond, and Island Pond shorelines are also in the refuge. All of Massasoit NWR, including these four refuge pond shorelines, has been closed to public access to protect the northern red-bellied cooter and aid in its recovery. Fishing, if allowed, would occur at ponds' edges or from boats in the water.

(c) When would the use be conducted?
The freshwater fishing season in Massachusetts runs throughout the calendar year. However, the majority of fish species present in these refuge ponds are "warm-water" species, such as largemouth bass, black crappie, and chain pickerel (see Massasoit NWR draft comprehensive conservation plan (CCP)/environmental assessment (EA), appendix A, table A-1), with peak fishing seasons occurring from late spring through summer.

(d) How would the use be conducted?
Anglers would use conventional hook and line gear.

(e) Why is this use being proposed?
The 1997 Refuge Improvement Act states that priority, wildlife-dependent public uses should receive enhanced consideration in planning and be facilitated on refuges to the extent they are compatible. Fishing is determined to be an appropriate use of refuges; this document determines whether fishing at Massasoit NWR is a compatible use.

AVAILABILITY OF RESOURCES:

No staff are dedicated to Massasoit NWR. Refuge staff are shared amongst the eight refuges in the Eastern Massachusetts Refuge Complex. Opening refuge shorelines to fishing would require increased law enforcement, biological monitoring, outreach, and maintenance at levels much higher than currently occurs. This effort would be necessary to prevent disturbance to the northern red-bellied cooter and its habitat. A fishing plan and environmental assessment (EA) would need to be written, and a public review period would need to be conducted. Federal fishing regulations would need to be amended. New regulatory and interpretive signs will need to be purchased, installed, and maintained. Coordination with adjoining landowners to approve access would be required in some cases. Parking would need to be constructed and trails developed to provide access to refuge shorelines. Permitting, planning, cultural resource surveys, and construction would require additional resources.

New Planning and Construction Estimated Costs:	
Develop fishing plan, assessment, new regulations and public proces	$10,000
Construct and install regulatory/interpretive panels	$2,000
Planning and construction of up to three parking areas and trails to ponds	$200,000
Total new costs:	**$212,000**

Recurring, annual costs:			
GS-11 Law Enforcement	1 staff	40 hours	$2,000
GS-12 Visitor Services	1 staff	30 hours	$1,500
GS-5 Biological Technician	1 staff	40 hours	$1,200
Occasional maintenance of trails	1 staff	25 hours	$1,000
Equipment, vehicles, and supplies (including brochures/trail guides)			$1,000
Total annual recurring costs:			**$6,700**

ANTICIPATED IMPACTS OF THE USE:

Fishing would occur from the shoreline or on the waters of Crooked Pond or on the refuge-owned sections of Hoyt Pond, Gunners Exchange Pond, and Island Pond shorelines. Northern red-bellied cooters, a federally listed species, rely on all of these ponds for foraging, basking, and nesting. Northern red-bellied cooters are generally active from March to October, with peak nesting occurring in late spring and summer (U.S. Fish and Wildlife Service 1994). Typically hatchlings emerge during late August through October; although rarely, they may overwinter in the nests (*http://www.mass.gov/eea/docs/dfg/nhesp/species-and-conservation/nhfacts/pseudemys-rubriventris.pdf*; accessed December 2016). Therefore, we considered impacts to the northern red-bellied cooter and the habitat at all of these sites throughout the year.

Fishing occurs on non-refuge owned portions of Hoyt Pond, Gunners Exchange Pond, and Island Pond. Some refuge-owned shorelines are suitable for fishing, but there is no easy access to these shorelines that would avoid disturbance to adjacent private landowners or construction of parking areas and trails to the shoreline. In particular, the refuge-owned shoreline on Hoyt Pond is not conducive to fishing due to its slope. The refuge-owned shorelines of Crooked Pond and Gunners Exchange Pond do provide northern red-bellied cooter nesting habitat, and our Island Pond shoreline has nesting potential with suitable management. Due to the overlap in peak fishing times and northern red-bellied cooter nesting activity, we would expect direct disturbance to nesting northern red-bellied cooters at the Gunners Exchange Pond shoreline site if fishing were allowed on refuge property. It can take a female cooter several hours from the time she emerges from the water, to find a nesting spot, dig the nest chamber, lay her eggs, and cover the nest (U.S. Fish and Wildlife Service unpublished reports 2014 and 2015). Any human presence during the day, even for a short amount of time, could disrupt this behavior. With increased human access, we would also expect an increase in trampled vegetation and possibly shoreline erosion, littering, and vandalism (Knight and Cole, 1995).

We would expect the biggest impacts of fishing to be observed at Crooked Pond, where at least 8 females nested in 2015 (U.S. Fish and Wildlife Service unpublished data). Crooked Pond is only 10 acres, and because nearly the entire pond is visible from much of the shoreline, human presence anywhere on the shoreline can impact basking turtles throughout the pond (S. Koch, personal communication 2016). Additionally, anglers would most likely be drawn to the sandy point and beach areas (totaling less than ½ acre), the only openings on the shoreline clear enough for casting fishing lines, and also the only suitable nesting areas for northern red-bellied cooters on Crooked Pond. Therefore, in addition to impacts to the shoreline habitat described above, any human presence during the spring, summer, and fall is also likely to cause a disruption to northern red-bellied cooters normal nesting, basking, and foraging behaviors. The turtles are doing as well as they are specifically due to the lack of human use of the shoreline. Additionally, an increase in human related trash, bait, or fish scents left on the shoreline by anglers (whether intentional or accidental) will attract more predators (such as coyote, skunks, and raccoons) which are already suppressing northern red-bellied cooter nest success at this site.

Opening refuge-controlled pond shorelines to fishing would increase the amount of law enforcement, outreach, maintenance, and biological monitoring needed to minimize disturbance to the northern red-bellied cooter and to monitor and remediate sensitive pond shoreline habitats. It is anticipated that litter (fishing line and gear, bait, and food and drink litter) would be left by anglers, and shoreline, erosion and vegetation damage would occur. This would result in a significant increase in the amount of time refuge staff spends at the refuge or working on this use, which would detract from other resource, habitat or visitor services management at the other refuges in the Refuge Complex.

PUBLIC REVIEW AND COMMENT:

As part of the comprehensive conservation planning (CCP) process for the Massasoit NWR, this compatibility determination will undergo a public comment period concurrent with the release of the draft Massasoit CCP/ Environmental Assessment.

DETERMINATION (CHECK ONE BELOW):

__X__ Use is not compatible

_____ Use is compatible with the following stipulations

JUSTIFICATION:

Although fishing is identified as a priority public use of the Refuge System and is therefore an appropriate use, fishing on the four refuge ponds is not compatible with the purpose for which Massasoit NWR was established, which is to protect threatened and endangered species. The shorelines of Island, Crooked, and

Gunners Exchange Ponds provide habitat for the federally listed northern red-bellied cooter. The fourth pond, Hoyt Pond, is not conducive to fishing due to its slope. The refuge lies within designated critical habitat for the northern red-bellied cooter. Due to the overlap in peak fishing times and northern red-bellied cooter nesting activity, we would expect direct disturbance to nesting red-bellied cooters if fishing were allowed. Along shorelines where northern red-bellied cooters bask, increased human presence would also cause additional direct disturbance to northern red-bellied cooters and likely would result in an increased predator presence due to bait and other food sources left on site. Allowing access to Crooked Pond would especially detract from the refuge's purpose because of 1) the high density of northern red-bellied cooters in the pond, 2) the pond's small size and near 100 percent visibility from most of the shoreline, 3) the overlap in timing of peak fishing and peak northern red-bellied cooter activity, and 4) the overlap in physical nesting habitat and human-accessible shoreline. Furthermore, this activity would require redirecting refuge law enforcement and biological staff, who are already overextended across the 8-refuge complex conducting mission critical work.

In summary, after consideration of the potential impacts on northern red-bellied cooters and their current and potential habitat, and that the refuge lies within their designated critical habitat and that the refuge lacks administrative means to ensure proper management of this use, we have determined that fishing is not compatible on Massasoit NWR because it would materially interfere with and detract from the refuge's purpose to conserve and protect threatened and endangered species.

SIGNATURE:

Refuge Manager: ______________________________ ______________________________
(Signature) (Date)

CONCURRENCE:

Regional Chief: ______________________________ ______________________________
(Signature) (Date)

MANDATORY 15 YEAR RE-EVALUATION DATE: ______________________________

LITERATURE CITED:

Knight, R. L., and D. N. Cole. 1995. Wildlife responses to recreationists. Pages 51-69 in R.L. Knight and D.N. Cole, editors. Wildlife and recreationists: coexistence through management and research. Washington, D.C., Island Press.

U.S. Fish and Wildlife Service. 1994. Plymouth Redbelly Turtle Recovery Plan. Second Edition. New England Field Office. Concord, NH. 42 pp.

____ unpublished reports. 2014 and 2015. Eastern Massachusetts National Wildlife Refuge files.

FWS Form 3-2319
02/06

FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Massasoit National Wildlife Refuge

Use: Bicycling

This form is not required for wildlife-dependent recreational uses, take regulated by the State, or uses already described in a refuge CCP or stepdown management plan approved after October 9, 1997.

Decision criteria:	YES	NO
(a) Do we have jurisdiction over the use?	✔	
(b) Does the use comply with applicable laws and regulations (Federal, State, Tribal, and local)?	✔	
(c) Is the use consistent with applicable Executive orders and Department and Service policies?	✔	
(d) Is the use consistent with public safety?	✔	
(e) Is the use consistent with goals and objectives in an approved management plan or other document?		✔
(f) Has an earlier documented analysis not denied the use or is this the first time the use has been proposed?	✔	
(g) Is the use manageable within available budget and staff?		✔
(h) Will this be manageable in the future within existing resources?		✔
(i) Does the use contribute to the public's understanding and appreciation of the refuge's natural or cultural resources, or is the use beneficial to the refuge's natural or cultural resources?		✔
(j) Can the use be accommodated without impairing existing wildlife-dependent recreational uses or reducing the potential to provide quality (see section 1.6D, 603 FW 1, for description), compatible, wildlife-dependent recreation into the future?		✔

Where we do not have jurisdiction over the use ("no" to (a)), there is no need to evaluate it further as we cannot control the use. Uses that are illegal, inconsistent with existing policy, or unsafe ("no" to (b), (c), or (d)) may not be found appropriate. If the answer is "no" to any of the other questions above, we will **generally** not allow the use.

If indicated, the refuge manager has consulted with State fish and wildlife agencies. Yes ✔ No_____

When the refuge manager finds the use appropriate based on sound professional judgment, the refuge manager must justify the use in writing on an attached sheet and obtain the refuge supervisor's concurrence.

Based on an overall assessment of these factors, my summary conclusion is that the proposed use is:

Not Appropriate ✔ **Appropriate** _______

Refuge Manager: ____ Date: ______________________

If found to be **Not Appropriate**, the refuge supervisor does not need to sign concurrence if the use is a new use.

If an existing use is found **Not Appropriate** outside the CCP process, the refuge supervisor must sign concurrence.

If found to be **Appropriate**, the refuge supervisor must sign concurrence:

Refuge Supervisor:____ Date:___________

A compatibility determination is required before the use may be allowed.

603 FW 1
Exhibit 1
Page 2

JUSTIFICATION FOR A FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Massasoit National Wildlife Refuge

Use: Bicycling

NARRATIVE:

The U.S. Fish and Wildlife Service (Service) policy on Appropriate Refuge Uses (603 FW 1) states that: "General public uses that are not wildlife-dependent recreational uses (as defined by the National Wildlife Refuge System (Refuge System) Improvement Act (Improvement Act) of 1997) and do not contribute to the fulfillment of refuge purposes or goals or objectives as described in current refuge management plans are the lowest priorities for refuge managers to consider. These uses are likely to divert refuge management resources from priority general public uses or away from our responsibilities to protect and manage fish, wildlife, and plants, and their habitats. Therefore, both law and policy have a general presumption against allowing such uses within the Refuge System."

To comply with the policy on appropriateness, we are evaluating several non-priority public uses for Massasoit NWR suggested during the public scoping process. Bicycling is not a priority public use of the Refuge System. Bicycling will not be allowed on the 1.1-mile trail or anywhere else on the refuge.

The most critical piece of this analysis was the consideration of the potential impact bicycles would present to turtles moving from Crooked Pond across the trail into the uplands. Refuge staff has observed the impact bicycles have had on reptiles and amphibians at other refuges within the Eastern Massachusetts National Wildlife Refuge Complex on similar types of trails. Each year, staff observation and/or visitor reports have documented that bicycles have run over hatchlings, frogs and/or salamanders. Given that the trail route is in such close proximity to Crooked Pond, and the refuge was established for the protection of the Federally-endangered northern red-bellied cooter, allowing this use would be in direct conflict with the refuge purpose.

Further, bicycling may degrade the trail and cause erosion, and create safety hazards for other visitors. Foot travel will be allowed on established 1.1-mile fireline which will be managed as a nature trail so that visitors may experience five of the priority (wildlife-dependent) public uses, including wildlife observation, photography, interpretation, environmental education, and hunting. Bicycling is not required to experience any of these wildlife-dependent uses. Bicyclists have been demonstrated to ride off-trail in unauthorized areas in other conservation areas, and have trespassed on the Massasoit NWR. The presence of old roads and firebreaks on the Massasoit NWR would provide opportunities for bicyclists that chose to ignore or be ignorant of refuge restrictions to access parts of the refuge that are environmentally sensitive, and where more than the occasional trespass would have serious resource protection ramifications.

Given Service policies, current conditions, required maintenance, and demand, we conclude that bicycling is not an appropriate use for Massasoit NWR. Prohibiting bicycling will prevent erosion and soil compaction that might occur on the trail from bicycles and the frequency and extent of wildlife disturbance caused by cyclists. Biking is not a wildlife-dependent public use, nor is it necessary to support any other appropriate priority public use, and it may decrease the enjoyment of the refuge by other visitors. There are also many other sites throughout the surrounding area that provide bicycling opportunities.

FWS Form 3-2319
02/06

FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Massasoit National Wildlife Refuge

Use: Horseback Riding

This form is not required for wildlife-dependent recreational uses, take regulated by the State, or uses already described in a refuge CCP or stepdown management plan approved after October 9, 1997.

Decision criteria:	**YES**	**NO**
(a) Do we have jurisdiction over the use?	✔	
(b) Does the use comply with applicable laws and regulations (Federal, State, Tribal, and local)?	✔	
(c) Is the use consistent with applicable Executive orders and Department and Service policies?	✔	
(d) Is the use consistent with public safety?	✔	
(e) Is the use consistent with goals and objectives in an approved management plan or other document?		✔
(f) Has an earlier documented analysis not denied the use or is this the first time the use has been proposed?	✔	
(g) Is the use manageable within available budget and staff?		✔
(h) Will this be manageable in the future within existing resources?		✔
(i) Does the use contribute to the public's understanding and appreciation of the refuge's natural or cultural resources, or is the use beneficial to the refuge's natural or cultural resources?		✔
(j) Can the use be accommodated without impairing existing wildlife-dependent recreational uses or reducing the potential to provide quality (see section 1.6D, 603 FW 1, for description), compatible, wildlife-dependent recreation into the future?		✔

Where we do not have jurisdiction over the use ("no" to (a)), there is no need to evaluate it further as we cannot control the use. Uses that are illegal, inconsistent with existing policy, or unsafe ("no" to (b), (c), or (d)) may not be found appropriate. If the answer is "no" to any of the other questions above, we will **generally** not allow the use.

If indicated, the refuge manager has consulted with State fish and wildlife agencies. Yes ✔ No_____

When the refuge manager finds the use appropriate based on sound professional judgment, the refuge manager must justify the use in writing on an attached sheet and obtain the refuge supervisor's concurrence.

Based on an overall assessment of these factors, my summary conclusion is that the proposed use is:

Not Appropriate ✔ **Appropriate** _____

Refuge Manager: ________________________________ Date: __________________

If found to be **Not Appropriate**, the refuge supervisor does not need to sign concurrence if the use is a new use.

If an existing use is found **Not Appropriate** outside the CCP process, the refuge supervisor must sign concurrence.

If found to be **Appropriate**, the refuge supervisor must sign concurrence:

Refuge Supervisor:__________________________________ Date:________

A compatibility determination is required before the use may be allowed.

603 FW 1
Exhibit 1
Page 2

JUSTIFICATION FOR A FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Massasoit National Wildlife Refuge

Use: Horseback Riding

NARRATIVE:

The Service policy on Appropriate Refuge Uses (603 FW 1) states that: "General public uses that are not wildlife-dependent recreational uses (as defined by the Improvement Act) and do not contribute to the fulfillment of refuge purposes or goals or objectives as described in current refuge management plans are the lowest priorities for refuge managers to consider. These uses are likely to divert refuge management resources from priority general public uses or away from our responsibilities to protect and manage fish, wildlife, and plants, and their habitats. Therefore, both law and policy have a general presumption against allowing such uses within the Refuge System."

To comply with the 2006 U.S. Fish and Wildlife Service policy on appropriateness, we are evaluating several non-priority public uses for Massasoit National Wildlife Refuge (NWR) suggested during the public scoping process. Horseback riding is not identified as a priority public use of the National Wildlife Refuge System under the National Wildlife Refuge System Administration Act of 1966 (16 U.S.C. 668dd-668ee), as amended by the National Wildlife Refuge System Improvement Act of 1997 (NWRSIA).

Horseback riding may degrade the trails and cause further erosion. Foot travel will be allowed on a 1.1-mile nature trail so that visitors may experience five of the priority (wildlife-dependent) public uses, including wildlife observation, photography, interpretation and environmental education, and hunting. Horseback riding is not required to experience any of these wildlife-dependent uses. Furthermore, portions of the trails are sloped and rocky. Horseback riding may degrade the trail, causing further erosion on areas of the trail, or create safety hazards for other visitors. Horses may also leave manure along the trail, degrading the enjoyment of the refuge by other visitors.

Additionally, horse manure may contain viable seeds from invasive plants (Wells and Lauenroth 2007), which may be a management problem for the refuge. Trail maintenance is another issue. Massasoit NWR is an unstaffed refuge and will likely remain unstaffed for the near future. The trail will be monitored and maintained occasionally when refuge staff are available and at the refuge for other assignments. Any additional damage to trails would potentially divert limited refuge staff resources to address a non-priority public use.

Given the refuge purpose, Service policies, current conditions, aesthetic and ecological implications, required maintenance, and demand, we conclude that horseback riding is not an appropriate activity for Massasoit NWR. While we have observed illegal use of the refuge by horseback riders, and it was brought up at the public scoping meeting, allowing this activity could impact the trail conditions, introduce non-native species, and pose a threat to trampling of wildlife and native vegetation. Prohibiting horseback riding may positively impact soils and wildlife; if only by reducing the amount of erosion and soil compaction that might occur on the trail, the frequency and extent of wildlife disturbance, and disallowing a potential vector of invasive plants. Horseback riding is not a wildlife dependent public use, nor is it necessary to support any priority, wildlife-dependent public use, and may decrease the enjoyment of the refuge for other visitors.

LITERATURE CITED

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FWS Form 3-2319
02/06

FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Massasoit National Wildlife Refuge

Use: Pets

This form is not required for wildlife-dependent recreational uses, take regulated by the State, or uses already described in a refuge CCP or stepdown management plan approved after October 9, 1997.

Decision criteria:	**YES**	**NO**
(a) Do we have jurisdiction over the use?	✔	
(b) Does the use comply with applicable laws and regulations (Federal, State, Tribal, and local)?	✔	
(c) Is the use consistent with applicable Executive orders and Department and Service policies?	✔	
(d) Is the use consistent with public safety?	✔	
(e) Is the use consistent with goals and objectives in an approved management plan or other document?		✔
(f) Has an earlier documented analysis not denied the use or is this the first time the use has been proposed?	✔	
(g) Is the use manageable within available budget and staff?		✔
(h) Will this be manageable in the future within existing resources?		✔
(i) Does the use contribute to the public's understanding and appreciation of the refuge's natural or cultural resources, or is the use beneficial to the refuge's natural or cultural resources?		✔
(j) Can the use be accommodated without impairing existing wildlife-dependent recreational uses or reducing the potential to provide quality (see section 1.6D, 603 FW 1, for description), compatible, wildlife-dependent recreation into the future?		✔

Where we do not have jurisdiction over the use ("no" to (a)), there is no need to evaluate it further as we cannot control the use. Uses that are illegal, inconsistent with existing policy, or unsafe ("no" to (b), (c), or (d)) may not be found appropriate. If the answer is "no" to any of the other questions above, we will **generally** not allow the use.

If indicated, the refuge manager has consulted with State fish and wildlife agencies. Yes ✔ No_____

When the refuge manager finds the use appropriate based on sound professional judgment, the refuge manager must justify the use in writing on an attached sheet and obtain the refuge supervisor's concurrence.

Based on an overall assessment of these factors, my summary conclusion is that the proposed use is:

Not Appropriate ✔ **Appropriate** _____

Refuge Manager: __________________________________ Date: ____________________

If found to be **Not Appropriate**, the refuge supervisor does not need to sign concurrence if the use is a new use.

If an existing use is found **Not Appropriate** outside the CCP process, the refuge supervisor must sign concurrence.

If found to be **Appropriate**, the refuge supervisor must sign concurrence:

Refuge Supervisor:__________________________________ Date:____________

A compatibility determination is required before the use may be allowed.

603 FW 1
Exhibit 1
Page 2

JUSTIFICATION FOR A FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Massasoit National Wildlife Refuge

Use: Pets

NARRATIVE:

The U.S. Fish and Wildlife Service (Service) policy on Appropriate Refuge Uses (603 FW 1) states that: "General public uses that are not wildlife-dependent recreational uses (as defined by the National Wildlife Refuge System (Refuge System) Improvement Act (Improvement Act) of 1997) and do not contribute to the fulfillment of refuge purposes or goals or objectives as described in current refuge management plans are the lowest priorities for refuge managers to consider. These uses are likely to divert refuge management resources from priority general public uses or away from our responsibilities to protect and manage fish, wildlife, and plants, and their habitats. Therefore, both law and policy have a general presumption against allowing such uses within the Refuge System."

Since the refuge has never been open to visitation, this is not considered a pre-existing use. We do, however, recognize that there has been illegal trespass by the public, some of whom had their dogs on- and off-leash. Disturbance to wildlife and habitat in conjunction with the failure by pet owners to comply with refuge regulations is part of the justification for disallowing pet walking on the refuge. Refuge staff have witnessed at other locations where dogs are allowed on-leash, that dog owners repeatedly violate leash requirements and let dogs run off-leash. Dogs and other pets both on and off-leash can have a significant impact on wildlife. Jones and Stokes (1977) demonstrated that domesticated dogs can have serious detrimental impacts on local concentrated nesting bird populations. Studies have demonstrated that dogs can, and do, flush incubating birds from nests with possible serious consequences to declining bird populations (Yalden and Yalden 1990, Soluri 1994, Gill 1994). Further, the presence of domesticated dogs can disrupt breeding displays (Baydack 1986) and disturb roosting activity in ducks (Keller 1991). Other studies have shown that even when dogs are restrained on leash, they can displace native migratory bird species from natural habitats and cause a drop in diversity of local bird fauna (Banks and Bryan 2007). Dog waste is unsightly for refuge visitors, and it can transmit diseases that may threaten the health of some wildlife and other domestic animals. Domestic dogs can introduce various diseases (distemper; parvovirus, and rabies) and transport parasites into wildlife habitats (Sime 1999). Additionally, not all refuge visitors are pet-friendly, and unrestrained dogs can disturb other refuge visitors. Lastly, dogs off-leash in sensitive turtle nesting areas could be detrimental to the productivity of nesting northern red-bellied cooters. Even though these areas are closed to the public, unauthorized trespass by dog owners in the past has occurred at Massasoit NWR, including in sensitive areas, and we anticipate continued unauthorized trespass would not only occur but increase if dogs were allowed on the refuge, as some dog owners would want their dogs to be able to swim in refuge ponds.

The town of Plymouth and MSSF have miles of trails where the public can take their dog to participate in outdoor recreation, allowing pet recreationists to disperse over a greater area. This dispersion decreases the likelihood that an individual pet will disrupt wildlife or have a negative interaction with wildlife-dependent recreationists. Additionally, being an unstaffed refuge, we do not have the resources to monitor this use regularly or to provide receptacles for animal waste, which if left along the refuge's single small trail, diminishes the quality of other visitor's wildlife recreational experience. To ensure the protection of wildlife and habitat, to provide quality wildlife-dependent recreation opportunities, and to support the refuge's establishing purpose in protecting the northern red-bellied cooter, the manager has determined the presence of pets to be not appropriate on Massasoit NWR.

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FWS Form 3-2319
02/06

FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Massasoit National Wildlife Refuge

Use: Sunbathing and Swimming

This form is not required for wildlife-dependent recreational uses, take regulated by the State, or uses already described in a refuge CCP or stepdown management plan approved after October 9, 1997.

Decision criteria:	**YES**	**NO**
(a) Do we have jurisdiction over the use?	✔	
(b) Does the use comply with applicable laws and regulations (Federal, State, Tribal, and local)?	✔	
(c) Is the use consistent with applicable Executive orders and Department and Service policies?	✔	
(d) Is the use consistent with public safety?		✔
(e) Is the use consistent with goals and objectives in an approved management plan or other document?		✔
(f) Has an earlier documented analysis not denied the use or is this the first time the use has been proposed?	✔	
(g) Is the use manageable within available budget and staff?		✔
(h) Will this be manageable in the future within existing resources?		✔
(i) Does the use contribute to the public's understanding and appreciation of the refuge's natural or cultural resources, or is the use beneficial to the refuge's natural or cultural resources?		✔
(j) Can the use be accommodated without impairing existing wildlife-dependent recreational uses or reducing the potential to provide quality (see section 1.6D, 603 FW 1, for description), compatible, wildlife-dependent recreation into the future?		✔

Where we do not have jurisdiction over the use ("no" to (a)), there is no need to evaluate it further as we cannot control the use. Uses that are illegal, inconsistent with existing policy, or unsafe ("no" to (b), (c), or (d)) may not be found appropriate. If the answer is "no" to any of the other questions above, we will **generally** not allow the use.

If indicated, the refuge manager has consulted with State fish and wildlife agencies. Yes ✔ No_____

When the refuge manager finds the use appropriate based on sound professional judgment, the refuge manager must justify the use in writing on an attached sheet and obtain the refuge supervisor's concurrence.

Based on an overall assessment of these factors, my summary conclusion is that the proposed use is:

Not Appropriate ✔ **Appropriate** _____

Refuge Manager: ______________________________ Date: ____________________

If found to be **Not Appropriate**, the refuge supervisor does not need to sign concurrence if the use is a new use.

If an existing use is found **Not Appropriate** outside the CCP process, the refuge supervisor must sign concurrence.

If found to be **Appropriate**, the refuge supervisor must sign concurrence:

Refuge Supervisor:________________________________ Date:__________

A compatibility determination is required before the use may be allowed.

603 FW 1
Exhibit 1
Page 2

JUSTIFICATION FOR A FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Massasoit National Wildlife Refuge

Use: Sunbathing and Swimming

NARRATIVE:

U.S. Fish and Wildlife Service policy does not specifically encourage sunbathing and swimming. Massasoit NWR has never been open for this use and it is not considered to be a secondary use that would support priority wildlife-dependent uses at the refuge. The only areas where swimming and sunbathing could take place on the refuge are at the coastal ponds which are closed to all public access in order to protect the northern red-bellied cooter. These uses would have adverse impacts on refuge wildlife and habitat and encourage visitation to areas that were established specifically for species protection. Crooked Pond and the refuge-owned shoreline sections of Hoyt, Gunners Exchange and Island Ponds will remain closed to all public recreational use including sunbathing and swimming. In the Plymouth area, there are multiple places the public can visit that allow for these uses in a more appropriate, already established location.

Appendix C


Bill Thompson

Eastern wood peewee

Wilderness Review

- **Introduction**
- **Inventory Criteria**
- **Wilderness Inventory Conclusions**
- **Conclusion**

Introduction

The purpose of a wilderness review is to identify and recommend to Congress the lands and waters of the National Wildlife Refuge System that merit inclusion in the National Wilderness Preservation System (NWPS). Wilderness reviews are required elements of Comprehensive Conservation Plans, are conducted in accordance with the refuge planning process outlined in the Fish and Wildlife Service Manual (602 FW 1 and 3), and include compliance with the National Environmental Policy Act (NEPA) and regulations on public involvement. Wilderness Study Areas (WSAs) are areas that meet the criteria for wilderness identified in the Wilderness Act. Section 2(c) of the act gives the following definition:

> *A wilderness, in contrast with those areas where man and his works dominate the landscape, is hereby recognized as an area where the earth and its community of life are untrammeled by man, where man himself is a visitor who does not remain. An area of wilderness is further defined to mean in this Act an area of undeveloped Federal land retaining its primeval character and influence, without permanent improvements or human habitation, which is protected and managed so as to preserve its natural conditions, and which (1) generally appears to have been affected primarily by the forces of nature, with the imprint of man's work substantially unnoticeable; (2) has outstanding opportunities for solitude or a primitive and unconfined type of recreation; (3) has at least 5,000 acres of land or is of sufficient size as to make practicable its preservation and use in an unimpaired condition; and (4) may also contain ecological, geological or other features of scientific, educational, scenic, or historical value.*

The wilderness review process has three phases: inventory, study, and recommendation. In the inventory phase, we identify lands and waters that meet the minimum criteria for wilderness as Wilderness Study Areas. In the study phase, we evaluate a range of management alternatives to determine whether a Wilderness Study Area is suitable for wilderness designation or management under an alternative set of goals and objectives not involving wilderness designation. In the recommendation phase, we forward a wilderness study report with recommendations on wilderness designation from the Director through the Secretary and the President to Congress. We prepare that report after our Regional Director has signed the record of decision for the final Comprehensive Conservation Plan.

We manage any areas recommended for designation to maintain their wilderness character in accordance with the management goals, objectives, and strategies in the final Comprehensive Conservation Plan, until Congress makes a decision or we amend the Comprehensive Conservation Plan to modify or remove the wilderness proposal. If the inventory does not identify any areas that meet the Wilderness Study Area criteria, we document our findings in the administrative record for the Comprehensive Conservation Plan and end the study process. We will manage non-wilderness areas following the management direction outlined in the Comprehensive Conservation Plan.

Inventory Criteria

The wilderness inventory is a broad look at the planning area to identify Wilderness Study Areas. A Wilderness Study Area is a roadless area of undeveloped Federal land and water that meets the minimum criteria for wilderness as identified in Section2(c) of the Wilderness Act.

Minimum Wilderness Criteria

A Wilderness Study Area is required to be a roadless area or an island of any size, meet the size criteria, appear natural, and provide outstanding opportunity for solitude or primitive and unconfined recreation.

Evaluation of Roadless Criteria

Roadless refers to the absence of improved roads suitable and maintained for public travel by means of motorized vehicles primarily intended for highway use. A route maintained solely by the passage of vehicles does not constitute a road.

The following factors were the primary considerations in evaluating the roadless criteria:

A. The area does not contain improved roads suitable and maintained for public travel by means of motorized vehicles primarily intended for highway use.

B. The area is an island, or contains an island that does not have improved roads suitable and maintained for public travel by means of motorized vehicles primarily intended for highway use.

C. The area is in Federal fee title ownership.

Evaluation of Size Criteria
The size criteria can be satisfied if an area has at least 5,000 acres of contiguous, roadless, public (Federal) land, or is sufficiently large that its preservation and use in an unimpaired condition is practicable.

The following factors were the primary considerations in evaluating the size criteria.

A. An area of more than 5,000 contiguous acres. State and private lands are not included in making this acreage determination.

B. A roadless island of any size. A roadless island is defined as an area surrounded by permanent waters or that is markedly distinguished from the surrounding lands by topographical or ecological features.

C. An area of less than 5,000 contiguous Federal acres that is of sufficient size as to make practicable its preservation and use in an unimpaired condition, and of a size suitable for wilderness management.

D. An area of less than 5,000 contiguous acres that is contiguous with a designated wilderness, recommended wilderness, or area under wilderness review by another Federal wilderness managing agency such as the Forest Service, National Park Service, or Bureau of Land Management.

Evaluation of Naturalness Criteria
The Wilderness Act, section 2(c) defines wilderness as an area that “generally appears to have been affected primarily by the forces of nature with the imprint of human work substantially unnoticeable.” The area must appear natural to the average visitor, rather than “pristine.” The presence of historic landscape conditions is not required.

An area may include some human impacts provided they are substantially unnoticeable in the unit as a whole. In evaluating the naturalness criteria, we also consider significant hazards caused by humans, such as the presence of unexploded ordinance from military activity and the physical impacts of refuge management facilities and activities. An area may not be considered unnatural in appearance solely on the basis of the sights and sounds of human impacts and activities outside the boundary of the unit. We considered the cumulative effects of those factors, in conjunction with the size of the land base and its physiographic and vegetative characteristics in our evaluation of naturalness.

The following factors were the primary considerations in evaluating naturalness.

A. The area appears to have been affected primarily by the forces of nature with the imprint of human work substantially unnoticeable.

B. The area may include some human impacts provided they are substantially unnoticeable in the unit as a whole.

C. The presence of unexploded ordnance from military activity or the existence of other significant hazards caused by humans.

D. The presence of physical impacts of refuge management facilities and activities.

Evaluation of Solitude or Primitive and Unconfined Recreation Criteria
A Wilderness Study Area must provide outstanding opportunities for solitude or primitive and unconfined recreation. The area does not have to possess outstanding opportunities for both elements, and does not need to have outstanding opportunities on every acre. Further, an area does not have to be open to public use and access to qualify under this criteria; Congress has designated a number of wilderness areas in the Refuge System that are closed to public access to protect resource values.

Opportunities for solitude refer to the ability of a visitor to be alone and secluded from other visitors in the area. Primitive and unconfined recreation means non-motorized, dispersed outdoor recreation activities that are compatible and do not require developed facilities or mechanical transport. These primitive recreation activities may provide opportunities to experience challenge and risk, self-reliance, and adventure. These two elements are not well defined by the Wilderness Act, but can be expected to occur together in most cases. However, an outstanding opportunity for solitude may be present in an area offering only limited primitive recreation potential. Conversely, an area may be so attractive for recreation use that experiencing solitude is not an option.

The following factors were the primary considerations in evaluating outstanding opportunities for solitude, or primitive unconfined recreation.

A. The area offers the opportunity to avoid the sights, sounds, and evidence of other people. A visitor to the area should be able to feel alone or isolated.

B. The area offers non-motorized, dispersed outdoor recreation activities that are compatible and do not require developed facilities or mechanical transport.

Evaluation of Supplemental Values Criteria

The Wilderness Act states that an area of wilderness may contain ecological, geological, or other features of scientific, educational, scenic, or historical value. Supplemental values of the area are optional, but the degree to which their presence enhances the area's suitability for wilderness designation should be considered. The evaluation should be based on an assessment of the estimated abundance or importance of each of the features.

Wilderness Inventory Conclusions

Evaluation of Roadless Criteria

Each parcel of the refuge is either bisected or bordered by a major paved road used for public travel by motorized vehicles. The Island Pond parcel is bisected by paved roads and is bordered by Long Pond Road. The Crooked Pond parcel has a road that bisects the northwestern corner of the parcel and is abutted by roads and development that lead up to the conserved land.

Evaluation of Size Criteria

This 209-acre refuge does not meet the minimum size criteria of greater than 5000 acres for a Wilderness Study Area.

Evaluation of Naturalness Criteria

Due to its past agricultural use and its current management of habitat for northern red-bellied cooters, migratory songbirds, hazardous fuel reduction, and other early successional species habitat using mechanical vegetation removal and prescribed burns, this refuge does not meet the Naturalness criterion. There is evidence of heavy equipment and human induced fires.

Evaluation of Solitude or Primitive and Unconfined Recreation Criteria

The refuge parcels are small in size. The large Myles Standish State Forest, that abuts the refuge is open for public access and attracts many visitors. Due to its proximity to development and to the heavily used State Forest, the refuge does not meet the solitude or primitive and unconfined recreation criteria for a Wilderness Study Area.

Evaluation of Supplemental Values Criteria

The refuge does contain features that are of ecological value and interest for research and education. The refuge is managed for the federally endangered northern red-bellied cooter. It is also currently managed for pitch pine-oak upland forest habitat conducive to several rare plants and invertebrates dependent on xeric pitch pine-scrub oak shrubland association (sandplain heathland community) habitat. Therefore, the refuge does meet the supplemental values criteria for a Wilderness Study Area.

Conclusion

No Massasoit NWR parcels meet the criteria for a Wilderness Study Area and the refuge is not recommended for further evaluation. While the refuge meets the supplemental value criteria, it does not meet the minimum requirements for wilderness in regard to size, roadlessness, naturalness, or outstanding opportunity for solitude or primitive and unconfined recreation.

Table C-1. Massasoit NWR Wilderness Review Finding Summary

Refuge unit and acreage (fee simple only)	(1) has at least 5,000 acres of land or is of sufficient size to make practicable its preservation and use in an unconfined condition, or is a roadless island;	(2) generally appears to have been affected primarily by the forces of nature, with the imprint of man's work substantially unnoticeable;	(3a) has outstanding opportunities for solitude;	(3b) has outstanding opportunities for a primitive and unconfined type of recreation;	(4) contains ecological, geological, or other features of scientific, educational, scenic, or historical value.	Parcel qualifies as a wilderness study area (meets criteria 1, 2, and 3a or 3b)
Massasoit NWR 209 acres	No. The refuge is 209 acres, located in the densely populated town of Plymouth, Massachusetts in Plymouth County, Massachusetts.	No. The refuge has a previous land use of agriculture. The refuge is managed with mechanical vegetation removal and prescribed burns.	No. The refuge parcels are small in size. The large forest that abuts the refuge is open for public access and attracts many visitors. Public access is limited due to the protection of the endangered red-bellied cooter.	No. The small size of the refuge precludes outstanding opportunities for unconfined or primitive recreation.	Yes. The refuge and its surrounding area is designated habitat for the endangered Northern red bellied cooter. The refuge is currently managed for habitat conducive to the candidate species, New England cottontail, and rare invertebrates.	No.

Appendix D


USFWS

Controlled burn at Massasoit National Wildlife Refuge

Fire Management Program Guidance

- **Introduction**
- **The Role of Fire**
- **Wildland Fire and Management Policy and Guidance**
- **Management Direction**
- **Fire Management Goals**
- **Fire Management Objectives**
- **Strategies**
- **Fire Management Organization, Contracts, and Cooperation**

Introduction

The mission of the National Wildlife Refuge System (Refuge System) is "to administer a national network of lands and waters for the conservation, management, and where appropriate, restoration of the fish, wildlife, and plant resources and their habitats within the United States for the benefit of present and future generations of Americans" as stated in the National Wildlife Refuge Improvement Act (October 9, 1997)

The Role of Fire

Historically, natural fire and ignitions by Native American people played an important disturbance role in many ecosystems by removing fuel accumulations, decreasing the impacts of insects and diseases, stimulating regeneration, cycling nutrients, and providing a diversity of habitats for plants and wildlife.

In the heavily fragmented and manipulated areas of the northeastern U.S., that role of fire has been modified significantly. However, when fire is used properly it can:

- Reduce hazardous fuels build-up in both wildland urban interface and in non-wildlife urban interface areas.
- Improve wildlife habitats by reducing the density of vegetation, and/or changing plant species composition.
- Sustain and increase biodiversity.
- Improve open woodlands and shrub lands by reducing plant density.
- Reduce the susceptibility of plants to insect and disease outbreaks.
- Assist in the control of invasive and noxious species

Wildland Fire and Management Policy and Guidance

In 2001, the Secretaries of the Departments of Interior and Agriculture approved an update of the 1995 "Federal Fire Policy." The 2001 "Federal Wildland Fire Management Policy" directs Federal agencies to achieve a balance between fire suppression to protect life, property and resources, and fire use to regulate fuels and maintain healthy ecosystems. It also directs agencies to provide a management response to all wildfires, commensurate with values at risk, safety, and costs for suppression.

This policy provides nine guiding principles that are fundamental to the success of the fire management program. Firefighter and public safety is the first priority in every fire management activity. The role of wildland fires as an ecological process and natural change agent will be incorporated into the planning process.

Fire management plans (FMPs), programs, and activities support land and resource management plans and their implementation. Sound risk management is the foundation for all fire management activities. Fire management programs and activities are economically viable, on the basis of values to be protected, costs, and land and resource management objectives. Fire activities, including FMPs, are based on the best available science and incorporate public health and environmental quality considerations. Federal, state, Tribal, local, interagency and international coordination and cooperation are essential. Standardization of policies and procedures among Federal agencies is an ongoing objective.

The fire management considerations, guidance, and direction should be addressed in the land use resource management plans, such as comprehensive conservation plans (CCP). The FMP is a stepdown plan derived from the land use plans and habitat plans, with more detail on fire suppression, prescribed fire and fuels management activities.

Management Direction

Massasoit National Wildlife Refuge (Massasoit NWR) was established in 1983 "to conserve the federally endangered Northern red-bellied cooter, as well as other wildlife and plant species." Comprised of 209 acres, this refuge is in Plymouth, Massachusetts. It is made up of three parcels: the Crooked Pond parcel which abuts the Myles Standish State Forest, Massachusetts' second largest State forest; and two smaller parcels with frontages on Island Pond, Gunners Exchange Pond, and Hoyt Pond (map 1-1). Massasoit NWR is located within an area designated as critical habitat for the northern red-bellied cooter. The refuge also provides habitat for other wildlife and plant species including rare moths and other native pollinators, migratory songbirds, and small mammals. Massasoit NWR is one of eight refuges that comprise the Eastern Massachusetts National Wildlife Refuge Complex (Refuge Complex), headquartered in Sudbury, Massachusetts. The most recent wildfire near the refuge was in 1995 when 95 acres burned and 100 homes were threatened (Crosby 2001, updated 2007). There have been ongoing hazard fuel reduction and resource management activities involving the use of prescribed fire.

Prescribed fire will be used as a future management tool to promote and accomplish the goals set forward in the CCP:

- Protect and enhance U.S. Fish and Wildlife Service (Service) trust resources and species and habitats of special concern.
- Maintain a healthy and diverse complex of natural community types comprised of native plants and animals to pass on to future generations of Americans.
- Conduct effective outreach activities to promote quality onsite and offsite wildlife-dependent public use programs to raise public awareness of the Refuge and the Refuge System, and to promote enjoyment and stewardship of natural resources in eastern Massachusetts.
- To work collaboratively with other refuge land management partners when protecting or enhancing landscapes from wildfire or applying fire (prescribed).

All aspects of the fire management program will be conducted in a manner consistent with applicable laws, policies, and regulations. Massasoit NWR will maintain a FMP to accomplish the fire management goals that follow (see Fire Management Goals). Any future prescribed fire, chemical, manual, and mechanical fuel treatments will be applied in a scientific way, under selected weather and environmental conditions.

Fire Management Goals

The goals and strategies of the Refuge System Wildland Fire Management Program Strategic Plan are consistent with Department of THE Interior and the USFS policies, National Fire Plan direction, the President's Healthy Forest Initiative, the 10-year Comprehensive Strategy and Implementation Plan, National Wildfire Coordinating Group Guidelines, initiatives of the Wildland Fire Leadership Council, and Interagency Standards for Fire and Aviation operations.

The current fire management goals for the refuge are to use prescribed fire to protect Service lands and wildlife from wildfire and to use prescribed fire as a tool to maintain a fire adapted ecosystem and meet the habitat goals and objectives identified in this CCP.

Fire Management Objectives

The purpose of the fire management program is to use prescribed fire, chemical, manual, and mechanical treatment to: Ensure public and firefighter safety while protecting property and natural resource values from wildfire.

- Reduce the wildfire impacts to all resource management activities. Reduce the threats associated with accumulations of hazardous fuel loads in upland habitats.
- Provide, enhance, and protect habitats for State and Federal endangered, threatened, and candidate species and species of special concern.
- Provide, maintain, enhance, and protect feeding, resting, nesting, and brood habitat that meet the requirements of migratory waterfowl, other migratory birds, and resident wildlife.
- Maintain health and vigor of the fire adapted pitch pine-scrub oak shrubland (sandplain heathland community), pitch pine-oak woodland/forest associations.

- Facilitate the control of invasive and exotic species.
- Increase habitat diversity in refuge upland habitats.
- Demonstrate and educate the public about the role and benefits of wildfire protection and prescribed fire use in resource management.
- Maintain ecosystem diversity within a landscape context.
- Comply with State Air Quality Implementation Plans and regulations to protect public health and the environment.

Strategies

Massasoit NWR will use strategies and tactics that consider public and firefighter safety, as well as resource values at risk. Wildfire suppression, prescribed fire, chemical, manual, and mechanical treatment methods, along with timing, and monitoring are described in more detail within the stepdown FMP.

Prescribed fire plans will be developed for specific sites, following the interagency Prescribed Fire Planning and Implementation Procedures Reference Guide (2013) template. Prescribed fire has the potential to reduce air quality by diminishing visibility and releasing pollutant particles during the combustion process. The refuge will meet the Clean Air Act emission standards by adhering to the Massachusetts air quality requirements during all prescribed fire activities.

Fire Management Organization, Contracts, and Cooperation

Fire management technical oversight for the refuge has been established in Region 5 of the Service, using the fire management zone approach. Under this approach, fire management staffing is determined by established modeling systems based on the past fire management workload of a group of refuges, and possibly interagency partners. The fire management workload consists of historical wildfire suppression activities, as well as past hazard fuels treatments. Massasoit NWR is managed as part of the Service's New England fire management zone, which supports the six New England states. The fire management staff and support equipment are located at Rhode Island and Eastern Massachusetts National Wildlife Refuge Complexes and Acadia National Park, and are shared among all refuge/park units under the direction of the National Park Service's North Country Zone Fire Management Officer. All fire management activities are conducted in a coordinated and collaborative manner between the Refuge and other Federal and non-Federal partners. The fire management zone has also developed a close working relationship with Massachusetts Department of Conservation and Recreation and Massachusetts Division of Fisheries and Wildlife. A new Interagency Spatial Fire Management Plan is currently being developed covering all the refuges within the Refuge Complex. A target date for completion is the end of fiscal year 2017.

References Cited:

Crosby, B.W. 2003. Images of America. Cape Cod Firefighting.

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73 Weir Hill Road
Sudbury, Massachusetts 01776
phone: 978/443-4661
http://www.fws.gov/refuge/massasoit/

Federal Relay Service
for the Deaf or Hard of Hearing
Phone: 1 800/877 8339

U.S. Fish and Wildlife Service
http://www.fws.gov

For Refuge Information
1 800/344 WILD

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